Chapter 1
Introduction: An Evolutionary History of Biosemiotics

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Abstract[1] The present chapter is intended to provide an introductory overview to the history of biosemiotics, contextualizing that history within and against the larger currents of philosophical and scientific thinking from which it has emerged. Accordingly, to explain the origins of this most 21st century endeavour requires effectively tracing – at least to the level of a thumbnail sketch – how the "sign" concept appeared, was lost, and now must be painstakingly rediscovered and refined in science. In the course of recounting this history, this chapter also introduces much of the conceptual theory underlying the project of biosemiotics, and is therefore intended to serve also as a kind of primer to the readings that appear in the rest of the volume. With this purpose in mind, the chapter consists of the successive examination of: (1) the history of the sign concept in pre-modernist science, (2) the history of the sign concept in modernist science, and (3) the biosemiotic attempt to develop a more useful sign concept for contemporary science. The newcomer to biosemiotics is encouraged to read through this chapter (though lengthy and of necessity still incomplete) before proceeding to the rest of the volume. For only by doing so will the disparate selections appearing herein reveal their common unity of purpose, and only within this larger historical context can the contemporary attempt to develop a naturalistic understanding of sign relations be properly evaluated and understood.

[1] Pages 1–20 of this chapter originally appeared as *The Biosemiotic Turn, Part I* in the journal *Biosemiotics* (Favareau 2008). The remaining pages appeared as *The Evolutionary History of Biosemiotics* in the volume *Introduction to Biosemiotics: The New Biological Synthesis* (Favareau 2007, in Barbieri, ed.). In keeping with the anthology nature of this volume, I have refrained from substantially changing the original text, though some citations have been updated to reflect the more recent work done by the scholars discussed herein. Accordingly, the bibliographic information for all works published after 2006 appear in the *Bibliography and Further Readings* at the back of this volume, rather than in the References list at the end of the chapter.

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Introduction

When considered together, the following two commonplace observations present an intransigent paradox for contemporary science:

(1) Biological being is a form of physical organization that has evolved in nature.
(2) A sign is something that stands for something other than itself.

In the physical world of nature, science tells us, things are just what they are: atoms do not "stand for" other atoms, and the revolution of the earth around the sun does not mark a new day or night for either of them. With the advent of biological forms of physical organization, however, all of this changes: atoms in their physical configuration as 'odorant' molecules do "stand for" the presence of nearby food or potential danger, and the last thing that the reader of these words is currently considering them as, is precisely what they really are in themselves: utterly inert and intrinsically meaningless black ink forms present upon a field of otherwise undifferentiated white.

The sign relation of "standing for" is ubiquitous in the biological world, but the resistance to studying sign processes in nature *as* genuine *sign* processes – as opposed to just studying the interactions of their material substrates – has a long and principled history in science. It is precisely this history that we need to understand first, if we are ever to understand how something as oddly named as "biosemiotics" has emerged as neither not an anti-science nor a pseudo-science, but as a genuine proto-science aimed at scientifically distinguishing and explaining the use of sign processes and sign relations both between and within organisms.

"Subjective experience" – which is also an undeniably ubiquitous characteristic of all living systems, provided that one does not conceptually reduce the rich multiplicity of organismic experience with the evolutionarily anomalous and biologically minority instance of self-conscious, language-employing *human* 'subjective experience' – is made possible only by the existence of genuine biological (i.e., non-human made) sign relations, yet has been shunned in natural science as a subject of inquiry in its own right.

Indeed, today it is more the norm than the exception for university life science majors to be instructed right at the outset of their studies that "science only studies observable phenomena. It functions in the realm of matter and energy [and therefore] it is a serious mistake to think that the methods of science can be applied in areas of investigation involving other aspects of human experience, e.g., matters of the mind" (Miller and Harley's *Zoology*, 1994: 11). Similarly, Nobel Prize winner Eric Kandel writes at the conclusion of his authoritative *Principals of Neural Science:* "most neuroscientists and philosophers now take for granted that all biological phenomena, including consciousness, are *properties of matter* . . . and some philosophers and *many neuroscientists* believe that *consciousness is an illusion*" (2000: 1318, italics mine).

And so the question accordingly arises: How did modern science – the communal knowledge-generating system *par excellence* – arrive at this sterile impasse – one where the investigation of individual knowledge-generating systems *as*

knowledge-generating systems per se has come to be seen, at best, as a vexingly paradoxical riddle and, at worst, as falling entirely outside the scope of legitimate scientific inquiry?

The first half of this history of biosemiotics attempts to partially illuminate the historical processes by which this particular explanatory Gordion knot was tied.

One might reasonably suppose that an examination into the uniquely influential works of René Descartes (1596–1650) would be a logical place to start this discussion, as Descartes' work is often seen as emblematic of the bifurcation between modernity and pre-modernity in both the sciences and in philosophy, and of demarcating the bifurcation between the "mental" and the "material" realms that we continue to continue his struggle to reconcile, in better and worse ways, today. And, indeed, it will be necessary to discuss Descartes' role in shaping the trajectory of modern science if the history of biosemiotics is to make sense within its larger narrative.

Yet Descartes, too, appears within this role informed by a set of prior understandings and explanatory narratives that are themselves contingent products of history. So if we are to understand the relationship of biosemiotics with regard to the modern science from which it proceeds, and which it to some extent challenges, we must also understand the relation of modern science to the practices and understandings about the natural world from which *it* proceeded and, for the most part, not merely challenged but actively proposed to supplant.

Thus, the first difference between the two projects of "biosemiotics vis-à-vis modern science" and of "modern science vis-à-vis everything that preceded it" can be clearly stated. For as we shall see shortly, the goal of biosemiotics is to *extend* and to *broaden* modern science, while adhering strictly to its foundational epistemological and methodological commitments. It does not seek in any genuine sense of the term to "oppose" much less "supplant" the scientific enterprise, but to *continue* and to *develop* it, re-tooled for the very challenges that the enterprise itself entails, if not demands.

Understanding how and why this is so requires that situate the biosemiotics project within the history of scientific thinking as a whole, and not just within the history and thinking of modern science as delimited and defined by Descartes and his successors.

Thus what better place to begin a history of biosemiotics than with Aristotle, the West's first genuine biologist? For only by tracing the winding evolutionary path that begins in the ancients' observational thinking about life processes, and continues through the heavily mediated symbolic thinking of the medievals about sign processes, may we at last begin to get a clearer view of the Gordian conceptual entanglements between signs and nature that Descartes sought to resolve, not with a yet more entangled synthesis, but with an Alexandrian cleaving that would leave these two halves disconnected and the thread that brings forth their unity forever cut.

And since it is the job of biosemiotics to attempt weaving this thread together again, we must first discover just how and why it got tangled up in the way that it did in the first place. We begin our history proper, then, before it ever occurred to anyone to tie such an explanatory knot out of the naturally occurring continuum bearing humans, culture, animals and nature.

Phase One: Semiotics Without Science

> There is no philosophical high-road in science, with epistemological signposts. No, we are in a jungle and find our way by trial and error, *building our roads behind us* as we proceed. Thus, we do not *find* sign-posts at cross-roads, but our *own scouts erect them*, to help the rest. – Max Born (1882–1970), Nobel Prize in Physics 1954 (Born 1943: 44)

Tracing back such sign-posts as the records that we have access to will allow us, the dawn of what we now call *scientific* knowledge and investigation (as opposed to the practices and dogma of received and "revealed" wisdom as the foundations for human action and belief) in the West is generally said to start with the efforts of the retroactively designated *natural philosophers* of sixth and fifth century BCE Greece. There, if the signs extant are telling us the truth, the investigations undertaken into the observable patterns of natural phenomena and the resulting explanations offered by the pre-Socratics marked a profound cultural and epistemological shift away from mankind's earlier ways of explaining the phenomena of the natural world as manifestations of the wills and whims of a dizzying assortment of intrinsic and extrinsic gods.[2]

And, indeed, this is how the narrative of the birth of science in the West is generally presented: This new form of communal, non-supernatural investigation that does not require god-cause as part of its explanations about the natural world is at the root of what we today call *science.* Historically familiar as that account may be, what is less often appreciated is the fact that this profound cultural and epistemological break between god-causal and non-god-causal explanation simultaneously birthed an even more irresolvable epistemological bifurcation – one that would plague the entire subsequent history of science for the next twenty-three centuries, as we shall see. For in the most general terms, writes historian of philosophy John Deely:

> the individuals credited with the introduction of philosophical thought into human civilizations were men who speculated on what constitutes the objects of human experience in so far as those objects have or involve an existence or being *independent* of what [any given agent, be it gods or human beings] may think, feel or do. The philosophers, in other words, are those individuals who are credited with introducing into human thought the idea of *reality,* or something which 'is what it is' on its *own* grounds, *regardless* of what further relations it may have 'to us' or *how it may appear in experience* (Deely 2001: 3).

"Soon enough this thinking became reflexive," Deely continues, "and raised the question of how [and later, if] such knowledge could be possible in the first place" (ibid). This latter observation, while hugely consequential for the history of science and sign theory that it is our goal to convey here, nonetheless gets us too far ahead of our story for the moment. Rather, we need to linger on Deely's first observation a little longer in order to fully understand all of what is to come, and to sufficiently appreciate the impact of this first major "turn" in our history of scientific understanding. For as biosemioticians will centuries later convincingly argue, this ability to apprehend and understand the extra-mental existence of a world that does

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[2] But see Denhizan 2008 for an illuminating reconsideration of the still lingering effects of the Mesopotamian worldview upon subsequent Western epistemology.

not reduce to our own sensational experience of it, is one of the distinguishing characteristics of our species-specific *human* form of cognition (Hoffmeyer 1996, Deacon 1997, Emmeche 2002, Favareau 2008, and many more).

Ancient Origins: Assuming a Natural Bridge Between World and Mind

Obviously, the slow-building origins of such a deeply human cognitive ability as the one described above must have pre-dated the appearance of the pre-Socratic philosophers by thousands, if not tens of thousands of years. Certainly, one finds highly developed evidence of this ability in the myths of ancient Sumer and Egypt, in the religion of the Caanites, in the burial rituals of Chinese Longshan culture, and the writing systems of the early Indus Valley dwellers. And by the time of the *Upanishads*, the earliest of which is said to date as far back as ninth century BCE, we find that the assumption of a fundamental dichotomy between reality (*Brahman*) and the world of experience (*maya*) is already being posited as the essential human condition – anticipating Plato, to say nothing of the modernists, by centuries and millennia, respectively.

A history of the various responses that have been proposed across cultures to this characteristically human question regarding the proper *relations* between "mind-dependant" and "mind-independent" phenomena would indeed be a fascinating study – although, of course, it is not one that we will have time for here. Restricting our analysis to just the Western scientific tradition, however, we can see right from the start, its recognition of the need to conceptualize a way of bridging the human apprehension of purely mind-dependent phenomena to the veridical apprehension of inescapably mind-independent phenomena.

It is for this reason that we find Plato (427–328 BCE) arguing for the necessity of our gaining *unmediated* access to direct reality in our between-lives apprehension of the Ideal Forms (e.g., *Timaeus 50a–c, Republic 476b–480a; 596a*) and, if we are diligent, through our concerted efforts at retrieving that same knowledge through the practices of *anamnesis* during the course of our own lives (e.g., *Meno 85d–86; Phaedo 72e–73a, Republic 534b–c*). It is also why we find Aristotle (384–322 BCE) arguing, conversely, for the necessity of *inherently mediating* and multiply generative "middle terms" of explanation (roughly akin to Peirce's *interpretants*) that we create, test and then either discard or adopt in our journey from brute perception to the more fine-grained understanding of reality (e.g., *Posterior Analytics* II 2, 90a7–9). Even more biosemiotically, Aristotle posits that the organization of *all* living form is such that nature "prepares the ground" in organisms for those *perceptual* capacities that will be necessary to allow them to achieve their organismic ends, and that "it is for the sake of this that [their] potentialities are acquired" (*Nichomechaen Ethics 1103a32–33*; *Metaphysics IX 1050a 5–10*).

For both Plato and Aristotle, however – and for the majority of their disciples over the course of the next two millennia – the notion that a reliably traversable

bridge between mind-dependant experience and mind-independent reality might be 'impossible' for human beings, even in principle, is an unacceptable absurdity (e.g. *Parmenides 135b–c*, *De Anima iii 3–5*).[3] Instead, the serious consideration of this most counter-intuitive idea by a majority of contemporary theorists is a most characteristically *modern* notion – and perhaps the one most responsible for bringing the research agenda of biosemiotics into being in the second half of the 20th century. For it is biosemiotics that will insist that, in the study of biological organization and agency of every kind, it is precisely the naturalistic establishment of *sign relations* that 'bridges' subject-dependent experience (such as we find both in animal sensations as well as in human 'mindedness') with the inescapable subject-independent reality of alterity – an alterity that *all* organisms have to find some way to successfully perceive and act upon in order to maintain themselves in existence.

Interestingly enough, however, the very naturalness of sign relations seems to have appeared unproblematic for the ancient Greeks, whose investigations into the patterns of orderliness discoverable in the natural world were predicated, for the most part, upon the assumption that human beings were built in such a way as to be able to derive veridical knowledge about the phenomena present before them in a world existing independently of their experience. Rather, it would be left to the Hellenistic and medieval Latin scholars who, in their attempts to synthesize the insights of Greek antiquity with Biblical revelation so as to develop the doctrines of the Catholic Church, became increasingly alert to the idea that the mediation between mind-dependant experience and mind-independent reality was not at all a straightforward one.[4] Not at all coincidentally, it is here where we first encounter serious intellectual engagement with the phenomena of signs *qua* signs.

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[3] One can detect some resonance with modernist scepticism in one or two of the minor traditions of the ancient world, most notably those of the "Middle Academy" thinkers Arcesilaus (c. 315–241 BCE) and Carneades (c. 213–129 BCE), and especially the later neo-Pyrrhonean scepticism popularized by Sextus Empiricus (c. 150–225 CE). In the case of the Academicians, however, such doctrine appear to be motivated more by a desire to weaken the stultifying hold that the un-self-critical "dogmatism" of the competing Stoic school then held on the popular imagination, then on the attempt to embark upon anything resembling Descartes' epistemological program of radical doubt (Long and Sedley 1987). Similarly, the Pyrronean revival of 2nd and 3rd centuries Rome appears to have used the inarguable conclusions of sceptical logic purely *instrumentally* in the quest to cultivate the spirit of *ataraxia,* or emotionally detached equanimity, as a "practical philosophy" and recipe for living – a worldview that Diogenes Laertius suggests that Pyrrho may have originally re-fashioned out of the belief systems he encountered in his time in India with Alexander's army (Burnyet and Frede 1997). Most critically: both schools argued *in favor of* the foundational epistemological usefulness of precisely those sense-perceptible "appearances" (Pyrro's *phianomena* and Carneades' *pithanon*) and pragmatic axioms of everyday "folk psychology" (Arcesilaus' *eulogon*) that constitute the "mind-dependant *illusions*" so bewailed by the – let us call them – "*Dogmatic* Sceptics" of modernity.

[4] Indeed, the briefest time spent with either the neo-Platonic theology of Augustine (354–430) or the Aristotelian apologetics of Aquinas (1225–1274) will reveal that 'naïve realism' is *not* a charge that can be levelled against the Latin thinkers (nor their counterparts in the Islamic world, for that matter).

Semiotic Analyses of World-Mind Relations in Hellenic Thought

Eco and Marmo (2000: 65) remind us that prior to the Hellenistic period, the word σημείο (L: *semeion*) was understood by the Greeks almost exclusively as a medical term – one roughly akin to the modern concept of *symptom*, in that referred it only to the outward manifestations of an internal state of affairs. And it is from this word *semeion,* of course, that the word "sign" – "something that suggests the presence or existence of some other fact, condition, or quality" [5] – proceeds.

Yet the broader understanding that "signs" are, in their first and most fundamental sense, relations holding over objects as apprehended by some perceiver ("Signum est res praeter speciem quam ingerit sensibus, aliud aliquid ex se faciens in cogitationem venire")[6] was first articulated in the West by Augustine of Hippo (354–430), who is thereby generally credited with developing the West's first true theory of signs *qua* signs. Augustine's development of such a theory was purely an instrumental one, subservient but necessary to his larger epistemological project of establishing a theory of human *knowing* that, as he felt all such theories should, could lead us to discover how it is that the source of all that is, the Divine God, has constructed we non-divine human beings such that we may partake of justifiably true knowledge of both his Creation and of Him.[7]

As a result, "it was Augustine," writes Umberto Eco, "who first proposed a *general* 'science' or 'doctrine' of signs per se – wherein the *sign* becomes the *genus,* of which *words* [are but a particular] *species*" (Eco and Marmo 2000: 65). The point is a critical one for us today, as we attempt to recover from the intractable conceptual errors introduced by the 20th century "linguistic turn" in failing to make the critical distinction between *signs* and *symbols*, as we shall have much opportunity to discuss later. What we need to attend to at this point in our narrative, however, is Eco's fertile clarification that *signs* (σημεία) for the Greeks were understood as *natural events* acting as symptoms or indices, and [that] they entertain, with that which they point to, a relation based upon the mechanism of inference [taking the form *if* → *then*]. *Words* (λέξη) for the Greeks, by contrast, stand in quite a *different* relation with what they signify [than this *if* → *then* relation]" (ibid).

The questions for Augustine and his commentators would then become: How to understand both: (1) the *if* → *then* relations of the natural world, and how these relations may be reliably inferred by living beings, as well as: (2) the function of this as yet still unspecified "different" (or additional) set of epistemological relations instantiated by human language use?

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[5] An absolutely ordinary – but quite profound, it turns out – definition from the *American Heritage Dictionary* (Houghton Mifflin 2006).

[6] "A *sign* is something which, offering itself to the senses, conveys something other than itself to the intellect." *De doctrina christiana* II 1, 1963, 33 (trans. Meier-Oeser 2003: o.l.).

[7] De- theologized, this is a large part of the contemporary biosemiotic project as well – which is why Augustine's extra-linguistic notion of the sign will remain important to us as we move from human knowing to animal sensing to cellular self-organization.

A theologian, Augustine resolves these questions much in the same way that René Descartes will attempt to resolve a similar issue thirteen centuries later: by appeal to an innate power bestowed in us by God. For the purpose of scientific explanation, however, this answer merely pushes the question away. Thus, the search for a more coherent understanding would become the project of a "forgotten" line of medieval inquiry that is yet rediscoverable as it culminates in the works of the scholars of the late medieval Iberian school (the so-called *Conimbricenses*) – and in particular, in the *Tractatus de Signis* of John Poinsot (1589–1644), as philosopher John Deely has been at the forefront of arguing for quite some time.[8] In our own time, the fact that these two tightly interrelated questions remain unresolved, both conceptually and scientifically, would become the initial impetus and driving force for the development of the project of biosemiotics (Sebeok 2002).

The development of that project will be discussed in this history in due time. Yet hints on how to go about approaching such dilemnas are already evident in Augustine, where we find, for the first time in the West, an extended philosophic discussion on both the similarities and the differences between "natural signs" (*signa naturalia*) and what might be called "cultural signs" – or what Augustine himself called "given signs" (*signa data*). *Signa naturalia*, for Augustine, are those signs that, "apart from any intention or desire of using them as signs, do yet lead to the knowledge of something else" (389/1963) – one might think of the relations of physical contiguity, such as the relation of smoke to fire, or the relation of a fossil to the animal's body that left it. "Given signs" (*signa data*), on the other hand, are "those [signs] which living beings mutually exchange in order to show, as well as they can, the feelings of their minds, or their perceptions, or their thoughts" (*ibid*) – such as exemplified, presumably, talk and gestures and the marks on this page and Augustine's *Confessions*.

Subsequent inquirers into the notion of sign relations will come to realize, however, that Augustine's distinctions here raise as many questions as they propose to answer. Among these many questions: *For whom* do such natural signs "lead to knowledge of something else" . . .*other than* those with the "intention or desire for using them" as such? Similarly: Must the given signs that "living beings mutually exchange in order to show . . . the feelings of their minds" be *deliberately* and *expressly* "exchanged" – or may they be subconsciously *performed* and *registered*? Do animals use *signa naturalia* or *signa data*? And in what relation towards each other do these two categories of "natural" and "given" sign relations ontologically stand? Perhaps most importantly of all: Is it the "perception" and "awareness" on the part of some agent that *gives* a sign its representational efficacy – or does the agent merely "apprehend" a relation in the world that is *already there*, regardless of its apprehension or non-apprehension?

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[8] See especially Deely's (1985) translation of Poinsot's *Tractatus de Signis* and its accompanying "critical apparatus" – as well as Deely's detailed explication of the works of the Coimbra school in Deely (2001) (esp. pp. 411–484) and of Poinsot's contribution to a post-modernist theory of perception and understanding in Deely (2007) (passim).

Not because he did not recognize these sorts of questions, but because they were extraneous to his purpose of examining how sacrament and scripture function as the revealed signs of God, did Augustine more or less leave the discussion of signs *qua* signs at this point (Deely 2001: 22). Still, as Meir-Oeser observes, "despite all the internal ruptures and inconsistencies, Augustine's doctrine of signs is based on a definition that, for the first time, intends to embrace both the natural indexical sign and the conventional linguistic sign as [but two sub-]species of an all-embracing generic notion of sign, thus marking a turning point in the history of semiotics" (2003: o.l.).

Certainly, from a history of biosemiotics standpoint, Augustine's early formulation of a sign as primarily being constituted by a relation between one aspect of the natural world and another aspect of that same natural world (a "perceiver") is so manifestly commonsensical and unencumbered with specially-created dichotomies, that had the contingencies of history been otherwise, and had sign study proceeded from Augustine's definitions, rather than from a radically disemboweled version of Aristotle, as we shall soon see it do, we may not have found ourselves here today still trying to establish as a general understanding the idea that the world of sign relations per se did not start with the advent of *homo sapiens* – and that a sign relation is not something that was created *ex nihilo* by the minds of human beings – but rather, that the minds of human beings are themselves the product of a *de novo* use of absolutely natural and biological sign relations.

Signs Without Being: The Loss of De Anima *to Inform* De Interpretatione

The contingencies that have been actualized by history have *not* been otherwise, however – and thus the understandings about sign relations that came to be most generally accepted by the thinkers of post-antiquity were to have dire consequences for subsequent centuries' attempts at incorporating the resulting notion of "sign" relations into the modern project of science. Anticipating briefly: the model of the scientific project that we have inherited today descends in a fairly straight line from the experimentalist instrument of Francis Bacon's *Novum Organon* – an historically situated rejection of what had served as the primary "instrument of logic" and investigation about the natural world for the medieval scholastics: Aristotle's six books on logic known collectively as the *Organon*.

But in calling for a revolution in the approach of scientific investigation from the deductive to the inductive, Bacon and his contemporaries yet inherited an impoverished notion of "sign relations" that would devolve into a literally irreconcilable mind-body dualism at the hands of René Descartes a mere twenty-one years later. This assumption of an essential dualism between material relations and sign relations continues to inform the practices and premises of modern science up unto the present day. And because of this, it is incumbent upon us to spend the necessary amount of time here retracing the historical trajectory that precluded for centuries

even the possibility of a science devoted to investigating the myriad ways in which material relations could come to function as sign relations in the lives of living beings.

Significantly, in the seven centuries that followed Augustine, the churchmen studying his doctrine of signs did so only in the sacred context in which it was intended. For examinations into the workings of the world, they turned, of course, to The Philosopher, Aristotle. But the Aristotle of the early Middle Ages was only a partial Aristotle at best, consisting only of the six books translated into Latin by Boethius (480–524) in the sixth century CE. These six books on logic, thought to have been collected by Andronicus around 40 BC so as to present the reader with a structured system of logic, would come to be *the* standard text of non-Biblical learning in the thousand years between the fall of Rome and the beginnings of the modern era – so much so that they became collectively known as just the *Organon* – the "instrument" of knowledge and well-ordered thought.

Critically, however, these six books were only one small part of Aristotle's overall understanding about the logic of human reasoning *and* the logic of the natural world. The rest of Aristotle's works – and the ones through which one can get an understanding of how the logic of human relations both comes out of and fits in with the logic of the natural world (a "biosemiotic" understanding, as it were) – were lost to the West for over a thousand years. And from these impoverished initial conditions, a magnificent edifice that was yet only half-informed was constructed over the course of the next ten centuries.

For the centrality of the Aristotelian *Organon* as the primary "instrument of logic" throughout the whole of the Middle Ages. Yet without the corresponding Aristotelian texts on nature and biology (and on the massively interdependent relations between *biological form* and *function*), the focus of the next dozen centuries, at least as far as the investigation into "sign relations" is concerned, would proceed from Aristotle's meditations of the sign *exclusively* as it is manifested in human experience. Indeed, *De Interpretatione* – that book of the *Organon* that deals most specifically with semantics, hermeneutics and propositional logic – focuses entirely on the relations of "words" and "sentences" and begins thus:

> Spoken words are the symbols of mental experience and written words are the symbols of spoken words. Just as all men have not the same writing, so all men have not the same speech sounds, but the mental experiences, which these directly symbolize, are the same for all, as also are those things of which our experiences are the images (*De Interpretatione:1).*

The implications of this latter notion – i.e., that "those things of which our experiences are the images" are tied in some deep way to "what all men have" in their very constitution *as* men (or, more properly, as human beings and as animals) – Aristotle declines to expand upon in *De Interpretatione*, mentioning suggestively that it "has been discussed in my treatise about the soul, [and] belongs to an investigation *distinct* from that which lies before us here'" (330 BC /1941: 38). Having access to the thought of Aristotle only through Boethius's translation of the six books of the *Organon*, however, the first six centuries of monastic scholars had no access to

this referenced "treatise about the soul" and were thus literally prevented from seeing how the arguments of *De Interpretatione* could be understood as but a particular subset of those in *De Anima* (and in *De Sensu et Sensibilibus*).

De Anima, of course, is about life, and the translation of "anima" as "soul" can be a misleading one to modern English speakers who are not philosophers. For anything resembling the body-separable, spirit-like "soul" of the Platonic, Christian and (later) Cartesian traditions is antithetical to what Aristotle is referring to by the term ψῦχή (Latinized as *anima*) in this work. And, in some ways, the understandings of our current science are closer to Aristotle's ideas about *anima* than has been the case at any time since his rediscovery in the West in the 11th century. Thus, a modern gloss on Aristotle's famous dictum that "the soul is the first actuality of a natural body that is potentially alive" might today read: "life is the emergent system property of the interactions of a self-catalyzing system that can adapt to its environment to persevere. Similarly, the basics of his hylomorphism may be restated to reflect the uncontroversial scientific understanding that the biological "form" of such life is the product of its evolutionary and ontogenetic embedding in the world, and itself consists of those particular sets of systemic relations that serve to organize a material substrate into a particular kind of organism.

Thus, to the extent that even this (highly oversimplified) gloss is representative of the interdependent recursivity of Aristotle's biology, we can see that for Aristotle: (1) animal form is shaped in regard to organisms' interaction with the world, and vice-versa (anticipating Darwin, although, of course Aristotle was assuming the fixity of these systemic organism-world arrangements, and not their evolution); (2) the organism's actions upon the world (which subsequently change that world) are both enabled by and constrained by the organisms' systemic biological constitution, including its perceptual capacities (anticipating von Uexküll); and (3) it follows that as the result of (1) and (2) there is both a "realism" to sign relations and a deep necessity for the joining together of the extra-biological relations of external reality to the embedded biological relations within organisms such that "what *occurs* in the case of the perceiving [system] is conceivably analogous to what holds true in that of the things themselves" (*De Sensu vii.)*. Understood biosemiotically, these are the "things of which our experience are the images" and that "all men" share as part of their biology, and that is alluded to in *De Interpretatione*: not self-subsistent external objects, but the knowledge-bearing, suprasubjective reality of sign relations.

In perception, as well as in imagination, in other words, "it is not the stone which is present in the soul but its form" (*De Anima viii*). Understood within Aristotle's overarching conceptual system of hylomorphism, and again translated for modern ears (especially those conversant with dynamic systems theory), this means that there exists a semiotic 'structural coupling' between the *relations constituting organisms* and the *relations constituting the external world* that ensures a veridical alignment between the two that holds across the *scala naturae*. And again, we can see how the development of evolutionary theory two millennia later (as well as the study of animal perceptual worlds *qua* perceptual worlds that we will be discussing shortly) can further inform this conjunction between bio- and semiotic- reality, making the prospects of a either a nominalist or a Cartesian divorce between knowers

and the world they know the bewitchment of a symbolic overcoding system that itself no longer recognizes its own grounding in the relations of the material world (see also: Deacon 1997, Hoffmeyer 1996).

Thus, the breaking apart of the subordinate study of human words and propositions in De *Interpretatione* from the superordinate study of animal organization and interaction in the world that Aristotle develops in *De Anima* – a more or less accidental bifurcation owing to the contingencies of history – became the starting point of a developmental pathway whose alternative trajectory would remain *terra incognita* long after the end of the Middle Ages and right up to the last half of the 20th century. Indeed, the ever-widening bifurcation in the scholastic period between the investigations of bio-logic and the investigation of semeio-logic resulted in the assumption that it is what the scholastics called the "mental word" (*verbum interius*) – or what we might designate more precisely today as "linguistically mediated experience" – that was to be the natural starting point and, eventually, the exclusive focus of "sign" study.

Yet this would prove to be a guiding assumption that is at the same too broad and too narrow; for in understanding the essence of a "sign" per se to be an object that is mediated through the mental experience of a human being, this assumption conflates what is merely one *example* from of the superordinate category of "sign relations" into the very *definition* of the entire category itself.

Doing so thus accomplishes a logical conflation and an explanatory reduction at the same time – a misstep that would have profound consequences for the next dozen centuries of philosophic inquiry, and by extension, for the subsequent foundation of modern scientific thought. For it will be precisely the persistent canalization of this evolutionarily inverted 'linguistic-mentalist' conception of what sign relations are *in their essence* that will prove a major obstacle in the forestallment of a successful explication of the biological and semiotic relations making possible animal knowing, human language, and the ways in which these sets of relations do and do not interact and overlap.

Early Medieval Thought: The Conflation of Signs with Mental Tokens

Of the two major "turns" in the history of Western thinking that would lead to the loss of the non-linguistic "sign" concept as a centrally mediating factor between observer-dependant and observer-independent reality, the first one was gradual and the second one more abrupt. The gradual turn was one bequeathed to us by the medieval scholars over the course of the thirteen centuries when they were most responsible for the shaping of Western thought. Unlike the latter "turn" taken at the outset of modernity by such self-conscious modernists as Francis Bacon and René Descartes, the medievals' gradualist and organic turn was *not* a self-conceived rejection of the modes of thinking that came before it; rather, it was intended to be a progressively developing improvement and refinement of all that had been discovered thus far.

For the virtually unparalleled sophistication and subtlety of scholastic thought was the result of a tradition of rigorous analytical commentary upon currently existing analysis, with, ideally, each succeeding iteration adding additional explanatory clarity, refinement, and depth. Such dialogical, community-based inquiry would give rise in time to the medieval invention of the *university* – without which, as Deely (2001: 83–184) reminds us, the later development (as well as the continued existence of) today's *scientific* "community of inquirers" would be unthinkable. Within such focused communal practice, writes Meier-Oeser,

> great effort [was put] into the conceptual analysis of the basic terms and notions. Thus, wherever terms like 'sign' (*signum*) or 'representation' (*repraesentatio*) appeared in the texts commented on, scholastic authors felt obliged either to give an explicit account of these concepts or at least to be able to refer to a place where this has been done. In view of this, the fact that Aristotle in his *On Interpretation* had incidentally called the word a 'sign' (*semeion, symbol*) of the mental concept or that Augustine had termed the sacrament a 'sacred sign' (*signum sacrum*) became most important for the later development of semiotics. For in both cases, the outcome was a large number of detailed explorations of the nature and divisions of *sign* (Meier-Oeser 2003: o.l.).

Indeed, there is simply no space here to do even perfunctory justice to the rich history of the medievals' inquiry into the nature and taxonomy of sign relations. It is a history well worth becoming acquainted with for anyone wishing to do 21st century biology, however, and particularly so in the field of Cognitive Science – given that the late scholastic treatises suggesting the principles required to establish a naturalistic path of mediation between brute sensation, categorical perception, and symbolic abstraction far exceed in analytic depth and detail any such analysis that has yet been offered in our own time.[9]

Nor should this rich fecundity be surprising, for the scholastics were following the principles of what we would today call "dynamic systems processing", and their central practice of analytical commentary was devised to "build into the process" of knowledge-generation the opportunities for systemic self-correction, recursive iteration, and continual, adaptive growth. Thus, far from being the trivial pursuit and pointlessly hypothetical discourse that the modernists would later self-servingly characterize it as, the scholastic project of knowledge yielded scientific riches that, once lost, would have to be "discovered" again in modernity (as we shall see later in this instalment) – as well as riches that have yet to be put to scientific use.

However, the communal scholastic project was a communal human project, after all – and we now know from the study of such dynamic systems in practice, that "initial conditions" can have a disproportionate effect on the eventual outcome states of such a system, and that the continued iteration of certain values at the expense of others can put such systems on a runaway trajectory of fatally self-perpetuating

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[9] Readers interested in pursuing this latter project should find in Tweedale (1990), Magee (1989), Broadie (1989) and especially Deely (2007) inspiration on where to begin. Those wishing more general overviews with which to begin their own investigation into medieval semiotics are strongly urged to consult Eco and Marmo (2000), Kretzmann (1982, 1988), Gill (1999), and Jackson (1969), as well as the relevant chapters in Escbach as Trabant (1983) and Deely (2001).

"locked-in" effects (Kauffman 1995). Something like this can be seen to have happened to the development of the *sign* concept during the Middle Ages, when, having only Boethuis' (480–525) translations of and commentaries upon Aristotle's linguistic and logical treatises, the medieval scholars inherited, from Boethius' Aristotelian commentaries, the notion of the "*ordo orandi"* (or "order of speaking"). Therein, the hierarchy of knowledge is: the things of the external world (*res*) are signified by mental concepts (*intellectus*) which are then signified by spoken words (*voce*) and these are, in turn, signified by written characters (*scripta*) (Magee 1989: 64–92). And supporting this system is the principle that: "at the fundament of written and spoken discourse there is a mental speech (*oratio mentis*) in which thinking is performed" (Meier-Oeser 2003: o.l.).

As oversimplified (and dangerously misleading) as it is, this explanatory schema as Boethius presents it might yet have enabled the development of a naturalistic understanding of human cognition and communication, given that the word "signify" (to generate new sign relations) is used instead of "represents" (to appear as a coded version) throughout. But since the context in which Boethius' words would be read, elaborated on and conceptually developed, was one in which, again, the primary non-Biblical "instrument for understanding" just happened to be, through the sheer accident of history, Aristotle's treatises on the internal logic of *language* and *linguistically-formed propositions* – and *not* his more general treatises on *biological form, function and development* that were lost to the West for the first eight centuries of the medieval period – it is not surprising that the general direction of the medievals' thought on cognition was one that took *linguistic* relations as paradigmatic of *sign* relations in general, rather than vice-versa.

Such a "mirror-image" hierarchy of cognition, we know now, is evolutionarily impossible. But, of course, the medieval scholars were not thinking in terms of an evolutionary universe, but in terms of a fixed one – and one wherein linear chains of being, put and held in place by an unselfconciously anthropomorphized God, were the received *explananda* demanding logically consistent *explanans*. Freed from the demand to provide an evolutionary account of how language-like signs (e.g., the *propositio,* the *lekta,* the *semeionenon,* etc.) must have had their origin in animal communication and cognition, the medievals instead had to account for how these sign relations fit together to *comprise* (as opposed to merely *support*) the uniquely human form of "reason."

Later Medieval Thought: The Conflation of Signs with Linguistic Mental Tokens

In the 11th century, Anselm of Canterbury (1033–1109) would develop the doctrine of "mental images" as the *verba naturalia*, or "words of thought" common to all human beings, anticipating 20th century notions of "mentalese" and "universal grammar" by almost a millenium. Taking such ideas to their logical (if ultimately futile) extension, the publication of Thomas of Efurt's (c. 1280–1350) *Grammatica Speculativia* at the beginning of the 14th century, inspired whole schools of "modist

grammarians" to seek to find the ways in which the modal syntactic and morphological characteristics or words (*modi significandi*) must somehow *derive* from the correspondingly modal conceptual representations of an intellect (*modi intelligendi*), that has been passively shaped by its interactions with the modalities proper to the external thing represented (*modi essendi*). In this way, the science of *signs* and the science of *language* were to become increasingly coextensive, and it is this epistemologically inverted hybrid of signs as language-like phenomena – rather than a true science of signs *qua* signs – that would go on to be incorporated into the progressive "linguo-mentalization" the sign concept that is the hallmark of late medieval thought.[10]

For even with the recovery of the lost texts of Aristotle from the Arab world in the 13th century, the much needed re-reading of *De Interpretatione* in light of *De Anima* never occurred (and, indeed, it has not truly occurred yet). Not surprisingly, then, would William of Ockham (c. 1285–1349) exacerbate the incipient dualism between extra-mental relations and sign relations by asserting that the universal properties of things were merely the universalizing mental *signa* (signs) of human minds. In such ground did the seeds of an increasingly linguaform and mentation-centric nominalism flourish, and the self-reinforcing "humanification of the sign" progress.

All of this is not to say, however, that the Middle Ages were entirely bereft of thinkers dedicating their considerable intellects to an examination of the role of sign relations in life. Most notably, Peter Abelard (1079–1142), Thomas Aquinas (1224–1274) and Duns Scotus (1266–1308) all struggled to incorporate the reality of natural, non-linguistic and non-manmade signs (*signa naturalia*) with the reality of the signs unique to human cognition (*signa rationalis*). Similarly, both Roger Bacon (1214–1293) and the anonymous author known to us today only as "Robert Kilwardby" (c. 1215–1290) independently called for, and made explicit attempts at establishing, a "science of signs" (*scientia de signis*) "in terms of a universal notion abstracted from the [phenomena of] particular signs" (Meier-Oeser 2003: o.l.).

Both of these latter projects foundered, however, given the prevailing interests and valences of their time, and were unable to resist the gravitational pull towards misunderstanding *human symbol use* as the archetypal relation that one studies when one studies "sign relations." For then, as now, the attempt to understand more general and fundamental sign processes through the application of criteria that only apply to more specific and derivative sign processes, resulted in an unrecognized "Orwellian rewriting of the evolutionary past in terms of the present"[11] that, not surprisingly, failed to satisfactorily account for the possibility of any sign relations emerging out of the world of nature per se.

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[10] And of modernity, as well, which, although determinedly paying little acknowledgement to its roots in the scholastic tradition has nonetheless inherited unquestioningly the premise that sign relations are human language-like and should be studied accordingly, and has taken this idea to extremes undreamt of by the medievals, as we shall have plenty of opportunity to observe shortly.

[11] This wonderfully insightful phrase is from Terrence Deacon's equally insightful *The Symbolic Species* (1997: 53), a highly recommended entry point into biosemiotics.

Approaching Modernity: The Replacement of Signs with Linguistic Mental Tokens

Much more in the spirit of the times than the projects of Bacon and Kilwardby was the well-received *Summa of Logic* of William Ockham, which urged that it is the 'logical and propositional' character of the sign that is the proper subject of sign study. With Ockham, the medieval concept of *significatio* – "the presentation of some form to the awareness," becomes subsumed under the naïve realist concept of "intuitive cognition" (saving him from the descent into *radical nominalism* that the more strict followers of his logic would later bear) and henceforth begins its long fall into neglect as a way of thinking about the centrality of sign relations as constituting a natural capacity of *all* sentient beings, while *suppositio* – "the capacity of substantive terms to stand for something in a propositional context" becomes increasingly assumed to be the most productive path on which to seek the *foundations* of human cognition (Meier-Oeser 2003: o.l.).

As the man who more than any other medieval thinker popularized the notion of 'nominalism,' Ockham is often referred to as being simultaneously the last of the scholastics and the first of the moderns – and while the first assertion will not bear scrutiny, it is easy to see in retrospect why the second claim is often made. For in Ockham we find the seeds of those preoccupations that would come to characterise so much of the quickly approaching age of modernity: the insistence upon a separation between faith and reason, between nature and nurture, and between all that is empirically determinable, and all that which partakes of only "nominal" (in name only) form.[12]

With Ockham, the Aristotelian categories of "being" are reduced from ten to two: *substances* and (biosemiotically enough!) their *properties* are the only genuine existents: while *quantity, relation, place, time, position, state, action,* and *receivability* are only "concepts in our minds" (*verba mentis*). Such so-called "connotative" concepts, for Ockham, (or may not) be caused by mind-independent substances and their properties, but in either case, they do not partake of a self-subsisting, mind-independent "reality" of their own (Spade 2006: o.l.).[13] And from this eliminativist perspective, it is but a few small steps – soon to be taken, as we shall see – to the modernists' understanding that only "matter" (if that) is "real."

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[12] It is germane to repeat here Deely's observation that it is precisely those aspects of Ockham's writings called the *via nominalia* that were "presciently called the *via moderna*" by his successors at Oxford as the High Middle Ages were coming to a close (2001: 395).

[13] The argument that universal properties and sign relations are mere mental nominalisms seems sound when applied to the attributions of human culture, such as *happiness* or *beauty*. It seems much less sound when applied to the physics of gravity or the ineliminable triadicity of the genetic code – both of which exert real causal influence in the world, while being irreducible to their material particulars. The unique mode of being that is *relation*, as the sciences of the 20th century will show us, is *in eliminable* from any kind of scientific explanation applicable to the kind of cosmos we are in. Being, as Aristotle seems to have always understood it, is not a noun, but a verb. It will be many centuries hence, however, before that common sense notion will be retrieved.

In retrospect, it is easy to see Ockham's "proto-modernism" as not just an isolated act of one man's intellect, but instead as a particularly astute reflection of the underlying *Zeitgeist* that was surely taking form in his particular time and place. For the two centuries just preceding his had had ushered in an age of trans-European commerce and interconnectedness not seen since the time of the Roman Empire. Along with this came a massive influx of foreign texts both ancient and contemporary and the arrival of an advanced mathematical technology, including innovations in observation and measurement, inherited from the Arab world in the full flower of their centuries-long development (Grant 1996). Rigorously wedding Ockham's conceptualist nominalism and his rejection of the Aristotelian categories with the burgeoning empirical and experimental "turn" started less than a century earlier by Robert Grosseteste (1168–1253) and Peter of Maricourt (l. 1269), Ockham's proteges Jean Buridan (1295–1357) and Nicole Oreseme (1323–1382) along with Thomas Bradwardine (1290–1349) and the Merton College school of "Oxford Calculators," would soon be arriving at many of the same mathematical and scientific conclusions later to be "discovered" by Galileo, Newton and Descartes.

Thus, the myth of the "birth of modern science" wherein the West is awakened out of its dogmatic Aristotelian slumber by its reading of Copernicus in the 16th century turns out to be far too neat by half. More accurate to say, as we will see happening shortly, that the self-conscious "birthing of modern science" consisted more in the deliberately public act of "putting to sleep" the old dogs such as Aristotle and the scholastic thinkers. And it will not be until six or seven centuries later that science will retrospectively find out how wise or unwise of an idea that will have turned out to be.

The Road Not Taken: Signs as Organizational Relations

Before ending our brief survey of the pre-modern era, however, it will be illuminative to ask: What then of the medieval road that was *not* taken into modernity?

This road, one that has all but vanished even from modernity's history of medieval thought (Deely 2001: 447–484), and the one most relevant to the 21st century project of biosemiotics, held that a *sign*, above all, partook of the properties of a suprasubjective *relation*. Such relations are understood to be, common-sensibly enough, genuinely existing phenomena in the real world (e.g., gravity, acceleration, organismic lineage) that, because they are *constituted* relationally, can never be explanatorily *reduced* to the properties of any of (or even to the brute sum of) their component material *relata*.

Rather – and as these late medievals saw long before science would develop the corresponding notions of "emergent properties" "downward causation" and "autopoeisis" – what gives "relation" *qua* "relation" its characteristic property and force is that it is a genuinely existing state of affairs in the world that *holds over* the being of two or more material bodies or energy configurations in their interactions with one another – whether *causally by nature* (e.g., gravity and solubility

in physics) or *conventionally by culture* (e.g., political hierarchy and social status relationships). Only later will it become clear, as biosemioticians such as Barbieri (2003a, 2007) and Hoffmeyer (1992, 1996) will point out in our own time, that such genuinely causal relations of "holding over" two phenomena may also be, and often are, *conventional by nature* (e.g., the genetic code, the emergent relations of the adaptive immune system, and even the accomplished products of Darwinian evolution that are "organisms" themselves).

So, too, did the many of the now-forgotten scholars of Latinity discover at last that the unique property of the *sign* (a misleading term of reification for what is in every instance a *sign relation*) is that, as a subset of the genuine form of existential being that is "relation" a sign relation simultaneously "holds over" and exerts a uniquely organizing influence upon the *relata* involved in that sign relation (e.g., a word and its meaning, or a symptom and its cause). But exactly in what sense this last formulation is non-trivial, it will be up to centuries-later discoveries in science and biology – and not in rhetoric or logic per se – to reveal, as will become evident as this history of biosemiotics unfolds.

Yet as we have already seen, it was not the path of inquiry made available by proceeding from the understanding that sign relations are a subset of the genuinely causal existential phenomenon of relational organization that became the "taken road" by the majority of medieval inquirers. Rather, it was the obverse and absolutely incompatible attempt to understand sign use itself as a subset of essentially linguistic relations that would continue to be trod into the modern age, where its fundamental error of reverse derivation would prove fatal when the modern sciences of biology and chemistry called upon it to account for how any merely "biochemical set of relations" (i.e., organisms) could conceivably come to "know about" – much less "think about" – the set of physical relations existing independently of, and external to, those sets of biochemical reactions.

And yet, lacking anything resembling a theory of biological evolution – much less the empirical data of neuroscience, immunology, molecular biology, and developmental embryology – that might have compelled these early thinkers to choose the more general and primary, rather than the more species-specific and evolutionarily-derivative understanding of sign relations, the medieval scholars who pursued a human-language based understanding of sign relations may perhaps be forgiven, given the materials that they had inherited to work with.

Yet out of those materials emerged *both* the notion of signs as a subset of relational organization *and* the notion of signs as a subset of linguistically organized practice. And it was only at the very end of the scholastic period, literally during its very eclipse by the advent of the scholastic tradition rejecting modern age, that a successful synthesis between the two understandings would be attained – to lie undiscovered for centuries, as, once more, this particular owl of Minerva "spread its wings only with the falling of the dusk." Let us, then, here *briefly* trace the development of this untaken "turn" in Western thought as we conclude our introductory overview of science and sign theory in the first phases of their ongoing interdevelopment.

The Sign Concept that Still Lies in Wait

A hard-won realization built from centuries of sublime thought, it was only towards the absolute twilight of scholasticism and the dawn of the modern period that a minority of late medieval thinkers, primarily those associated with the Iberian University of Coimbra, would attempt a reconceptualization of the *sign as a relation* that may supercede any given human way of being. Proceeding from a hermeneutic reconsideration of Augustine's original assertion that "a sign, in every case, imports 'something relative to something else' (*aliquid stans pro alio*)", the most prescient of these Iberians, John Poinsot (1589–1644) in his *Tractatus de Signis,* refuted both Platonic realist and Ockhamist nominalist understandings of sign relations with his conclusion that: "the most *formal rationale* of a sign consists in *being* something *substituted for a significate,* whether as an object external, *or* as representable within" (Poinsot 1632/1985: 163; Deely 2001: 426).

In ways which we will expand upon more fully later in this history, Poinsot's understanding of the sign as being a phenomenon that is in its very essence a triadic relation of x *as* y *to* z – and only derivatively characterized by any actually instantiated realization of such a relation (whether a mental sign to a human knower, an odorant molecule to an opossum, or the exchange of Ca+ as a second messenger in the incessant interaction between living cells) – resuscitated the naturalistic Aristotelian understanding of a world of creatures whose internal organization give rise to their external interactions and vice-versa. In such a world, mind-dependant relations and mind-independent relations are tightly woven.

Moreover, Poinsot's that the term *sign* stands for a particular kind of relation in the biological world, instead of a reified thing reveals, as Deely reminds us "those 'things' or 'perceived objects' that we [mistakenly] *call* 'signs' – such as traffic lights, barber poles, words, [thoughts], and so on, are not, technically speaking, *signs* – but only *vehicles* of signification" for the system whose intrinsic-extrinsic relations are arranged accordingly (Deely 2001: 434). Biosemioticians will later argue that, Rather than being a "purely semantic" distinction, Poinsot's understanding, if adopted widely, may help constitute a radical corrective to the futile attempts to discover what it is about neurons (or about nucleotides, or second messenger molecules, or spoken sounds or the ink marks on this page) per se that "signifies" or is a "sign" of anything.

So re-oriented, the discoverable relevant relations "holding over" both system *x* and (entity, state or event) *y* – as those relations become actualized during the course of the interaction whereby *y* is acted upon as a *sign* of *z*, for *x* – can become the focus of empirical and falsifiable scientific investigation. While this may sound like a task only feasible within the massively complex calculations of advanced dynamics systems theory, one should bear in mind that this was exactly the kind of principled scientific and naturalistic "sufficient explanation" that Aristotle was calling for when he wrote that the relations proper to *biologically* organized systems are "enmattered formulable essences" partaking of an interdependent, but absolutely non-mysterian and scientifically examinable "double character" that any full explanation of such systems has to include in its account. "Hence," writes Aristotle

> a physicist would define an affection of soul differently from a dialectician . . .the former assigns the material conditions, the latter the form or formulable essence . . .Thus, [for the dialectician], the essence of a house is assigned in such a formula as 'a shelter against destruction by wind, rain, and heat'; while the physicist would describe it as 'stones, bricks, and timbers.' But there is a third possible description which would say that it was *that form in that material with that purpose or end*. Which, then, among these is entitled to be regarded as the genuine physicist? The one who confines himself to the material, or the one who restricts himself to the formulable essence alone? Is it not rather the one who combines both in a single formula? (*De Anima: i*).

Thus, from Poinsot's formulation to our current understanding about the generative, recursive dynamics of autopoetic systems, it is only one small step to realizing the full import of Aristotle's assertion about the "double character" of "enmattered formulable essences" in biology (where systems really do have locally teleological "purposes and ends"): i.e., that sign relations are those genuinely existing, materially manifested relations that *join* system-internal and system-external relations into a web of utilizable experience for *all* organisms – and, indeed, this is one of the founding premises of the contemporary project of Biosemiotics.

And yet, given the success of the medievals in deepening their understanding of the fundamental nature of sign relations to this point, one would hardly think that the time was ripe to abandon the progress made thus far altogether and to assert an even more radical separation of mind-dependant relations from 'reality' – if those mind dependant relations were not genuine configurations in the world, but independently existing immaterial 'entities' with a mysterious kind of origin and ontology of their own. The modernists will come to refer to these reified phlogiston-like entities as "thoughts" and "ideas" – and this mischaracterization will have serious consequences for the development of science as a whole. In the following section, we will explore this next and most debilitating epistemological turn in the history of sign theory in science. The will be the onset of a new kind of "Dark Age" wherein an acknowledgement of the biological reality of the sign *qua* sign relation, and its primacy in the organization and interaction of living being, becomes temporarily lost to view.

What will replace the understanding of the natural world as a place of interdependent and intersecting relations giving rise to a variety of semi-autonomous entities and forces will be the idea of a world of fundamental entities and forces interacting mechanistically to give rise to only more complexified versions of themselves. Causation, in this framework, can only be material and efficient – entity and force – leaving no room in the world of explanation (and, by extension, in the world) for the unique forms of causality exerted by formality and finality per se. Thus, instead of being understood as kinds of relations that systems can be in such that they exert a unique kind of causal efficacy of their own – one that would call for a more general and interdependent understanding of "entity" and "force" – formality and finality, having no place in the scheme of atomistic billiard-ball causality, were relegated to the newly-created ghostyard of explanation that was the impenetrably private "immaterial mind."

Such a discontinuous and divisive posit would itself constitute a schism between the classic-scholastic tradition of thinking and any possible system of cohesive

thought that could follow. Yet such a schism is, indeed, precisely what René Descartes had in mind when he announced his project to renounce all prior knowledge, and build the edifice of understanding completely anew, in 1641, in his nightgown, by the fire.

Phase Two: Science Without Semiotics

> What is a man? Shall I say a reasonable animal? Certainly not; for then I should have to inquire what an animal is, and what is reasonable; and thus from a single question I should insensibly fall into an infinitude of others more difficult; and I should not wish to waste the little time and leisure remaining to me in trying to unravel subtleties like these.[14]

So wrote the mathematical and philosophical genius René Descartes in 1641, thereby expressing his resistance to the prospect of becoming a biosemiotician, right at the outset of modernity – a modernity that this particular resistance not only heralded, but actually helped to bring into being.

The subsequent history of this resistance would fill many volumes. However, no understanding of the current state of biosemiotics or of the conditions which made its emergence necessary, if not inevitable, would be genuinely intelligible without a brief re-telling of an oft-told tale regarding yet another decisive turn in the road that has led us to our present pass – children of a hostile, and yet impossible, divorce between not only mind and body, nature and culture but, now too, unexpectedly, between scientific explanation and ordinary human understanding – a tale that the philosopher Bruno Latour has christened "The Strange Invention of an 'Outside' World" (1999: 3).

René Descartes: Bifurcating the Natural World into Body and Spirit

It seems natural to us, as the inheritors of Descartes' intellectual legacy, to set the terms of our understanding in the form of an "experiential debate" between that which is "in the world" independent of any minds, and that which is "in our minds" independent of what is in the world. As a consequence of the very terms of this experiential debate, however, latter stands in relation to the former as a kind of impotent Platonic shadow or blind mendicant – and the mind becomes the impenetrable glass through which we see the world darkly, rather than face-to-face.

Yet this commonplace modern understanding, like all human understandings, no matter how infrequently considered, has an interesting and illuminative history of its own. For René Descartes by no means came upon his radical ideas *ex nihilo*, regardless of how he would have us understand him doing so (or, indeed, as he himself may have understood himself as doing so) in the *Meditations* of 1641. For by 1641, both the scholastic tradition and the hegemony of Aristotelian explanation of

[14] René Descartes, Meditations on First Philosophy, Meditation Two: On the Nature of the Mind, 1641 [1973: 80].

natural phenomena had all but passed into eclipse in Europe. Modern mathematical notation – one of the primary instruments with which both Newton and Descartes would revolutionize our ideas of what it is to "do science" – made its belated arrival on the continent only in the preceding century (where its initial denunciation by Church authorities as a "pagan notion" of the Arabs and the Hindus, and thus to be resisted, stemmed exactly as little of the rising tide of secularity as did their subsequent denunciations of the works of Copernicus, Galileo and Kepler, and for much the same reason: i.e., an exponentially individualistic and mercantile society, the calculus of utilitarian efficiency trumped the zero-sum game of static absolutism).

Yet while the gradual defenestration of Aristotelian physics had already begun in earnest with the works of Buridan (1300–1358) and Oresme (1323–1382) two centuries earlier, equally critical to the spirit of Descartes' project (and to the successful way that it resonated through the ensuing three centuries) was the turn away from received authority and toward the autonomy of the individual that was the *zeitgeist* of the later Middle Ages. Humanism, the Renaissance, a bourgeoning urbanite and merchant population, the Reformation, anticlericalism, the rise of the universities and the antagonism between change and conservatism that marks any such period of rapid development all formed the backdrop against which Descartes would "autonomously" resolve to "abandon the study of the letter, and to seek *no knowledge other than that which could be found in myself* or else in the great book of the world" (*Disc 1:9*).[15]

This was a move that was to prove critical for the subsequent history of Western thought, for what Descartes reports he finds when he looks inside himself is not an *innenwelt* of referential relations reaching out into the world and structured through participation in a ubiquitous human culture of symbolic reference stretching back at least 12,000 years to the establishment of human settlement (to pick an inarguably late but, because of that, uncontestable date in the evolution of symbolic culture). Rather, and bizarrely, he finds instead an immaterial solipsist who suspects he's being lied to.

"I suppose, then," Descartes writes, "that all the things that I see are false; I persuade myself that nothing has ever existed of all that my fallacious memory represents to me. I consider that I possess no senses; I imagine that body, figure, extension, movement and place are but the fictions of my mind . . . and of my former opinions I shall withdraw all that might even in a small degree be invalidated by the reasons which I have just brought forward, in order that there may be nothing at all left beyond what is absolutely certain and indubitable" (1641 [1973: 150]).

Descartes' project, of course, is a quest for "absolute" (read: non-relative) certainty – and the discovery of at least one contextless and necessarily true axiom or assertion that will serve as the foundation for a sturdy system of reliable and correct knowledge to be constructed. Having already devised one such sturdy knowledge-bearing system – that of analytic geometry and its Cartesian co-ordinate system – in 1637, Descartes now embarks on a radical version of the subtractive method in order to successfully discover a single Archimedean point of truth.

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[15] *Discourse on the Method of Rightly Conducting One's Reason and Seeking the Truth in the Sciences*, 1637 [1973: 24].

Thus convinced of the need to reject the *entirety* of received opinion from the past – as well as to renounce the belief in the primacy of embodied sense experience as being the most fundamental route to "knowing" – Descartes decides to consider as "false until proven otherwise" the entirety of both tradition *and* sensation and to seek absolute certainty in the only place then left available to him – i.e., "the thoughts *which of themselves* spring up in my mind, and which were not inspired by anything *beyond my own nature alone"* (ibid).

This decision to assume that methodological solipsism could serve as the foundation for the construction of a veridical, empirical science was, indeed, a "bifurcation" from the understandings of an inherently embodied cognition that had been assumed from antiquity and developed continually, if variously, by the scholastics right up until the time of Descartes himself (e.g., in the works of the Iberian school and, especially, John Poinsot).

Moreover, Descartes' attempt to "build anew from the foundation [and in so doing] establish a firm and permanent structure in the sciences" (1641 [1973: 144]) by first razing to the ground the edifice of inherited error and by then sterilizing himself against the deception of bodily interface with the world by denying the efficacy of embodied relations was ultimately only considered a completely *constructive* success by Descartes – who then goes on to build his edifice for the securing of absolute certainty anew upon his *cogito*, and its corollary proof of the prerequisite existence of a benevolent and non-deceiving God.

Yet, "having abjured history as a means to truth," writes philosopher of science Alisdair MacIntyre, "Descartes recounts to us his own history as the medium through which the search for truth is to be carried on" (1974: 59). And as it is this account that set the course of the next three centuries of thinking about "knowing" in the West, it is worth considering MacIntyre's analysis of Descartes' history-changing enterprise in full:

> "Descartes starts from the assumption that he knows nothing whatsoever until he can discover a presuppositionless first principle on which all else can be founded. [In so doing] he invents an unhistorical self-endorsed self-consciousness and tries to describe his epistemological crisis in terms of it. Small wonder that he misdescribes it. . . .[for first among the many features of the universe and about his own historically embodied being] he does not recognize that what he is *not* putting in doubt is his own capacity to use the French and Latin languages . . . .[as well as] what he has inherited in and with these languages: namely, a way of ordering both thought and the world expressed in a set of meanings. These meanings have a history . . .[but] because the presence of his languages was invisible to Descartes [he does not realize that] how much of what he took to be the spontaneous reflections of his own mind is in fact a repetition of sentences and phrases from his school textbooks – even the *Cogito* is to be found in Saint Augustine" (1974: 60).

Inspired by the reformationist and revolutionary *zeitgeist* of his time, however, Descartes was not the only one of his contemporaries agitating for a clean break with the medieval past. The feeling had been growing, rather, at least since Petrarch retroactively designated the preceding thousand years, between the collapse of the Roman Empire and his own 14th century Italy, to have been "the Dark Ages" of human thought. The multiple European Renaissances, the Protestant Reformation, the rise of the mercantilism and the rapid advancement of printing, lens and machine technologies: all played their parts in laminating this retrospective construction of

a "backward" time from which humanity was finally emerging – and contributed to an idealization of the individual "over and above" history and nature – without which the self-conscious seeding of a "scientific revolution" in the first part of the 17th century could hardly have fallen upon more fertile ground.

But if we see the coalescing of this scientific revolution, as most historians rightly do, as one of the major branching-off nodes in the cladistic history of Western thought – and, more importantly, as the branch on which we yet now reside – it will do well for us to examine what Descartes and his radical contemporaries may have unwittingly 'left behind' at this consequential forking of the roads . . .as it just may be something we are going to have to go back and retrieve today if we are to carry on the very vision of scientific progress that Descartes and his contemporaries have bequeathed to us.

For in "asking how an isolated mind could be *absolutely* as opposed to relatively sure of anything in the outside world," notes historian and anthropologist of science Bruno Latour, Descartes "framed his question in a way that made it impossible to give the only reasonable answer . . .[i.e.,] that we are *relatively* sure of the many things with which we are daily engaged . . .[But] by Descartes' time, this sturdy relativism, based on the number of *relations* established *with* the world, was already in the past, a once-passable path now lost in a thicket of brambles" (1999: 4).

Medievalist John Deely echoes Latour's point, expanding upon it even more precisely when he observes that "if we put [late-medievalist John] Poinsot's claim that the doctrine of signs transcends *in its starting point* the division of being into *ens reale* and *ens rationis* into contemporary terms, [then] what is being asserted is that semiotic [whereby the worlds of mind-dependent relations and mind-independent relations are bridged for the cognitive agent through the mediating relation of sign use] transcends the opposition of *realism* to *idealism*" that has come to define the "mind-body" and the "knowledge/fact" debates initiated by René Descartes and persisting to this very day (2001: 483).

With Descartes, rather, "the priority of *signs to objects* becomes lost to view, and [thus the] *objects of experience* become not a partial revelation of surrounding nature and culture, but a screen separating the mind from things" (Deely 2001: 520). Unfortunately, Descartes was not alone in advocating "radical surgery" that would amputate *res cogitans* from the rest of *res extensa* and banish it to its own little private world – an immaterial world, moreover, that would soon be recognized as a scientifically unexaminable world – and yet the only world, supposedly, in which something as ghostly and non-localizable as "sign relations" could appropriately be thought to dwell.

"Nothing Lost": Modernity Proceeds Apace

Certainly, William of Ockham (1285–1349) may have helped forge the blade for Descartes' radical surgery with his own wholesale denial of the existence of mind-independent universal relations and the reduction of our apprehension as such to "only thought-objects in the mind (*objectivum in anima*)" (1323 [1991]) – a

considerable ontological demotion of Aquinas' (1225–1274) far more subtle (and biosemiotic) understanding of the apprehension of such relations – like all sign relations – as partaking of "a dual being: one in singular things, another in the soul, and both [contribute their respective] accidents to it" (1252 [1965]). Even more balefully, it can be seen that at the heart of Ockham's cutting away is a dissection that offers no complementary implement for then suturing mind and world back together again.[16]

The more immediate precedent for Descartes' dualism, however, was undoubtedly Francis Bacon's *Novum Organon* – the "new instrument" that, in 1620, announced the inherent futility of reliance on "a mind that is already, *through the daily intercourse and conversation of life,* occupied with unsound doctrines and beset on all sides by vain imaginations" (1620 [1863], italics mine). Instead, and again very much in the spirit of his age, Bacon would proclaim twenty years before Descartes that "Our only remaining hope and salvation is to begin the whole labour of the mind again. . .[and] that the entire work of the understanding be commenced afresh" (*ibid*).

Like Descartes, Bacon saw "error" as a ubiquitous product of the men both of his time and of all time before him – and, like Descartes, rather than understanding fallibility to be an intrinsic aspect of the effective functioning of symbolic reasoning – sought a "mechanism" designed to subtract it out of the human repertoire entirely.[17] "The mental operation which follows the act of sense I for the most part reject," declared Bacon, anticipating Descartes' dream argument (though not his ball of wax). "There thus remains but one course for the recovery of a sound and healthy condition – namely, that the entire work of the understanding be commenced afresh" – again, prefiguring Descartes here, but now advancing the completely contradictory prescription that: "the mind itself be from the very outset not left to take its own course, but guided at every step; and the business be done as if by machinery" (*ibid*).

Bacon's mind-correcting machinery would come from outside: in the communally objective project of empirical experimentalism and induction. Descartes'

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[16] It would yet be several centuries after Descartes' attempt to describe the non-minded world of animals as "mere clockwork mechanisms" (1649/1991: 365–6, 374) – and almost 100 years after Lloyd Morgan would deploy his Occamite Canon – before biologist Francis Crick would note that: "While Occam's razor is a useful tool in the physical sciences, it can be a very dangerous implement in biology" given that the evolution does not organize living beings "parsimoniously" in any straightforward kind of sense. "It is thus very rash to use simplicity and elegance as a guide in biological research" warns Crick (1988).

[17] The tradition of seeing the human being as the perpetually duped and deceived animal – *homo decipi*, as it were – would turn out to be one of the most enduring, if unfortunate, tropes of all modernity, snaking its way out of Plato's cave, through the "revolutionary" pronouncements of Marx and Freud, and to the "revelationary" pronouncements of neuronal and genetic eliminative materialism on the one hand, and the pseudo-postmodernism of "radical deconstructionism" on the other. As I have argued elsewhere (Favareau 2001b), nothing could be more diametrically opposed to the understandings advanced by biosemiotics than this self-regarding yet internally-contradictory stance that I hereby dub "the Fallacy fallacy."

mind-correcting machinery would come from within: in the irrefutable and eternal truths of mathematics and logical deduction. Abduction – the mind-producing process of acting upon what is presently given in an exploratory fashion, equipped only with the underdetermined understandings that have proved most effective thus far – was out of the picture for the interim (at least "officially" and in the symbolically self-reporting human world; the animals, we may assume, were going about their business as they always do: abductively, but not self-reflectively so).

And though neither Bacon's error-reducing inductive method, nor Descartes' error-reducing deductive method succeeded in being adopted by their contemporaries *in toto*, the enacted *synthesis* of their mathematical-experimentalist methodologies – when coupled to the engine of generatively recursive collectivism initiated by the Royal Society in 1660 and still self-developing healthily to this day – would prove to be the single most effective technology for the securing of veridical knowledge ever developed by the mind of man.

Descartes' radical bifurcation, then, was not a failure – rather, in some sense it succeeded far too well. Which is to say that at least half of the severance was successful and went on to germinate beyond any reasonably foreseeable expectation. For after Descartes, the study of "bodies" would proceed entirely independently of the study of "mind" – their realms, after all, were separate in their essences – and thus the truth claims made by science need not be accountable to the truth claims made by the humanities, and vice-versa. And why should have the science of Descartes' time seen this liberation as in any way undesirable? As the more foundational of the two enterprises – in that the object of its study are those organizational principles of the world that exist extra-mentally and can only derivatively be "known" by human beings – why assume the additional burden of having to explain how it is and in what way a human being can come to "know" anything to begin with?

Bacon's experimentalism was soon institutionalized by Robert Boyle's (1627–1692) foundation of "public science", and the establishment of the Royal Society in 1660 made it clear: the laboratory would be the theatre of evidence, and what could not be shown there was outside the realm of science proper. To this domain of the visible and the material, the pure truths of mathematics would soon, too, be admitted, as a result of the works of Isaac Newton (1643–1727), thereby also vindicating Descartes. Thus armed with the error-correcting mechanisms of both induction and deduction – and with the exponential power of a group of interacting agents pursuing individual ends within the *telos* of a formalized system – the study of "bodies" and their material relations would allow human beings to actually leave the planet and return to it in less than another 300 years.

The other half of Descartes' explanatory bifurcation, unfortunately, did not fare as well. Amputated from the natural world of material and logical relations from which it came, "the mind" and all of *its* internal relations – e.g., sensation, perception, subjective experience, knowledge and, in the singular case of human beings, language and symbolic thought – was increasingly ruled unfit as an object of genuine scientific inquiry, and was as such left to hobble down an increasing impoverished back-lane of abstraction, speculation, and pure, virtually ungrounded symbol

use. For one of the more unfortunate effects of Descartes and his contemporaries' uniquely influential attempts to cure subjective error was that the "subject" began disappearing from scientific inquiry altogether.

But what needs to be foregrounded here is that it has never been the absolutely natural property of living organization called "the mind" (or, as neuroscientist Rudolfo Llinás (2001) is quick to clarify, "the property of being minded") per se that is to blame for this sad state of affairs. This condition is found everywhere throughout the animal world, once one realizes that the biological system property of "mind" is no more *synonymous* with "human (symbolic, linguaform) mind" than the term "body-" is synonymous with "human (biped, mammalian) body"– and that those creatures lacking language and the ability for abstractive thought are no "less" minded in the functional and biological sense than those lacking opposable thumbs (or, for that matter, gills or wings) are any "less embodied." Here, as everywhere in the natural world, huge differences in capability, capacity, and the structures which have evolved to meet the real-world challenges of life vary extraordinarily across species. But respiration remains respiration; digestion, digestion; locomotion, locomotion; and reproduction, reproduction regardless of whether we are talking about live birth and sexual copulation, egg-laying practices, pollination strategies or spore formation. There, and rightly so, the whole range of relevant and incommensurable differences is openly acknowledged, *in the full acceptance and understanding* that these species-specific adaptations are all serving precisely the one same biologically analogous end.

The single most compelling reason that the biological function of "knowing" is not likewise included in the list of universal attributes of living organisms is *not* because it isn't happening (and happing as variously and as species-specifically as does every other biological universal), but because our very conception of what *constitutes* "knowing" has been warped by Descartes' conflation of "mindedness" per se with "human mindedness" – and "knowing" per se with "symbolic cognition" (again, see Deacon 1997 for a very clear discussion distinguishing between these two *very* different life processes whereby organisms "know" the world).

Persistently, in the back of our minds (which might explain something right there!), we tend to equate "mind" and "knowing" *only* with our particular form of adaptation to this universal biological need.[18] Yet doing so, presents us with a two-fold problem: First, if all of the fine-tuned purposive, responsive, evasive, interactive and anticipatory behavior that we observe taking place *ubiquitously* throughout the animal world cannot be calling "knowing," then what shall we call it when, say, a previously motionless copepod reacts to the sudden presence of a quickly approaching predator by discharging a bioluminescent "depth charge" that is time-delayed so as to burst into illumination far from its site of origin in the copepod itself, instantly alerting the predator and sending it off on a false line of pursuit while the copepod

[18] A joke commonly attributed to comedian Steven Wright captures the dilemma well: "Last night I was all alone in my room and I started thinking, "You know, the human brain is probably the most magnificent structure ever created in nature." . . .but then I thought: "Wait a minute. Who's *telling* me this?"

swims safely away? Are we to say that the self-reflexive ability to symbolize its own experience and to articulate that set of symbols to another are the *criteria* for "knowing" per se? If so, then the bee can never "know" what flower to land on, the deer can never "know" which other animals in its surround to mate with and which to flee from, the penguin can never "know" which chick is her offspring, and – in fact – all other living beings except the human remain essentially the input/output automatons that Descartes claimed they are.

The second problem that this faulty definition raises is this: *If* all animals other than human beings are now and have always been mind-less, how did the human being "evolve" its own mind *ex nihilo*? The problem is a classic *reductio ad absurdum*, once "supernatural" explanations are deemed illegitimate. And remember, it was and is only supernatural explanation that allows Descartes to assume his bifurcation in the first place: God imparts to man a bit of His own Divine essence – "mind" – but He pre-programs the organization of all the other animals' lives "for them" by building into the mechanics of their mindless input/output actions His own Divine plan. It all seems a "bit much" to accept so uncritically at this late date, but not deliberately going back to examine one's inherited and critically unexamined starting assumptions often results in such odd effects . . .as Descartes himself realized all too acutely.

Finally, the unexamined conflation of "mind" with "human mind" leaves the entire question of the species-specific peculiarity of this kind of human "mindedness" untouched. If we are, indeed, dealing with yet another product of biological evolution, what is it that allows the human mind to engage in abstractive, symbolic reasoning, self-reflective intellection, "language games" of all kinds and the ability to imaginatively manipulate reality "off-line" as it were? What is the nature of this kind of cognition and sign use – and in what ways is it similar to and different from its functional counterparts in the lives of the termite and the baboon? Should we look for its source in the physical structure of the brain, as we look for the source of generating the ultrasound of echolocation in the larynx of the bat? Or should we, as Andy Clark (1997) suggests, look also in the distributed cognitive prostheses of the surrounding environment where we "off-load" our symbolic representations for cognitive exploitation in the way that the bluefin tuna exploits the very water vortices it produces in order to propel it along at speeds its own body could never accomplish on its own?

Few of these questions had even been asked prior to the last ten years – and far too few of them are being asked today, precisely because of the persistence of the still far too institutionally enshrined Cartesian conflation of "mind" with its specifically species-particular form of linguistic representation and symbolic reference – and, in some cases, its even less intellectually defensible notion as a disembodied and somehow self-realizing autonomous "entity." This persistent Cartesian misconception has been perhaps the single greatest "block [upon] the road to inquiry" (in the words of Charles S. Peirce), steering natural scientists away from the problem for centuries, and causing the subsequent "investigations" into its nature by philosophers after Descartes, time to become the embarrassingly fruitless project that it has been.

And this is the reason why we have spent so much time discussing this particular fork in the road. For with the explanatory surgery of Descartes' "mind-body bifurcation" now strongly in place by the end of the 17th century, the unparalleled success of the "body" sciences – including the "body" aspects of the biological sciences – were all but officially absolved from worrying about questions of subjective knowing in general, and thus felt no real pressing need to "waste what little time and leisure remaining . . .in trying to unravel subtleties like these" (Descartes 1641:[1973: 80]). Equally unhappily, those thinkers who did, felt an increasing lack of need to consult, or eventually to even be conversant in, science. Descartes' divorce between "material reality" (*res extensa*) and "knowing reality" (*res cogitans*) had worked too well, and the subsequent "history" of natural science – a science that must include beings that *both* know *and* are material – was explanatorily the worse for it.

"History," however, is a notion that comes to us from the Latin word for "narrative" (*historia*) which itself derives from the ancient Greek word for "witness" (ἵστωρ). Thus, unlike the linear record of geological change, history – even scientific history – has actors and, to paraphrase Chekhov, "if there's a gun on stage in act one, chances are that it is going to go off in act three" (1904). And this is precisely what happened next.

From Dyadic to Triadic Relations: "Information" Invades the Scene

Running off the momentum of the newly institutionalized *Novum Organon* of the Royal Society, the 17th through 19th centuries saw an explosion of biological knowledge initiated by Leeuwenhook's deployment of the microscope. Over time, the cellular structures of plants and animals, the exchange of nutrients and gases, the developmental stages of life from inception to death, and the synthesis of organic compounds from inorganic materials were all discoverable through the use of laboratory instruments, while fitting in perfectly with a growing but coherent corpus of physical and chemical understandings. It is only with Wilhelm Johannsen's (1857–1927) introduction of the "gene" concept in 1909 that "information" per se – and not merely its physical something that is going to have to be accounted for by science.

But "information," under the Cartesian schema, could only be one of two things: either a relation proper only to the mind – in which case it was scientifically unexaminable *perforce* – or a pure product of material interactions, operating under mathematico-logical conditions – in which case it was not truly "information *of*" something, but merely whatever it happened itself to materially be (e.g., a catalyst, an agonist, etc.). Von Baer's (1792–1876) discovery of the epigenetic development of the fertilized ovum into structures expressing hereditary traits, however, made both these definitions equally unsatisfactory.

Thus, in coining the word "gene" to denote "the functional unit of heredity" – whatever it might turn out to be – Johannsen, much like today's biosemioticians,

merely thematized – and by so doing explicitly problematized – what was implicitly being "discussed but not discussed" with the acceptance of von Baer's non-preformationist germ layer theory of embryonic development in 1827. For if preformationism is wrong, and an organism's cellular structure is not pre-given but developmental – as von Baer's experiments in comparative embryology showed it to be – then some "information exchange" is taking place within the developing embryo in order for undifferentiated cells to become differentiated tissue and thereafter, the resulting structures of arms, brains, livers and limbs.

Johannsen, again, had no more insight into what precisely this "unit of heredity" might turn out to be, nor how it functioned as it did, than did Darwin, Galton, Mendel, Flemming or Weismann – all of whom also posited germ theories of inheritance that, at their core, remained wholly unexplicated with regard to exactly *how* the interaction of this "germ" with the rest of the cellular material could result in the development of absolutely novel structure when at all points there is only. . .the germ and the material.[19] That it does so is clear – but just what the process *is* that explains its ability to do so was a question that the science of Johannsen's time had not even a coherent vocabulary for conceptualizing.

In delineating the distinction between hereditary genotype and metabolic phenotype, however, and in assigning a property to this gene that was in essence *informational* (in that it served to function for the creation of something other than itself for the system that it was embedded in as, materially, itself), Johannsen opened up the "problem of information" in a science that, since Descartes, had nothing but success in dealing with things that acted merely as what they were materially – and not things that acted both as what they were materially and what they were not, but could be used to functionally "stand for."

And accordingly, while great strides have subsequently been made in our understanding of the purely material relations underlying "the genetic code" – conceptually unclear still is the absolutely scientifically legitimate question of just in what sense *information* – defined not just as the inanimate sequence of nucleotides themselves but as the *functional relation* of those nucleotides to a system *for which* they serve as "sequences of code" – can be thought to be an intrinsic property of *things*. For Francis Crick, articulating his "central dogma" of genetic inheritance, "information" was synonymous with "the sequence of amino acid residues" per se (1985: 1); and for Claude Shannon and Warren Weaver, "information" was the diminution of uncertainty in a system absolutely without regard to cognitive

[19] Again, we are in an analogous position when we try to understand how "signs" of any kind – the ink marks on this page, the waggle dance of bees, a voltage change generated in a cortical neuron – comes to signify something other than itself, when there is only, physically, itself. And the answer of course, here and on the genetic level, is that we must look at "information-bearing" things not in their material isolation – where they are, in fact, nothing but themselves – but also in the function that they serve in the system that makes use of them *as* signs, in order to see how they can be both "nothing but themselves" and "standing for something other than themselves" in the operation of that system. Exploring this logic of relations within the scientific paradigm is, of course, the *raison d'être* of biosemiotics.

or semantic considerations (1949: 8). Both Crick's notion of "information flow" from gene to protein and Shannon and Weaver's mathematical theory of "communication across a channel" thus explicitly deny that the "information" that they are talking about "means" anything in the sense that we associate with the word "meaning."

But here again, we see the intransigent Cartestian conflation still subtly, and perniciously, at work, undermining even the possibility that material relations and symbolic relations might stand in any other relation to one another than that of mindlessness to human-minded. And thus, the rationality driving both Crick's that and Shannon and Weaver's denials is based upon the assumption that all "true meaning" is *symbolic* meaning – i.e., kind of relation that human beings are exploiting when they talk using language or think in terms of abstract representations. And in this sense, of course nucleotides and the exchange of electronic pulses along a length of wire carry no "*symbolic* meaning." Why, then, use this strange word "information" to describe them?

The lexical decision choice made here – as with the use of the terms "signal" in molecular biology, "message" in neuroscience and "communicates" in animal ethology – is, according to biosemiotician Marcello Barbieri, for all parties to understand that "the 'code' for talking about the genetic code is that the term "genetic code" is only a metaphor, and should not be understood as denoting what it would denote in everyday usage" (2003: 229). But if so, and in regard to the other three instances also: the question reasserts itself this 'metaphor' is a metaphor for what? "Processes we do not yet understand," certainly. But what kind of processes? It would seem that the answer is: not just physical processes *qua* their physics, but exclusively biological processes wherein physical phenomena are being acted upon by living systems as if they were veridically informative, representational and meaning-bearing phenomena. And once the existence of such genuinely *semiotic* processes in nature is admitted, a pressing question for science then becomes: How are we to investigate and understand these processes that are both ineliminably physical *and* ineliminably semiotic at the same time?

Yet the refusal to cross the self-imposed Rubicon inherited from the Cartesian legacy – a refusal born out of fear, generally, that if one does engage with issues of "meaning" one has automatically "crossed over" and *out* of the realm of doing real science – prevents theorists like Watson and Crick and Shannon and Weaver from seeing in what way their intuitions to use the words "information" and "communication" can point both them and us to a deeper understanding of those terms, one which is neither eliminative and reductionististic, nor mystical and unfalsifiable, but utterly naturalistic through and through – *if* we remain open to the understanding (that our dedication to science demands of us) that *all* things in the natural world evolved out of that natural world and nowhere else.

If, in other words, there are biological creatures that are alive today that use symbols, and exchange meanings, and have culture, and can deal in counterfactuals and can think abstractly – as undoubtedly there are – *and* there are other living beings evolving under the same physical conditions who are constituted from virtually the exact same genetic material, and who have developed myriad of other capabilities,

but just not those particular ones last listed – *and* you deny at the outset that all of this is the result of a Divine miracle – *then* 'thoughts', 'meanings', 'symbols', 'culture' and everything else that we associate today with the human mind must be *grounded* in the structures, events, principles and relations that constitute the natural world. Understanding this, the research questions then become: What particular relations in the naturally occurring world does human symbolic understanding exploit differently, say, than primate indexical understanding does, or that the iconic relations chemotaxis affords for the amoeba? Are the earlier processes still at work in the later ones? How much and what kind of environmental restructuring is necessary for the full functioning of each? And *is* there a primitive organizational sense whereby the digital "differences" in electronic pulses down a length of wire (or, in the biological case, an axon), and the sequential differences in base pairs affixed to the phosphate backbone of a DNA molecule really *do* in-form the immediate next moment of consequential change in a living system? How does all this work? And how does all this work *together?* These are the questions that biosemiotics will wind up asking, seeking *not* a reductionist anthropomorphism of "all things in nature as human" but just the opposite: a principled evolutionary and biological understanding of how all things in human (and in animal life) are natural – including "knowing", including "meaning", including "thought" and because of these last three, including "signs."

Interestingly enough, however, it is not the biosemioticians who stand ready to reject the notion that the biological set of relations constituting "sign processes" are, in fact, massively complex, organically organized material interactions; most biosemioticians would rejoice at such a discovery. Conversely, it is far too often the committed physicalist who so closely (and so incorrectly) equates the entire category of "semiotic processes" with the one limiting case of symbolic, human mental processes, that to talk about the former *is* to talk about the latter – in which case, of course, they are completely right to reject the initial premises. Descartes' bifurcation, in other words, is continuing to keep the sciences of material interaction and the sciences of semiotic interaction apart.

But if biosemiotics has any one single most constructive message to give the mainstream scientific community, surely it is precisely this: a semiotic process is not a ghostly, mental, human thought process. Rather, it is, in the first instance, nothing more nor less mysterious than that natural interface by which an organism actively negotiates the present demands of its internal biological organization with the present demands of the organization of its external surround. And the fact that this is done incessantly – by all organisms, and by us – should not blind us to the significant fact that such moment-to-moment activity is always and perpetually an *enacted accomplishment* – and thus one that is going to have to be explained, if we are ever to understand the bio-logical side of living organisms' material interactions.

Yet so scandalous and counter-intuitive was this notion of genuine sign relations in nature – so drenched with and indistinguishable from, as it were, their singular symbolic manifestation as "mental thoughts and human words," Descartes' 'divine birthright of human intelligence' – that when Darwin's contemporary George

Romanes (1848–1894) presented anecdotal evidence in support of even the possibility of animal intelligence, Edward Thorndike (1874–1949) announced that the goal of his own work would be dedicated to disprove "the despised theory that animals reason" (1898: 39). How human intelligence could ever have "evolved" out of a world of absolutely non-semiotic animal relations then becomes something of a paradox – and, in fact, J. B. Watson (1878–1958) and B. F. Skinner (1904–1990) drew out the logical entailments of this view to eventually argue that human mental states, likewise, were "an illusion" – a position implicitly endorsed by the approach of many manifestly competent neuroscientists, and explicitly argued for in the "eliminative materialism" of Paul and Patricia Churchland (1984, 2002). . .still victims of Descartes' destructive dualism, even after all these years.

Not surprisingly, then, do we begin to see at the dawn of the 20th century, cracks and fissures arising in the scientific edifice out of internal tensions generated by the need to keep "subjectivity" out of science not only in its methodology, but also as a focus of investigation – despite the absolutely undeniable facts that: (1) the natural world is full of subjective agents, (2) that the natural world itself must have produced these subjective agents once one rules out the possibility of supernaturalism as a legitimate scientific explanation, and (3) that it is the subjective experiences of these agents that lead them to act upon the natural world in ways that materially *change* that world (and in so doing, change the substrate that world then becomes for the evolution of subsequent subjective agents. . .). All of this undeniable natural phenomena only becomes denied *as* "natural" phenomena with the adoption of the quite unnatural bifurcation insisted upon by Descartes that puts the entirety of human "mind" – along with every kind of "knowing" operation one might conceivably be tempted to assign to the purposive behavior of non-human animals – into the ghostly realm of the absolutely immaterial . . .and, again, despite the overwhelming evidence to the contrary of the existence of a plentitude of knowing, material, purposively acting, biological beings.

Moreover, not only was Descartes' legacy of ontological bifurcation causing cracks and fissures to appear in the explanations being offered for any researcher in the biological sciences who looked too closely at the obviously enacted subjective experience of living organism and the informational capacity of the genetic code, but it was also exerting a complementary tectonic pressure on the long line of philosophers, humanists, and researchers in the social sciences, who found themselves on the other side of the Cartesian divide, trying ever unsuccessfully to meet a challenge that, by its very premises, could never be met. Eventually, a few of the most frustrated – which may really be to say, the most committed – members of these two groups started pushing back against their respective fields' Procrustean demands and Cartesian boundaries, and began scouting around on distant coastlines in an effort to more effectively redraw their disciplinarily inherited, but increasingly unusable maps.

It is to that ever-growing group of interdisciplinarians that we now turn, for their work will provide our entrée into the current state of the field, constituting, as it does, the most recent evolutionary turn in the natural history of *biosemiotics*.

Phase Three: Science with Semiotics

> The key question lying at the root of all this is: How could natural history become cultural history? Or, to put it another way. . .How did something become "someone"? – Jesper Hoffmeyer, *Signs of Meaning in the Universe* (1996: viii).

Because the current cohort of scholars constitutes the "first generation" of self-identified biosemioticians, the history of this cohort as a whole would have to consist in the history of each member, as he or she – faced with the internal contradictions or explanatory evasions of their home discipline – made their own unique pilgrimage to a place where biology and semiotics merged as one. Although doubtlessly fascinating, it would be impossible here to recount all these individual journeys from Istanbul and Los Angeles, Helsinki and Bologna, Toronto and St. Petersburg, Sao Paolo and Prague, and to describe the many and various disciplinary sites of origin spanning across biochemistry and philosophy departments, dynamic systems research labs and anthropological field sites, as well as lifelong private research investigations of individual scholars, many of whose final destinations are, as of this writing, unknown.[20]

What we must do here instead, in order to bring coherence to this account, is to focus on just those few figures most responsible for bringing this diverse group of scholars together. These would be the outspoken interdisciplinary organizers whose explicitly stated program of coalescing semiotics and biology increasingly attracted similarly inclined scholars into their orbit, and whose journals, conferences and book projects would come to constitute the gravitational center around which the interdiscipline of *biosemiotics* would gradually coalesce. And of this handful of "outspoken interdisciplinary organizers" perhaps none was more outspoken, more interdisciplinary, and more organizationally active and astute than the late Thomas A. Sebeok (1920–2001), without whom the current interdiscipline of biosemiotics would not have taken shape in its present form.

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[20] Moreover, and by necessity, not every attempt at a science of biological sign-use undertaken even in the last half century can be included in this short history. Such a survey would, of course, be impossible given the space available and would, by necessity, involve long discussions on the history and major figures of comparative psychology, cognitive science, molecular biology, Artificial Intelligence, pharmacology, cognitive neuroscience and much much more. Yet it is only because of such space limitations that even the individual accomplishments of such generally accepted "proto-biosemioticians" as Elia Sercarz (1988), Sorin Sonea (1988), Günter Bentele (1984), Yuri Stepanov (1971), F.S. Rothschild (1962), and Marcel Florkin (1974) are not discussed at length in this overview. This is not to say, however, that the works of these researchers are insignificant to the larger project whose narrative is recounted here. Florkin, Stepanov and Rothschild – a molecular biologist, a text semiotican, and a psychologist, respectively – each independently coined the term "biosemiotic" to describe where they wanted their investigations to be heading. But because no interdisciplinary movement resulted from these individual efforts, I have made the purely editorial decision to refrain from any in-depth discussion of them overview, and the works of Florkin and Rothschild are examined in much detail later in this volume. No slight on my part is intended by these purely editorial decisions, and those wishing to consult the original works are directed to the bibliography, as well as to the more inclusive "pre-histories" of biosemiotics by Sebeok (1998, 2001a) and Kull (1999a, 1999b, 1999c, 2005).

Joining Sign Science with Life Science: Thomas A. Sebeok

While a growing number of isolated scholars working in widely-separated disciplines were all working away at various *independent* lines of inquiry into the problems of information processing, intercellular communication, behavioral psychology, neurobiology and animal ecology – and long before the birth of such self-consciously "interdisciplinary fields" as "artificial intelligence" "dynamic systems research" or "cognitive neuroscience" – an academic polymath who once described himself as something akin to an "*Apis mellifera,* who darts solitary from flower to flower, sipping nectar, gathering pollen [and] serendipitously fertilizing whatever he touches" (Sebeok, 1995) was to pioneer the practices that the modern-day university refers to as "interdisciplinarity" in the course of founding the project that today bears the title of *biosemiotics.*[21]

This self-described *apis,* Thomas A. Sebeok (1920–2001), left his native Hungary at age sixteen to study at Cambridge University, before immigrating to the United States, where he received his doctorate in linguistics from Princeton in 1945 while simultaneously doing research under both Roman Jakobson at Columbia University and Charles Morris at the University of Chicago (Bernard 2001). A specialist in Finno-Ugric languages, Sebeok's appointment as the head of the Department of Uralic and Altaic Studies at Indiana University led to decades worth of extensive fieldwork not only investigating the internal organization of linguistic systems per se, but also in investigating the higher-order manifestations of such systems, in the form of anthropology, folklore studies and comparative literature (ibid).

Sebeok's growing interest in the organization of semiotic systems in general, combined with his aforementioned polymath intellect, led him to carry out some of the first computer analyses of verbal texts; to investigate the use of nonverbal signs in human communication; and to establish, with Charles Osgood, the pioneering interdisciplinary field of *psycholinguistics* in 1954. Six years later, during a fellowship at Stanford University's Center for Advanced Studies in the Behavioral Sciences, Sebeok indulged his lifelong passion for biology, studying both nonverbal human sign behavior as well as the communication practices of animals, both in the wild and as domesticated by human trainers (Tochon 2000). From this intense period of study came his programmatic call for the founding of the study of *zoösemiotics* – "a discipline within which the science of signs intersects with ethology, devoted to the scientific study of signalling behaviour in and across animal species" (1963).[22]

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[21] As is evident from the footnote above, Thomas A. Sebeok was not the first to coin the compound noun joining "bio" with "semiotics" (again, see Kull (1999a) for a detailed history of the use of the term) – however, it is the specific project that Sebeok initiated and christened as such that is the subject of this history and this book.

[22] Deely notes that it was Margaret Mead who, at the end of a contentious conference about animal communication that Sebeok had organized in 1962, proposed the specific form of the word "semiotics" to denote "patterned communication in all modalities, [whether] linguistic or not" (Deely 2004) – an understanding perfectly congruent with Sebeok's growing conviction that human

Sebeok's commitment to what he considered to be the two fundamental academic virtues of "publishing and teaching as much as possible and, equally importantly, doing one's best to facilitate the success of one's colleagues" (1995: 125, as cited in Kull 2003) led to his refashioning of the Indiana University's Research Center for Anthropology, Folklore, and Linguistics – of which he had been appointed chair – into the Research Center for Language and Semiotic Studies in 1956, and to the co-founding of the International Association for Semiotic Studies in Vienna in 1969. In his activities for both these institutions, Sebeok's reputation as a tireless book editor, indefatigable conference convener, inveterate journal contributor, and all around facilitator of academic interaction across continents and disciplines became (and remains) legendary among his peers.

Thus it was Thomas Sebeok who would be responsible, more than anyone else, for bringing practitioners from the life sciences and the social sciences into dialogue with each other for the course of the next almost forty years, resulting in the collaborative interdisciplinary project that we today know as Biosemiotics. The *Approaches to Semiotics* book series that he founded in 1964 eventually ran to 112 volumes over the course of its almost thirty year run; he was editor-in-chief of the journal *Semiotica* from its inception in 1969 until his death in 2001; and the list of international conferences that Sebeok played a role in initiating with the express goal of bringing scientists and semiotician together would constitute a document – and, indeed, it is one that has yet to be compiled.

Sebeok's Synthesis of East and West

Catalysts, by definition, enable reactions to occur much faster because of changes that they induce in their *reactants*. And so, too, it was with Sebeok who, in the course of building this interdisciplinary network (or symbiotic niche, as he might call it), must in addition be credited as the key figure most responsible for integrating both the current works and the rich theoretical traditions of otherwise forgotten academics toiling in the Soviet East into Western academia's collective consciousness. This he did often through his own smuggling of desperately proffered manuscripts across mutually antagonistic Cold War borders in the 1960s and 1970s (as memorably recounted in Sebeok 1998 and 2001) – actions which themselves serve as a wonderfully apt metaphor for his own "bee-like" approach to the unnecessarily antagonistic disciplinary partitioning between the science and the humanities that he devoted his entire career to cross-pollinating.

These trips darting in and out from behind what was then called the Iron Curtain turned out to have particular significance for the development of Sebeok's *zoosemiotics* program into what he would later call *biosemiotics* (Sebeok 1998). For while

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language "was not much more than that realm of *nature* where the logosphere – Bakhtin's dialogic universe – impinges in infant lives and then comes to predominate in normal adult lives" (Sebeok 2001a).

acknowledging his debt of understanding to both the Swiss "zoo biologist" Heini Hediger (1908–1992) for his pioneering work on the communicative practices of animals (and between animals and humans in the practices of animal training) – as well as to the Italian oncologist Giorgio Prodi (1929–1988) for his equally bold investigations into the semiotics of immunology and call for a comprehensive program of "natural semiotics" investigating the genetic, metabolic, neural and immunological sign exchange processes of the human body (a program that Sebeok would later characterize as "endosemiotics") (Sebeok 1976) – it was Sebeok's 1970 trip to the then "forbidden city" of Tartu in the Estonian Soviet Socialist Republic to meet the Russian semiologist Juri Lotman (1922–1993) – a trip that he would later describe as "a singular Mecca-like field for us pilgrims laboring in the domain of semiotics" (Sebeok 1998) – that would forge the link between Sebeok's lone bee-like investigations and an entire rich tradition of semiotic thought that, at the time, was virtually *terra incognita* in the West.[23]

The Cold War era was a difficult time for such East-West mutual collaboration, however, and Soviet émigré Vyacheslav Vsevolodovitch Ivanov (1929–) recalls that many scholars' works that were forbidden to be published in Moscow at this time had to be surreptitiously channeled to Lotman to be published in Tartu (1991: 36). In turn, it was Sebeok who was entrusted by Juri Lotman with his seminal biosemiotic manuscript *O Semiofere* for translation and publication in the West (Sebeok 1998).[24] Lotman's delineation of the realm of sign relationships permeating human life is, of course, a cognate of the word *biosphere* – the organizational space wherein living beings occur and interact – and was designed to foreground the autopoetic nature of *sets* of sign relations (such as "language" and "culture") as "modeling systems" for embodied action in the world of things by agents. And in this sense – the sense that Jesper Hoffmeyer will later use the same term, though unaware of its prior use by Lotman – it is a deeply biosemiotic notion.

Sebeok, however, found Lotman's own early explication of the concept – which largely restricts its scope of inquiry to the human and symbolic realm of interactions that Vernadsky called the *noosphere*[25] to be an explanatorily *necessary* concept for

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[23] Mihaly Csikszentmihalyi's (1934–) distinction between a "field" and a "domain" remained one central to Sebeok's life and thought. In short: A *domain* refers to an intellectual culture of shared meanings, definitions, assumptions, rules and evidentiary procedures (such as "science," or more finely, "medical science"), while a *field* comprises "all the individuals who act as gatekeepers to the domain. . .[and who decide] whether a new idea. . .should be included in the domain" (Csikszentmihalyi 1997: 27–28). And in 1970, Juri Lotman's Tartu-Moscow Semiotic School was by far the closest thing resembling an established *field* of disciplinary gatekeepers for the nascent world of international semiotic study (see Sebeok 1998, Kristeva 1994, Kull 1999c).

[24] The history of this manuscript's subsequent loss at the hand of a translator is recounted in Sebeok (1998). Suffice it to note for our purposes that it would not be until twenty years after the event, in 2005, that the English language translation of Lotman's manuscript would appear in the journal that Lotman himself founded in 1964, *Trudy po znakovym sistemam* – now known in English as *Sign System Studies*, Volume 33.1

[25] Lotman himself resisted this equivalence (1989: 43), insisting that the ability of cognitive agents to shape the material surround of their environment (Vernadsky's *noosphere*) differed from the

understanding our species-specific use of, and immersion in, a world of materially consequential sign relationships – but not to be an explanatorily *sufficient* one for doing so.

For it is one thing merely to assert, as he does himself some time later, that the human being is "a joint product of both natural and cultural forces" (Sebeok 1986a, b: xi). But in and of such an assertion in itself, it remains unclear if what is being talked about are two mutually exclusive and possibly antagonistic forces, or some kind of symbiotic relationship, or merely two largely artificially designated extremes along what is, in fact, a continuum. Still left fully unexplicated then, felt Sebeok, was an explanation of how the set of sign relations constituting the human symbolic semiosphere emerged from – and in some sense remained dependant on – our simultaneous existence as biological beings. For that explication, Sebeok would have to look elsewhere.

Sebeok thus continued his own decades-long study into animal communication both by reading the majority of research literature then extant and through his hands-on work with zoobiologist Heini Hediger (Sebeok 2001b). And as he did so, he became increasingly convinced that the sign relations taking place in animal communication and those in human language – while belonging to a common genus of interaction in the natural world, were yet divergent species that also needed to be understood on their own terms. Starting in 1977 and continuing well into the 1990s, Sebeok published in-depth critiques of the various underestimations, overestimations, anthropomorphism and machino-morphism being then attributed to animal cognition (e.g. Sebeok 1977, 1980, 1988, 1990a).

In these writings, Sebeok is particularly adamant in insisting that what "ape language trainers" such as Duane and Sue Savage-Rumbaugh (1977, 1986), Allen and Beatrix Gardner (1979, 1989) and David and Ann Premack (1977, 1984) were attempting – or at least what they were succeeding at – should not be confused with the idea that these apes had acquired the ability to use "language" in the true sense of the word. Rather, felt Sebeok, such researchers were merely shaping the animals' behavior along purely iconic and indexical (stimulus-response) levels – without themselves having a discriminating enough understanding of sign relations to understand the underlying difference between the two phenomena. Thus, by pronouncing the resulting Skinnerian chain of purely associative reflexes to be the equivalent of "language," Sebeok concluded, these researchers were "looking in the destination

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purely "abstract" cognitive interactions of the *semiosphere*. The distinction that Lotman fails to draw here – as is so often the case in such discussions about "mind and world" that yet accept the assumptions of Cartesian dualism on some fundamentally under-examined level – is the failure to differentiate between the *symbolic* level of embodied, biologically based sign processing, and its equally biological iconic and indexical substrates, with which it is on an experiential continuum. Such delineations are critical to the project of a scientifically sound biosemiotics that can yet account for the realities of abstraction and counterfactual reasoning, and we will have much more to say about these delineations presently. For an edifying discussion of the Lotman/Vernadsky controversy, see Chang (2002) and Kull (1999c).

for what should have been sought in the source" (as he succinctly titled his 1980 paper reviewing this work).

Sebeok was convinced that approaching animal communication as a truncated form of human language, just as Terrence Deacon would argue later in an elegant book-length consideration of language origins, "inverts evolutionary cause-and-effect" (1997: 53). For to Deacon – and to Sebeok – the proper question is not: "Do animals have language the way that we do, and if not, why not?" but rather: "As animals ourselves, how is it that we have language?" For what makes human "language" unique, both Sebeok and Deacon agree, is not the mere ability to map sounds or gestures onto physically co-present things as referents in the first instance – but the far rarer ability to be able to flexibly, systematically and effectively manipulate representations of non-present, impossible and counterfactual conditions in the knowledge that we *are* "manipulating representations" (and not the things themselves) in doing so.

Yet what modern semiotician ever thinks of signs as other than exclusively human cultural products? And what modern scientist ever thinks of biological organization as itself perfused with signs?

The explication that Sebeok was to find was one that he himself had to help to create. And so to understand the synthesis that Sebeok was to propose as the "starting point" for his proposed interdiscipline joining the life sciences with the sign sciences – his *biosemiotics,* as he was soon to call it – one must first understand how Sebeok's long-standing study of the semiotic logic of relations explicated by the American philosopher and scientist Charles S. Peirce (1839–1914) served as the substrate upon which Sebeok's later rediscovery of the research into the perceptual worlds of animals undertaken by the then all-but forgotten Estonian biologist Jakob von Uexküll (1864–1944) would act as a powerfully synthesizing reagent.

Sebeok's Synthesis of Charles S. Peirce

A laboratory trained chemist, astronomer, mathematician and logician, Peirce advanced a logic of sign relations – or "semeiotic" (as Peirce had called it) – that Sebeok was well conversant in, having studied under at least three self-proclaimed epigones of Peirce – i.e., C.K. Ogden (1889–1957), Roman Jakobson (1896–1982) and Charles Morris (1901–1979).[26]

And because Peirce's "architectonic of triadic logic" deeply informs so much of Sebeok's work, it would be impossible to continue this particular "line of emission" in the history of biosemiotics without providing here at least a summary overview

[26] Later, Sebeok himself would be instrumental in tracking down the author of an obscure unpublished doctoral dissertation on Peirce and commissioning him to revise the all-but-forgotten manuscript thirty years later for publication. This work (Brent 1993) has since become the definitive biography of Peirce.

(or brief flash, as it were) of this, one of the two main sources of incandescence illuminating Sebeok's biosemiotic vision.[27]

A scientist by training and by temperament, it is germane to note that "sign" relations for Peirce are a species of a larger genus of relations whereby potentiality becomes actualized, and the actualized interacts with other likewise realized actualities so as to result in pattern. This, of course, sounds extremely abstract on first glance – but in point of fact, nothing could be more natural (literally) to those brought up in the scientific faith. On the inanimate level, for example, the very "beginning" of our contemporary cosmos was a single point of undifferentiated energy (if, indeed, "energy" is not already too sophisticated a term) whose "development" into our current universe is nothing other than the *history* of its successive recursive change as, at each point, literal physical possibilities are made available only as the result of immediately preceding action, and as one of those possibilities is actualized, a new and slightly changed set of possibilities (and constraints) come into being. Thus, we see (retrospectively): the uncoupling of the unified force, which results in the generation of quarks that then makes possible the generation of hadrons, the results of whose interaction in the rapidly cooling universe gives rise to the existence of neutrons, that can then later join together with the protons to form the universe of atoms that. . .*ad infinitum* (or *finitum*, as the case may eventually be).

The point is that there is nothing mysteriously "metaphysical" about Peirce's notions of what he calls *firstness, secondness,* and *thirdness.* Rather, these relations refer, in a radically fundamental sense, to the scientifically examinable (and scientifically necessary) relations of *possibility, actualized existence* and *law*. That the more recent conceptualizations of chaos and complexity theory have given us a better vocabulary with which to talk about such utterly natural phenomena (e.g., iteration, interaction, emergence, downward causation and – in the case of living organisms – autopoesis) attests to the richness of Peirce's "logic of relations."

A major part of Peirce's logic is his "semeiotic" – or logic of sign relations. Its simplest 'biosemiotic' formulation begins with the observation that the last-most-current or "given" state of affairs in the world to the perceiving agent is present to that agent *in its firstness* as an unlabeled "raw feel" (what others have termed its *qualia*). Of all the things that unlabeled sensation "could be," the agent – given the set of existing possibilities and constraints made possible at that moment by its own biological organization and set of prior associations – "experiences" that set of feels *as x* (hunger, the color red, a flower, etc.), and this *secondness* of experience builds a web of brute sensations into a web of meaningful perceptions.

And, finally, once not just the sensations and the perceptions but the *relations* within that web themselves (i.e., of sensations *to* perceptions, and of perceptions *to* other perceptions) become representable 'as signs' in their own right (e.g., musical

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[27] For more in-depth overviews, see Colapietro (1989, 1996), Deely (1990, 2001), Deledalle (2000), Parmentier (1994), Savan (1976), and the e-resource for all things Peircean, *Arisbe*, at: www.cspeirce.com

notation, mathematical notation, linguistic notation, etc.), the malleable conventionality of *thirdness* becomes available to living organisms, for the re-contexulaization of both *firstness* and *secondness* (sensation and perception) into what we generally refer to as symbolic 'understanding'. And it was precisely the mystery of how and why it is that human beings have become such "savants" in the use of thirdness, while the majority of other species have not, that drove Sebeok to search beyond the elegant theoretical logic of Peirce and into the cacophonous real world of animals and their sign behavior.

Sebeok's Synthesis of Jakob von Uexküll

Sebeok recounts how he had come across what is largely considered to be an execrable translation of an early version of von Uexküll's *Theoretische Biologie* decades earlier, while still a student at Cambridge, but found it both "baffling murky" and "beyond doubt over my head" – as well not at all germane to his then-current project as a sixteen year old Hungarian student attempting to learn English (2001: 64, 1998: 34).

Thirty years later, Sebeok would read von Uexküll's fully finished version in the original German – and this re-reading, in the words of contemporary biosemiotician Marcello Barbieri, "was a kind of fulguration on the road to Damascus" for Sebeok (Barbieri 2002: 285). There is much truth in this characterization, as we shall see. For in his rediscovery of von Uexküll, Sebeok felt had that he had not only found the long missing piece of the puzzle that he had been looking for, but was also convinced that he had found what so many other laborers in so many other fields should have been looking for all this time as well – i.e., an absolutely naturalistic way of understanding the link between the human world of signs and the animal world of signs. So it is to Jakob von Uexküll and his study of the perceptual worlds of animals that we now turn.

Cited by both Konrad Lorenz (1903–1989) and Nico Tinbergen (1901–1972) as the founder of the modern discipline of ethology, Estonian-born German biologist Jakob von Uexküll (1864–1944) devoted his entire life to the study of animals, training first as a zoologist and afterwards going on to the pioneering work in muscular neurophysiology that would result in *Uexküll's law of neuromuscular regulation,* often cited as the "first formulation of the principle of negative feedback [and thus reafferent control] in living organisms" (Lagerspetz 2001: 646). A dedicated physiologist as well as a biologist, Uexküll drew a distinction between the two projects that is worth quoting in the words of his contemporary archivist in full:

"Already in his first monograph Uexküll (1905) assigned different roles to physiology and biology. Physiology should organize the knowledge about organic systems by looking for causalities. Having preserved the advantage of the experimental method, physiology should help to [inform] biology. In distinction to physiology, biology has to use the scientific method to go beyond the investigation of causalities by exploring the laws that [account for] the purposefulness of living matter. Therefore biology should study organisms not as objects, but as active subjects, thus

focusing on the organism's purposeful abilities that provide for the active integration into a complex environment. Biology therefore had to deal with holistic units and to maintain a broader scope than physiology in order to grasp the interactive unity of the organism and the world sensed by it. For describing this unity, Uexküll introduced the term *Umwelt* (1909)" (Rüting 2004).

A forerunner and conceptual pioneer of the study of feedback and reafferent control in the workings of what will later come to be called complex adaptive self-organizing systems, Uexküll had no access to the rich vocabulary of "autopoetic" explanation that his own groundbreaking work would engender almost a full century later. Yet Ludwig von Bertalanffy's (1901–1972) "general systems theory" – as well as its increasingly sophisticated descendents (i.e., cybernetics, catastrophe theory, chaos theory and complexity theory) – all issue from von Uexküll's notion of the *Funktionskreis* or "functional cycle" of perception and action that effectively "couples" the ever-changing system that is the organism to the ever-changing system that is the world.

Thus, in the discussion about "causalities" above, Uexküll has no recourse to the vocabulary of "emergent system properties" "recursive downward causation" "dynamic instability" or "autopoesis" that would allow him to delineate for his readers the distinction being drawn between the purely material and efficient relations of brute physiological stimulus-response regularities and the higher-order "systemic" relations between world and organism (as well as organism parts to whole) that are the bottom-up product of – as well as the top-down shaper of – those physiological interactions (both in real-time and in evolutionary time) to begin with.

That said, both Uexküll's pioneering work on marine biology, as well as his prescient conceptualization of feedback systems, leave him only dimly remembered, if at all, in the two fields he most directly spawned (animal ethology and dynamic systems research).[28] And this is undoubtedly due to von Uexküll's Baerian resistance to the Darwinism of his time and to the somewhat "telic" understanding of what he calls "Nature" (1934/1957, 1940/1982). Like von Baer, Uexküll felt that Darwin "treated the concept of causality incorrectly and did not consider the internal [component in the active self-organization and creation] of individual organisms" (cited in Kull 1999d). Given that all these men – Darwin, no less than von Baer and von Uexküll – were working long before the development of modern genetic knowledge, it is perhaps no surprise that each of them sees more clearly the "reverse but complementary" side of the picture that the other neglects.

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[28] We pass over here, due to the limitations of space, von Uexküll's influence on the then-developing field of neuroscience, and especially his influence upon one of its principal founders, Charles Scott Sherrington (1857–1952), who credits von Uexküll frequently and whose work on the neurobiology of reflex, posture and muscle movement was a direct outgrowth of von Uexküll's earlier experiments (Lagerspetz 2001: 646). Suffice it to say that the notion of the "neural net" is already prefigured in Uexküll (1928: 106) – and while many contemporary neuroscientists and roboticists take these notions as their starting points, few have worked their way back to von Uexküll for the purposes of either further enlightenment, nor for the acknowledgement of a debt (but see Fuster (2003) and Ziemke and Sharkey (2001) for exceptions).

It can be seen, however, that von Uexküll was working still very much within a 19th century Romantic intellectual culture that was still vibrant in Estonia, while the science of Darwin's England was increasingly utilitarian, mechanistic and Malthusian. Such historical influence often reveals itself in von Uexküll's word choice. Thus, the original wording of the bracketed text in the paragraph above reads that "Darwin did not consider the internal *strive for perfection* of individual organisms" in lieu of the less teleologically "loaded" description of what is essentially the same concept of proximate, systemic interaction towards homeostatic optima observable in all living organisms that I have substituted for it here.

However, and as Hoffmeyer notes, just as Darwinism needed Mendelian genetics for its full coherence, "it is only through its *integration* with the theory of evolution that [von Uexküll's] *umwelt* theory can truly bear fruit" (1996: 58). For just as the transmutation of species needs a shuffling mechanism to allow for the variations which are then acted upon in natural selection, so too does von Uexküll's Kantian notion – i.e., that, as regards the subjective experience of living creatures, "it is utterly in vain to go seeking in the world for causes that are independent of the subject; we always come up against objects which owe their construction to the subject" (1926: xv) – need to be supplemented with a theory of how such subjects themselves have come to be so uniquely constructed. For von Uexküll, however, this was not seen a problem, but as the very mark of the limits of Kantian reason. "There lies concealed, eternally beyond the reach of knowledge, the subject – Nature" concludes von Uexküll, who would also speak unselfconsciously about "nature's sovereign plan" (1934/1957: 80).

Sebeok, however, as an epigone of Peirce, believed that in science, as in *umwelt*, such ubiquitous law or "plan" is precisely what calls out to be explained. And thus Sebeok began to undertake the long interdisciplinary project of attempting to introduce into the framework of mainstream science and evolutionary theory, an operationalizable synthesis of the Peircean logic of sign relations with the Uexküllian naturalistic research project of *Umweltforschung*. With now a clear vision that the abyss between sign study and biology had found its bridge, Sebeok began the project that we today call *biosemiotics* – a project whose goal was nothing less than a scientific understanding of how the subjective experience of organism, as realized differently by each species' particular biological constitution – comes to play a genuinely causal role in the ongoing co-organization of nature.

A Project of Mass Cross-Pollination: Sebeok's Synthesis of Researchers

As can be inferred from the above, the rediscovery of von Uexküll's work had a profound effect on Sebeok's subsequent work and thought. Two decades later, he would recollect that his re-reading of Uexküll's *Theoetische Biologie* after thirty intervening years studying human and animal communication practices "unfolded a wholly unprecedented, innovative theory of signs, the scope of which was nothing less than 'semiosis in life processes' in their entirety" (1998: 7).

Apt, then – though requiring a little further clarification – is Barbieri's (2002) claim that after experiencing the intellectual "fulguration" that von Uexküll's *umwelt* theory was to him, Sebeok "decided to end his individual search and start an active campaign of proselytization" (285). For unlike the Biblical Saul, Sebeok knew full well that his search was not truly "over" – and that in von Uexküll's *umwelt* theory, he had found but *one* more critically important tool for understanding, with which he could proceed in his ongoing investigations. In this sense, Sebeok was more like Isaac Newton – or perhaps even Francis Bacon, with his own new-found *Novum Organon,* as we have discussed above – than like the spiritually 'completed' Saul.

In other ways, however, Barbieri's charge of "proselytization" is a fair one, given that many of the scholars laboring in the fields of biosemiotics today who find von Uexküll's articulation of *umwelt* to be a manifestly helpful terminological tool were, quite directly, brought to this realization through the efforts of Thomas Sebeok himself.

Indeed, "Sebeok would often point out that the list of those who did semiotics without knowing it would fill the pages of an infinitude of books" writes Sebeok's frequent collaborator Marcel Danesi as part of his mentor's obituary: "If we recall correctly, he referred to this state of affairs as the "Monsieur Jourdain syndrome." Monsieur Jourdain was, of course, the character in Molière's *Bourgeois Gentilhomme* who, when told that he spoke good prose, answered by saying that he didn't know he spoke in prose. Analogously, Sebeok would point out to some scholar in a field such as psychology, anthropology, or medicine, that he or she was, like Monsieur Jourdain, doing something of which he or she was not aware – i.e., *semiotics*. "The number of converts he made for semiotics in this way are innumerable" writes Danesi (2002: o.l.).

A turning point came in 1977, when Sebeok delivered his now-famous speech on "Neglected Figures in the History of Semiotic Inquiry: Jakob von Uexküll" at the *Third Wiener Symposium on Semiotics* in Vienna. Thure von Uexküll (1908–2004), Jakob's son, was in the audience, and not long after, Sebeok, along with Thure (a physician whose pioneering work on the semiotics of psychosomatic disorder and treatment virtually single-handedly raised the field of psychosomatic medicine to prominence in Germany, where it is now part of the mandatory curriculum for all medical students), and Giorgio Prodi (1929–1988), an oncologist studying the "endosemiotics" of immunological self-organization and cell signaling – "conducted a week-long open-ended seminar, so to speak, on the practical and conceivable ins and outs of biosemiotics" (Sebeok 1998: 8).

These "intensive triadic brainstorming" sessions, as Sebeok characterized them, "led directly to the series of pivotal seminars held annually in the late 1980s and early 1990s" at the Glotterbad Clinic for Rehabilitative Medicine near Freiburg (ibid). Drawing an ever widening circle of biologists, physicians, philosophers and semioticians into his orbit, Sebeok in effect fashioned what he would later come to term an interdisciplinary "cybernetic loop" or "self-excited circuit" (Sebeok 1998: 9).

A steady stream of international conferences, monographs, journal articles, special issues, and book collections followed (see Kull 1999a and 2005 for two

excellent overviews) – most of them either initiated by, or with significant contributions from, Thomas Sebeok himself. Indeed, in his memorial remembrance of Sebeok, seminal biosemiotician Jesper Hoffmeyer remarks that "without Sebeok's enormous influence and prestige to pave the way, the growth of biosemiotics might well have been seriously hampered through the usual territorial defense mechanisms released more or less automatically in academia whenever somebody attempts crossing [its] Cartesian divides" (Hoffmeyer 2002: 385).

The resulting "yet even more modern synthesis" of Peircean semiotics with Uexküllian *umwelt* theory in the overarching framework of dynamic systems theory that underpins much of modern biosemiotics and that is the direct result of Thomas Sebeok's "proseltylization" in the years following his rediscovery of von Uexküll is not a synthesis that I have either the space for, nor have been commissioned to, explicate in any minimally sufficient detail here (but see Baer 1987, Brier 2003, Danesi 1998, 2000, Deely 1995a, Pertrilli and Ponzio 2001, Sebeok and Umiker-Sebeok 1992 for thoroughgoing discussions thereof).

Suffice it to say, though, that even those colleagues-in-biosemiotics who today reject the Peircean perspective, or the primacy of perceptual *umwelt*, or the likely success of the project of biosemiotics itself (and there are some loyal skeptics who most helpfully hold this view, as we shall see) – even these scholars are no longer scattered researchers working in sterile isolation from one another and in utter ignorance of each other's work, but are instead today "colleagues" in a field called Biosemiotics *because* of the tireless "proselytization" (and cross-pollination) efforts of Thomas A. Sebeok throughout the 1970s, 1980s, 1990s and those years of the 21st century ending only with his death.

In effect, summarizes Barbieri, "the making of biosemiotics [in the form of the field that we see it as today] has been heretofore a 40-year-long affair which can be divided into two phases: the first (1961–1977) was a period of uncoordinated attempts, often of utterly isolated initiatives, while the second (1977–2001) was a period in which individual ideas could fall on a more receptive ground and contribute, under the discreet supervision of Thomas Sebeok, to the collective growth of the field" (2002: 286).

And, indeed, Sebeok's obituary states that of all of his accomplishments, "he was most proud of having brought into being a group of theoretical biologists and semioticians to pursue this field of investigation" (SLIS 2002). It is the ongoing coalescence of this group that we will turn our attention to now – for the history of this ongoing coalescence *is* the extant "history" of Biosemiotics per se (though what will come out of this coalescence, and where that history will lead, remain matters of pure *potentia* at this time).

Sebeok's Legacy and the Continuation of the Biosemiotic Project

One of the many tributes paid to Sebeok in obituary was made by his long-time colleague Marcel Danesi, who – summing up a lifetime's work in fields as diverse as anthropology, linguistics, computer science and zoology, reiterated the claim that what Sebeok himself was most proud of was his having "transformed semiotics

back into a "life science" – having taken it back, in effect, to its roots in medical biology [and specifically, the uninterrupted tradition of symptomology found in all cultures]. In other words, he uprooted semiotics from the philosophical, linguistic, and hermeneutic terrain in which it has been cultivated for centuries and replanted it into the larger biological domain from where it sprang originally" (2002: o.l.).

Interestingly enough – and perhaps a tribute to Sebeok's underlying vision all along – it is not "semioticians" per se that one finds attending the conferences and penning the journal articles in the field called biosemiotics today, but molecular biologists, embryologists, philosophers of science, zoologists, roboticists, neurobiologists, psychologists and dynamic systems theorists instead. And most of these have found their way into the field through their own unique and surreptitious pathways, many of whom hold a variety of views regarding the relationship of signs to biology that in no way derive from the works of Peirce or von Uexküll, much less than those of Sebeok himself.

For it turned out that the nerve that was ready to be hit by the promise of a scientifically informed biosemiotics was not at all one that was calling out for excitation in the academic world of semiotics (with a few conspicuous exceptions of course, which will be discussed below). Rather, the priming was taking place variously, but steadily, over the last 50 years of scientific advance and inquiry in the West.

For while Sebeok was busy building networks in Scandanavia and in eastern Europe, back in the West individual researchers in the fields of neurobiology, clinical psychology, molecular biology, artificial intelligence, and philosophy of mind (to name a few) were busily engrossed in their own attempts at either resolving or undoing the disastrous Cartesian dichotomy separating bodies and minds. In neurobiology, for example, one saw the works of Gerald Edelman (1992), Antonio Damasio (1994), Walter Freeman (2000), and Joaquin Fuster (2003)[29] among many others; in AI, the "distributed cognition" theories of Andy Clark (1997), Rodney Brooks (1999), Marvin Minsky (1988), and Douglas Hofstadter (1979); in biology proper, there were the critiques of Walter M. Elsasser (1998), Richard Lewontin (1992), Robert Rosen (1991), and Howard Pattee (1982a, 1988); and in dynamic systems theory, the works of Edward Lorenz (1963), René Thom (1989), Ilya Prigogine (1984), Susan Oyama (1985), and Stuart Kauffman (1995, 2000) – again, just to mention some few of the most obvious.

But these researchers (and many more, some of whom will eventually make their way into the interdiscipline of biosemiotics and whom we will be discussing presently) were, as said, largely pursuing their own independent research agendas, working and exchanging ideas amongst their own disciplinary colleagues, and were not actively involved in constructing a network of researchers from widely divergent academic backgrounds in the sense that Thomas Sebeok was.[30]

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[29] "Bio-semiotic" premises are implicitly discoverable – though never fully articulated as such – in all of these neurobiologists' works to some extent, though none save Fuster show any acquaintance with the work of von Uexküll or Peirce that informs much of contemporary biosemiotics.

[30] Though perhaps it would be fair to say that Stuart Kauffman eventually did also pursue such a deliberately interdisciplinary project, via his long-standing participation in the Santa Fe Institute.

Some small interdisciplinary networking groups *were* independently breaking out here and there at this time, however. Kull recalls three regular series seminars on theoretical biology that arose independently in the Soviet east during the 1970s – one in St. Petersburg led by Sergei Chebanov, one in Moscow led by Aleksei Sharov, and one in Tartu, Estonia led by himself that "all later made a shift towards biosemiotics" (2005: 21). In the West, geneticist Conrad Hal Waddington (1905 – 1975) held a series of conferences entitled *Towards a Theoretical Biology* each year from 1966 to 1969 that attracted such participants as Lewis Wolpert, Brian Goodwin, R.C. Lewontin, David Bohm, W.L. Elsasser, René Thom, Howard Pattee, Ernst Mayr, and John Maynard Smith. Yet while all of these participants undoubtedly both contributed to, as well as came away from, these conferences with an enriched notion of the phenomenon of "self-organization" in complex systems, these conferences did not result in the creation of any one coherently ongoing "group" or specifically focused collective agenda, such as can be found in the current project of biosemiotics.

Instead, the major line of development that would result in the constitution of the field of biosemiotics as it exists today was a series of informal but increasingly productive seminars emerging from the University of Copenhagen beginning in the 1980s and culminating in the ongoing international Gatherings in Biosemiotics conferences which have been held annually since 2001. And by almost every account, the figure at the center of this activity was then, and remains now, the man whose name is now most closely associated with the field of biosemiotics, the Danish molecular biologist and public intellectual Jesper Hoffmeyer (1942–).

Joining Life Science with Sign Science: Jesper Hoffmeyer

Long before beginning his career as a biochemist at the University of Copenhagen in 1968, Jesper Hoffmeyer had already developed, since his days as a student activist in the mid-1960s, a deep theoretical interest in the complicated relationships between science and religion, technology and nature, and authority and belief in the lives of modern individuals. Son of a social reformist physician who had co-edited an antifascist periodical called *Kulturkampen (The Struggle for Culture)* in the 1930s, Hoffmeyer's own deep interest in the intersection of nature and culture led to his founding of a journal entitled *Naturkampen (The Struggle for Nature)* in the 1970s.

A prolific science writer and journalist as well as a working university professor and molecular biologist, Jesper Hoffmeyer "had, by the 1980s, become one of the most visible intellectuals in the debate on technology and society in Denmark" (Emmeche et al. 2002: 38). Deeply inspired by the work of cybernetician and anthropologist Gregory Bateson (1904–1980), Hoffmeyer had been struggling to articulate a non-reductionist understanding of the relationship of organisms to their genomes at a time when the rapid advancement of gene sequencing technology was promising a yet more reductionist understanding of the same, and Richard Dawkins was capturing the popular imagination (as well as that of some scientists) with his notion of "the selfish gene" (1976).

Recalling this period, Hoffmeyer writes that in 1984 it had occurred to him that "the historical consequence of making dead nature [i.e., physics] the model of nature at large was that all the talking – and all mindfulness – went on exclusively in the cultural sphere. As a result we now suffer the divided existence of the two great cultures, the humanities and the scientific-technological culture" (2002: 99).

Finding it intuitively unnatural to attempt an explanation of the hereditary efficacy of DNA in isolation from the DNA-organism system in which it always appears, Hoffmeyer claims that he wanted to invoke in his scientific colleagues of that time "a new kind of curiosity, a curiosity directing its attention towards, what we might call "the wonder of the code" and which does not put that wonder aside by the enclosure of the codes into one or the other state space [of deterministic physics] or life-world [of pure subjective experience]. For it is the nature of the "code" to point outside of its own mode of existence – from the continuous to the discontinuous message, from the physical and therefore law bound message [of the nucleotide sequence] to the more free message [of the organism whose actions in the world will or will not result in that nucleotide sequence's eventual evolution and survival], and back again in an unending chain" (2002: 99).

"For it is the nature of the 'code' to point outside of its own mode of existence." Almost certainly unaware then of the maxim of St. Augustine, much less of the obscure late-scholasticism of John Poinsot, Hoffmeyer's common-sense appreciation of the profoundly important distinction between material organization and that same material organization in its use as a sign for something other than itself led him, like Sebeok before him, to an investigation into the semiotic logic of relations between organisms and their environment (1984), between organisms and each other (1988), within organisms (1992), and in the triadic logic of the 19th century scientist-philosopher Charles S. Peirce (1996).

By 1985, write his biographers, was committed to the idea of developing "a semiotics of nature, or *biosemiotics* as he chose to call this effort – [one that could intelligibly explain how] all the phenomena of inherent meaning and signification in living nature – from the lowest level of sign processes in unicellular organisms to the cognitive and social behavior of animals – can emerge from a universe that was not [so] organized and meaningful from the very beginning" (Emmeche et al. 2002: 41).

In this regard, again like Sebeok, whose path he would not yet cross for several more years, Hoffmeyer's personal passion for, and dedication to, this project – as well as the quality of the work on the subject that he began producing – drew an ever-growing coterie of like-minded individuals into his orbit. In 1984, his initial formulation of a theory of analog-digital "code-duality" in biology was published, and soon thereafter he began his intensive series of collaborations with biologist Claus Emmeche, who would later go on to head the Center for the Philosophy of Nature and Science Studies at the University of Copenhagen, and to become a major figure in biosemiotics in his own right – in addition to authoring a body of related work on dynamic systems theory (1992, 2000a), artificial intelligence (1991, 1994), and the history and philosophy of science (1999, 2002).

By 1986 both Hoffmeyer and Emmeche were attending a Copenhagen study circle with the physicist Peder Voetmann Christiansen wherein the semiotics of Peirce were much discussed. Philosopher and literary analyst Frederik Stjernfelt joined this group (known then as the "Helmuth Hansen Study Circle" after the Danish philosopher) soon thereafter, eventually inviting French mathematician and theoretical biologist René Thom – whose work also drew heavily upon Peircean semiotics and Uexküllian umwelt theory – to deliver a lecture on his development of catastrophe theory (Stjernfelt 2002: 58).

Microbiologist Mogens Kilstrup would later find his way into Hoffmeyer's circle, as would the biologist and cyberbetician Søren Brier (1995, 1998, 2001) , who would several years later establish the interdisciplinary journal *Cybernetics and Human Knowing* in which many of the Helmuth Hansen group would publish seminal articles.[31] During this time, too, Hoffmeyer continued to publish his ideas on code-duality and self-description, now drawing also upon the works of biophysicist and systems theorist Howard Pattee (1969, 1972, 1982a).

In 1989, Hoffmeyer published a seminal article on "the semiosis of life" in Danish, and this was followed by his founding of the proto-biosemiotic journal *OMverden* (roughly: "*Umwelt*") in 1990. "The journal was an intellectual success," writes his biographers, "but a [financial] failure for the publishing company, so its life was brief" (Emmeche et al. 2002: 41). The journal did find its way into the hands of both Thure von Uexküll and Thomas A. Sebeok, however, and when Hoffmeyer went to attend a conference on psycho-neuro-immunology in Tutzing later that same year, he met both of these men for the first time – having spotted Sebeok walking around the conference with a copy of *OMverden* protruding from his jacket pocket (Hoffmeyer 2002: 384).

The joining together of "Sebeok's people" with "Hoffmeyer's people" was a signal event in the development of the contemporary field of biosemiotics. From Sebeok's "semioticians exploring biology" side came such accomplished scholars as John Deely (1986), Myrdene Anderson (1990), Floyd Merrell (1996), and Martin Krampen (1981)[32] – and from Hoffmeyer's "biologists exploring semiotics" side came himself, Claus Emmeche, Søren Brier, Mogens Kilstrup, Frederik Stjernfelt and Peder Voetmann Christensen. It was in the aftermath of this meeting that Sebeok was to declare the investigations of the life sciences and the sign sciences must

[31] A journal dedicated to the study of "second-order cybernetics, autopoesis and cyber-semiotics" – roughly, the role of feedback and generative recursion in the organization of observing systems, self-maintaining systems, and sign-using systems – Brier's journal is deeply influenced by the work of biologists Humberto Maturana and Francisco J. Varela (1987), cyberneticians Heinz von Foerster (1982) and Ernst von Glasersfeld (1987) as well as the pioneering interdisciplinarity of cybernetician/anthropologist/psychologist Gregory Bateson (1973).

[32] These four, along with Sebeok, Thure von Uexküll and Joseph Ransdell issued a polemical call for a "new paradigm" of semiotically informed science (and vice-versa) at just about the same time that Hoffmeyer was independently coming to the same conclusion in 1984 (see Anderson et al. 1984).

be co-extensive if either was to proceed (1990), and from this point on, the term *biosemiotics* is used to refer to this project by all parties involved.

Less than one year later, Hoffmeyer and Emmeche's seminal two-part paper on code-duality appeared in Anderson and Merrell's anthology *On Semiotic Modeling* (Hoffmeyer and Emmeche 1991) and in Sebeok's international journal *Semiotica* (Emmeche and Hoffmeyer 1991), winning the publisher's top annual award, and bringing the work of the Helmuth Hansen group to an international audience. In 1992, the volume *Biosemiotics: The Semiotic Web* was published, to which no less than twenty-seven authors contributed. This exposure served to establish an ever-growing interface with other biologists and semioticians whose research was converging along these lines, and so the internationally-minded Danish Society for the Semiotics of Nature was also officially established at this time, with the express purpose of bringing together researchers from around the world who were interested in pursuing this new line of inquiry.

It was also in 1992 that theoretical biologist Kalevi Kull, a convener of some of the earliest conferences on semiotic approaches in theoretical biology taking place in the Soviet Union in the 1970s and curator of the Jakob von Uexküll Centre at the University of Tartu in Estonia, would meet Jesper Hoffmeyer at Thure von Uexküll's Glottertal conference near Freiburg – and from then on become the de facto historian both of biosemiotics in the Sebeok-Hoffmeyer tradition and of the tradition of Eastern European theoretical biology in general. Kull would also begin presenting an annual lecture course in biosemiotics at the University of Tartu in 1993 that continues to this day, and has been instrumental in arranging the annual International Gatherings in Biosemiotics, in addition to his own considerable contributions in advancing the field (e.g. Kull 1998a, b, 2000, 2001a, 2001b).

In 1993, Jesper Hoffmeyer published his first full-length monograph on biosemiotics *En Snegl Pa Vejen: Betydningens naturhistorie (A Snail on the Trail: The Natural History of Signification)*, and this book was later translated into English to appear as *Signs of Meaning in the Universe* (1996). It is this exceedingly readable book, perhaps more than any other, that provides most newcomers their entry – and, in many cases, their impetus – into the field, and that most clearly lays out the project of biosemiotics as an attempt to situate culture within nature, while not reducing either to the blind forces of purely mechanical efficient causation.

Written in the attempt to popularize the ideas of biosemiotics to the widest possible audience, the following passage conveys much of the flavor of the work. After discussing the evolution of single-celled life, multicelluars, and the increasing variety of animals' sensory capacities, Hoffmeyer turns to the evolution of human cultural cognition and writes:

> Among all the roles in the ecological theatre there was one pertaining to creatures with lengthy life histories and an especially well-developed talent for capitalizing on their experiences. Often theses creatures, the apes, had developed brains capable of accommodating an extremely complex image of their surroundings, a very sophisticated *umwelt*. [And eventually] there came a day when this creature realized that it was itself an *umwelt* builder; that its role was, in act, a role; that other creatures performed other roles and had different kinds of *umwelt*; that the world was one thing and *umwelt* another; and that, when one died, this

> *umwelt* would actually disappear while the world as such would carry on. . . . [Yet over time, this creature was able to] create a bond of a quite unprecedented nature: a double bond founded on the need to share the *umwelt* with one another, i.e., making private experiences public property, turning the subjective into the objective. To cut a long story short, this creature . . .invented the spoken word. (1996: 34–35)

With its provocative ideas cloaked in the simplest of language, the English language publication of Hoffmeyer's *Signs of Meaning* was enthusiastically reviewed (1998) and remains as of the time of this writing probably the single most widely read and frequently cited text on biosemiotics. Its impact on scholars internationally continues as each year new biosemioticians come into the fold as a result of their "stumbling upon" this work (as has been frequently recounted at the annual International Gatherings in Biosemiotics).

And, indeed, directly as a result of the reception to the work's international availability in 1996, Hoffmeyer found himself "communicating with a cross-disciplinary audience of scientists, philosophers and scholars from various specialties [and was] invited to conferences in the fields of systems theory, self-organizing complex systems, cognitive science, general semiotics, media and communication theory and, of course, an increasing number of workshops and symposia devoted specifically to biosemiotics and its relations to other fields of semiotics and biology" (Emmeche et al. 2002: 42).

A slew of journal articles and conference presentations on biosemiotics by the members of the Helmuth Hansen group and their growing coterie of international colleagues followed (see particularly the special issues of *Semiotica* of 1998 (Vol 120 3/4) and 1999 (Vol 127 1/4), as well as the *Annals of the New York Academy of Sciences* 2000 (Vol 901) and, for a more extensive list of publications covering this period, Kull 2005: 20). Eventually these second-generation heirs of Sebeok's Glottertal conferences were able to bring together a growing group of younger researchers for whom the idea of dynamism in autopoetic systems was no longer a "radical proposal" – but was, instead, the starting point from which to proceed to try to build a coherent interdiscipline. And by the middle of the year 2000, the first annual International Gatherings in Biosemiotics was being planned.

A Diverse Ecosystem of Researchers: The Gatherings in Biosemiotics

Thomas Sebeok was most content, it seems, when he was bearing many torches – and after his death at age eighty-one in 2001, each of these had to be picked up and passed on.

Already by this time, however, the center of gravity for the biosemiotics project had been establishing itself at the University of Copenhagen under the auspices of Jesper Hoffmeyer and Claus Emmeche who, along with theoretical biologist Kalevi Kull and cybernetician Søren Brier, established the Biosemiotics Group at the University of Copenhagen in the early 1990s.

And it was this group that, in 2001, finally succeeded in inaugurating an annual international conference devoted exclusively to biosemiotics.

Quite unsure at the time about who, if anyone besides themselves, would show up, the first International Gatherings in Biosemiotics turned out to be an unprecedented success. Held on May 24–27, 2001 at the Institute for Molecular Biology at the University of Copenhagen (in the very room, it was noted, that Wilhelm Johannsen first introduced the word "gene" into science in 1909) the first of these annual conferences was attended by over 30 presenters from 18 countries and produced papers in neurobiology, zoology, artificial intelligence, linguistics, molecular biology, cybernetics, meta-systems transition theory, and the history and philosophy of science.[33]

The international Gatherings have been held five times since then, and while not every researcher working in the field of biosemiotics attends these annual meetings, many – if not most – of the principal contributors to the field do. There, the second-generation heirs of Sebeok's Glottertal conferences bring together a growing group of formerly independent researchers and their younger colleagues for whom the idea of dynamism in autopoetic systems is no longer a "radical proposal" – but is, instead, the starting point from which to proceed to try to build a coherent interdiscipline. In addition, with the inaugural publication this year of the peer-review *Journal of Biosemiotics* and the establishment of the long-planned International Society for Biosemiotic Study in 2005, this "third phase" in the growth and development of biosemiotics promises dramatic changes to the field – most of the more interesting ones, of course, being unforeseeable.

Even from this early standpoint, however, we can discern certain patterns and currents that are sure to play a role. The following selective list of just the most regular of the international conference's participants gives a flavor of the interdisciplinary convergences – and divergences – of approach in the quest to articulate a truly comprehensive science of life and sign processes.[34]

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[33] Many of these papers have since been published in *Sign Systems Studies*, Vol 30.1 (2002).

[34] This history would not be complete without mentioning those related researchers who, although not regular attendees at the Gatherings, continue to produce work that has particular relevance for most biosemioticians. Among these scholars must surely be included Stanley Salthe (1993), Kochiro Matsuno (1999), Luis Rocha (2001), Peter Cariani (2001), Robert Ulanowicz (1986), Mark Bickhard (1999), John Collier (1999), Merlin Donald (1991), David Depew (1996), Bruce Weber (2000) and perhaps most important of all Terrence Deacon (2003), whose 1997 *The Symbolic Species* is perhaps the clearest and most compelling application of Peircean semiotic to evolutionary biology yet produced. And while Deacon does not identify himself as a 'biosemiotician' per se, seminal biosemiotician Claus Emmeche spoke for many when he remarked at the recent Gregory Bateson Centennial Symposium in Copenhagen that "Many biosemioticians consider themselves not only Peirceans, but Deaconians as well." Accordingly, Deacon's work is well represented in the present volume.

Pre-Gatherings Contributions from Outside the Copenhagen-Tartu Nexus

One of the approaches that did not come strictly out of the Copenhagen-Tartu lineage was represented at the inaugural *Gatherings* conference by Prague cell physiologists Anton Markoš and Fatima Cvrčková (2002, 2002a, 2002b) who advance an understanding of living systems that is fundamentally *hermeneutic*. Representatives of a growing interdisciplinary movement towards theoretical biology and interdisciplinary study in the Czech Republic,[35] Markoš and Cvrčková view the current work being done within the contemporary biological paradigm (including their own work) to be an effective – but by necessity only partial – illumination of processes that exceed the potential of formalized representation to exhaustively map them.

Taking an approach towards living organisms that owes as much to the "historically effected hermeneutics" of Hans-Georg Gadamer (1900–2002) as it does to the self-regulatory symbiotic systems theories of Lovelock (1996) and Margulis (1987), Markoš writes that: "[Since the moment of its inception,] life has never ceased to exist and has again and again been confronted by actual conditions, by memory, by forgetting, and by re-interpretations of the remembered" (2002: 163). As Markoš reminds us in his masterful exegesis of scientific study, *Readers of the Book of Life*, the living organization of an organism changes itself and its relations to its surround on a moment-to-moment (as well as on an evolutionary) basis in a way that no machine logic or mathematical formalization could ever (predictively) account for, and it is this very embodiment of a possibility-collapsing "non-logic" that allows a living system to effectively explore and to creatively exploit novel state spaces, giving it "the characteristics of a field, a culture, a statement, and of course, [only] sometimes also of a machine" (2002: 163).

With Gadamer, Markoš asserts that "the nature of knowledge is hermeneutical and is rooted in experience, history and in structures" that are themselves ever-changing as each new moment is changed as a result of the actions taken in the one prior. Attempting to reduce this rich world of living-acting-perceiving-and-signifying onto the "necessarily incomplete, reduced, flattened" descriptions of the objectivist scientific model (Cvrčková 2002: 184) would be akin to attempting to realize Hoffmeyer's self-referential notion of creating "a map which is so detailed that the map maker and the map that he is making are swept up into it" – something that not even the world-modeling organism itself can ever fully objectify, much less make static (1996: 40). Self-described "working biologists just like any others," Cvrčková and Markoš remind us never to lose sight of Korzybski's admonition that "the map is not the territory" – lest we find ourselves taking seriously such

[35] This movement also includes biologist and philosopher of science Zdeněk Neubauer, systems theorist Ervin Laszlo, cognitive scientist Ivan Havel, animal ethologist Karel Kleisner, and geologist Václav Cílek. An excellent English language introduction to their ideas can be found in Havel and Markoš (2002), which collects the proceedings of a conference that also features contributions from Giuseppe Sermonti, Pier Luigi Luisi, and Mae-Wan Ho. Markoš, Grygar et al.'s *Life as its own Designer* (2009) offers a more in-depth presentation of the group's ideas.

map-sensible but experientially-nonsensical claims as "the genetic code is just a metaphor" and "consciousness is an illusion" ("an illusion. . .", one should always ask of such a pronouncement, *". . .of what*?").

Likewise making the acquaintance of the biosemiotician at the first *Gatherings* were Yağmur Denizhan and Vefa Karatay (1999, 2002) a dynamic systems engineer and a molecular biologist, respectively, from Boğaziçi University in Istanbul, who build upon the work of theoretical physicist and computer scientist Valentin Turchin's (1931–) meta-systems transition theory in order to model the dynamics of self-increasing complexity in embedded systems, and the subsequent emergence of bottom-up system properties that then come to function recursively as top-down biases and constraints.

Also presenting their work were Physicsts Edwina Taborsky (1998) and Peder Voetmann Christensen (2000), who, almost alone among biosemioticians, have sought to explicate Peirce's own understanding of his semeiotic as being a subset of a logic of relations that can be used to understand how *any* set of relations hold together. Peirce's highly complex architectonic regarding (roughly) *possibility, being, and law* may yet prove to be rich mine for physicists, as well as for biosemioticians, and Taborsky and – along with systems theorists Stanley Salthe (1993) and Koichiro Matsuna (1999) – Christensen are among the first to be blazing this trail.

Relatedly, while physicists Christensen and Taborsky are approaching the organization and interactions of energy and matter from a triadically interactive perspective, biophysicist Howard Pattee has devoted the last 37 years of his life to the study of "precisely those dynamical aspects of physics (time, energy) that are necessary to implement codified instructions" – or, in other words: What are the physics necessary (if not sufficient) for semiosis? (Umerez 2001).

One of the original attendees at Waddington's "Towards a Theoretical Biology" conferences of 1969–1972 Pattee was forecasting, as early as 1965, those few who would listen, that "we may expect that the origin of life problem will shift away from the evolution of the building blocks and the elementary operations of joining them together, to the more difficult problem of the *evolution of control* in complex organizations. This problem is more difficult because the idea of "control" is not defined in the same sense as we can define biochemicals [per se]. . .A live cell and a dead collection of the identical biochemicals in the same structural organization differ essentially in the amount of *intermolecular control* that exists in each unit (1965: 405–406).

Like so many whose work we've had the occasion to overview here, Pattee's precisely articulated questions would in time help generate the conceptual frameworks and vocabularies needed for addressing them. Thus, the general principles behind such bottom-up and top-down "intermolecular control" would later be codified as "autopoiesis" by Maturana and Varela (1973, 1974) and as "dissipative structure" by Ilya Prigogine (1969), while for Pattee, the notions of the *epistemic cut* and *semantic closure* are necessary to a complete understanding of how and in what scientifically examinable way, matter can come to "stand for" something other than itself in and to a system – and this, of course, is the ultimate research question of biosemiotics.

Developments and Challenges 2001–2010

It would require a book-length monograph of its own to detail the interdisciplinary research interests and data presented annually, at the International Gatherings in Biosemiotics – all of which, in one way or the other, are devoted to the central question of the non-mystical role of "representation" and its "meaning" in the organization and interactions of living organisms. Rather, the most that I can do here is to present a short and by no means complete list of some of the more regular contributors to these conferences and their respective fields of interest, and to strongly encourage the reader to these scholars' work in the original.[36]

In the areas of animal studies, ethology and zoology, Mette Böll (2002), Karel Kleisner (2007, 2008), Dominique Lestel (2002), Timo Maran (2003), Dario Martinelli (2005), Stephen Pain (2007), Morten Tønnessen (2003), and Aleksei Turovski (2000) are all pursuing biosemiotic lines of investigation in their work. Examination into the relations of intercellular signaling processes are being undertaken by molecular biologists Luis Emilio Bruni (2007, 2008), Mia Trolle Borup (2005), Franco Giorgi (2009), Abir Igamberdiev (1999), and Mogens Kilstrup (1997), as well as by immunologist Marcella Faria (2005), embryologists Johannes Huber and Ingolf Schmid-Tannwald (2005), cell biologists Michal Schmoranz (2009) and and Jana Švorcovaá (2009), and pharmocologist Sungchul Ji (2002).

Researchers into dynamic systems theory who are incorporating biosemiotics into their models include Victoria Alexander (2009), Eugenio Andrade (2003), Arnellos Argyris (2007, 2010), Stephan Artmann (2007), Martien Brands (2006), Hernán Burbano (2005), John Collier (2005, 2008), John Darzentis (2006), Yagmur Denizhen (2002, 2008), Assen Dimitrov (2004), László Hajnal (2003), Wolfgang Hofkirchner (2002), Vefa Karatay (2006), Koichiro Matsuno (2007, 2008), Toshiyuki Nakajima (2005), Stanley Salthe (1993, 2008), and Edwina Taborsky (1998, 2001).

Neurosemiotic approaches to brain research and consciousness studies have been proposed by Peter Cariani (2001), Terrence Deacon (1997, 2010), Donald Favareau (2001, 2002, 2008a); Anton Fürlinger (1998), Franco Giorgi (2009), Yair Neuman (2003, 2008, 2009), Sidarta Ribeiro (2003), Andreas Roepstorff (2004), and Allessandro Villa (2005). Relatedly, biosemiotically informed approach to Artificial Intelligence and cognitive robotics has been undertaken by Ryad Benosman (2001), Noel and Amanda Sharkey (1999, 2002), Douglas A. Vakoch (2004, 2008), Stacey Ake (2007), and Tom Ziemke (2003).

Edward J. Baeziger (2009), Franitsek Baluska (2004, 2006), Peter Barlow (2007), Almo Farina (2004), Pierre Madl (2005), Maricela Yip (2005), and Gregory Bateson's biographer Peter Harries-Jones (1995, 2008) all apply a biosemiotic approach to their research into sustainable ecosystems, while anthropologists and cultural theorists Myrdene Anderson (1999), Thierry Bardini (2001), Mark

[36] Bibliographic information for works cited in this section, but published after 2006 can be found in the *Bibliography and Further Readings* section appearing at the end of this volume.

Reybrouck (2005) and Wendy Wheeler (2007) focus on the cultural semiotics of human-to-human interaction, and researchers associated with the Distributed Language Group such as Stephen J. Cowley (2008, 2009), Charles Goodwin (2006, 2007), Alexander Kravchenko (2009), Joanna Rączaszek-Leonardi (2009), and John Schumann(2005, 2009) are extending the notions of distributed cognition, interaction, and mind.

Enriching and informing all of this discussion is the work of semiotic scholars and philosophers Stacey Ake (2006), Pricsa Augustyn (2005, 2009), Han-Liang Chang (2005, 2008), Sergey Chebanov (1994), Juipi Chien (2004, 2007), Paul Cobley (2006, 2009, 2010), Marcel Danesi (2000, 2007), John Deely (2008, 2009, 2010), Eliseo Fernandez (2008, 2009), Johnathan Hope (2008, 2009), Tuomo Jämsä (2005), Konrad Talmont-Kaminski (2005, 2007), Andres Luure (2002), Aleksei Sharov (2002), Adam Skibinski (2004), Frederik Stjernfelt (2007, 2009), and Tommi Vekhavaara (2002, 2003, 2007), as well archivist for the Jakob von Uexküll Institute for *Umweltforschung*, Torsten Rüting (2004).

And as the result of this intense collaboration and international exchange of ideas, the biosemiotic project of examining the sign processes in life processes is becoming more interdisciplinary and more international every year. In 2005, the International Society for Biosemiotic Study that Thomas Sebeok had proposed over a decade ago was officially founded, and in 2005, the first issue of the international *Journal of Biosemiotics* appeared.

Moreover, and as the surest sign of growth, principled divisions within the biosemiotic project are already beginning to appear. The reach of biosemiotics is growing, and bringing into its orbit those from farther fields. Thus, no longer can it be agrees that a self-identified "biosemiotician" agrees that the semiotic categories of Peirce – or even the *Umweltforschung* of von Uexküll – are the proper starting points on which to build a scientific articulation of sign processes in biology.

Rather, in the nine years since Sebeok's death, the annual International Gatherings in Biosemiotics have been blessed with a steady stream of external challengers and internal self-critique. Tommi Vehkavaara (2002, 2007) and Stefan Artmann (2005, 2007) have been most vocal, and most productive, in challenging the assumptions of the consensus articulation in informed and informative ways. Such informed criticism is of inestimable value to a growing field whose members spend the majority of their year responding to uniformed criticism ("No, it's not sociobiology; no, it isn't spiritualist or vitalist; no, we don't think that an amoeba has thoughts; or that you can attract a spouse using subliminal Neuro-Linguistic-Programming techniques. . .").

And as productive as these meetings have been for the exchange of ideas and the development towards a common goal, equally important is the fact that they have also resulted in a series of penetrating critiques. Such critiques, coming from within the circle of those who have spent considerable time with the published materials (as opposed to those critics from the outside who, upon hearing the term "biosemiotics," simply conflate the project with "sociobiology" "anthropomorphism" or some variant of New Age pseudo-philosophy and then proceed – as they should, were the equation to be correct – to dismiss it out of hand as a pseudo-science), offer

penetrating analyses of both the existing shortcomings as well as the future problems that may be inherent in the current articulation of the biosemiotic project as it stands today, and suggest alternative possible ways to develop a semiotically-informed biology without reliance upon the ideas of von Uexküll or Peirce.

Philosopher of science Stefan Artmann, for example, sees biosemiotics as an example of a consilience-seeking "structural science" which he defines (with Küppers 2000) as: any "transdisciplinary formalization programme that tries to discover abstract analogies between research problems of different empirical sciences in order to contribute to their solution" (2005: 234). Along with the majority of biosemioticians, Artmann believes that the more such work is successful, the faster "biosemiotics" will become just an uncontroversial part of everyday biology. "This is the ironic fate of every productive structural science," writes Artmann, "It begins as educated analogizing, constructs step by step an interdisciplinary bridge between disciplines, transforms their way of thinking, supports the progress of scientific knowledge with the help of its transdisciplinary formal reasoning – and eventually becomes superfluous" (2005: 238).

Such an evolution, I feel justified in asserting, is exactly what most proponents of biosemiotics are hoping for – the "best case scenario" resulting from all their efforts to articulate the natural history, and the natural constitution, of the use of sign relations in the biological world. Unlike the practitioners of what he suggestively calls the "Copenhagen interpretation" of biosemiotics (e.g., Hoffmeyer, Emmeche, Kull, et al.), however, Artmann (2005) proposes that a "model-theoretic" approach incorporating mathematical representations of sign relational possibilities (somewhat akin to formalisms of Artificial Intelligence/Artificial Life research) will be critical if the field is to move forward – yet Artmann finds a strong resistance among the Peirceans towards "reducing" sign relations in this way.[37]

Philosopher Tommi Vehkavaara similarly objects that "Charles Peirce's and Jacob von Uexküll's concepts of sign assume an unnecessarily complex semiotic agent" (2003: 547) and that in order for these concepts to be naturalizable for use in an effective biology, they must be shown as arising out of "more primitive forms of representation" (2002: 293). For Vehkavaara, "the minimal concept of representation and the source of normativity that is needed in its interpretation can be based on the "utility-concept" of function" in a self-maintaining system that is able to switch "appropriately between two or more means of maintaining themselves" while in continuous interaction with their environment (2003: 547). Vehkavaara thus urges the adoption of concepts from Mark Bickhard's (1999, 2003) "interactivist" models of autonomous agency as prerequisites to the emergence of the kind of triadic

[37] It should also be noted here that many of the "non-Peirceans" from outside of the Copenhagen school – such as Prague physiologists Anton Markoš and Fatima Cvrčková – also eschew the idea that formalized equations between "digital signs and bodily (or analog) entities [could] be reduced to an unequivocal correspondence" (Cvrčková and Markoš 2005: 87). Rather, for the majority of more complex organisms (and certainly for mammals), the action of interpretation upon a sign is "its own shortest description" (a la the incompressible algorithms discussed by Kauffman 2000).

sign relations discussed in higher animals by von Uexküll and, *mutatis mutandis,* by Peirce.

Without a doubt, though, the most radical challenge to the Peircean approach to understanding the sign relations of living systems comes from embryologist and *Systema Naturae* (and now also *Journal of Biosemiotics*) editor Marcello Barbieri, who posits an alternative biosemiotic paradigm that is not organicist and qualitative in its origins, but mechanist and quantitative through and through.

Marcello Barbieri: Not Interpretation, but Organic Codes

A molecular biologist and experimental geneticist for over thirty years, Barbieri first proposed his "ribotype theory" of the origin of life in 1981. Working in the tradition of Manfred Eigen (1977), Freeman Dyson (1985) and Graham Cairns-Smith (1982), Barbieri realized from his work in embryology that just as the epigenesis of embryonic development requires an "endogenous increase in complexity" that "reconstructs" the phenotype from the "incomplete projection" of information that is the genotype (2003: 213–215), so, too must have this embodied logic or "natural convention" have had to evolve for doing so at the time when the *esopoesis* of precellular molecular aggregation was evolving into the *endopoesis* of polymerizing ribosoids (and, eventually, into the true *autopoesis* of "cells") (2003: 142).

For Barbieri, this naturally evolved "convention" – though interactive always in a triadic relationship of genotype, phenotype and ribotype – is not to be explained (or non-explained, as he would argue) as being so fundamentally coextensive with life that it – like growth, metabolism, and self-initiated movement – is merely assumed to be a "first principle" of living organization from which the rest of the investigation of biology is to proceed – a position that he feels the Copenhagen school is guilty of perpetuating.[38]

Rather, posits Barbieri, the earliest macromolecular precursors to tRNA not only predated, but actually brought into existence cellular genotypes and phenotypes, through their own physical constitution's ability to establish a reliable correspondence between freestanding nucleic and amino acid aggregates. "Any organic code is a set of rules [or conventions] that establish a correspondence between two independent worlds, and this necessarily requires molecular structures that act like *adaptors*, i.e. that perform two independent recognition processes," writes Barbieri, "This gives us an objective criterion for the search for organic codes, and their existence in nature becomes therefore, first and foremost, an experimental problem" (2005: 119).

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[38] In all fairness, not all members of the so-called Copenhagen tradition subscribe to this line of thinking – Taborsky (2001) and Christiansen (2002), for example, certainly do not – nor, indeed, did Peirce himself. Artmann (in preparation) and Barbieri (2001, this volume) have argued convincingly, however, that the assumption that true *sign* processes start with life (and, for all practical purposes, vice-versa) is retrievable in the works of Hoffmeyer, Emmeche, Kull, et al., and I do believe that this assertion is a reasonable one.

"The cell is the unity of life," writes Barbieri, "and biosemiotics can become a science only if we prove that the cell is a semiotic system."[39] And since at least 1981, this is exactly what Barbieri has been proposing. "Historically we are still very much in a period of DNA supremacy," he wrote back then, "and it will take perhaps a new generation of biologists to realize that genes alone could not have started life on earth any more than proteins alone could. The reason for this is that we are imbued with the concept that a cell is essentially a throwaway survival machine built by the genes, and a genuinely new attitude toward the origin of life will become popular only when this view is replaced by a different one (1981: 571).

Highlighting the introduction of yet another limiting and still far-too-consequential dichotomy into the narrative of Western science, Barbieri argued in his 1981 article that Wilhelm Johannsen did for molecular biology exactly what Descartes did for traditional biology, divorcing genotype from phenotype just as Descartes divorced the mind from body – and in so doing introduced an irresolvable explanatory dualism that is incompatible with the biological reality of interdependent levels of organization.

Rather, argues Barbieri, "the very definition of phenotype leads us therefore to conclude that the genotype-phenotype duality cannot be a complete theoretical description of an organism. It is a didactic concept which was introduced by Johannsen in 1909 to differentiate between hereditary and phenomenological characteristics, and it was only an unfortunate accident that the duality has been elevated to the status of a theoretical category" (1981: 577).

Indeed, he continues "the real distinction between genotype and phenotype is based therefore on the distinction between the one-dimensional world of information and the three-dimensional world of physical structures. The critical point is that there is no *direct* communication between these two dimensions of reality. A gene cannot build a protein any more than a protein can instruct a gene. The central dogma states that information does flow from genes to proteins, but only because it has been "taken for granted" that a third party exists which can actually implement the transition. What is not usually emphasized is that such an intermediary cannot be either another group of genes or another group of proteins" (ibid).

In pointing to the need for a triadic explanation of not just genes and proteins, but genes (one-dimensional information sequences), proteins (three-dimensional physical structures), plus whatever it is joins them explanatorily, and that uses genes to make proteins, Barbieri was not just calling for a new way of thinking about how living cells operate today – but also of how living cells came to be in the first place. Thus was what he then called *semantic theory of evolution* necessary, along with a *semantic theory of the cell* – and from 1981 to 1985, Barbieri worked virtually in isolation to articulate them both.

The gene-carrying cell that we know today, he posited, may have begun as a colony of ribonucleoproteins engaged in producing other colonies of ribonucleoproteins. Proposed before the Cech and Altman's Nobel prize-winning discovery

[39] Personal correspondence with the author April 21, 2006.

ribozymes in 1989, Barbieri had already forseen the possibility of – and, perhaps more importantly, the need for – something that would play the role of a *polymerizing ribosoids* in 1981. This "ribotype" as he dubbed it, itself had the character of a primitive RNA molecule, yet also had the capacity to catalyze a peptide bond between amino acids. It thus served to *bring together* the previously distinct worlds of RNA molecules and amino acids, introducing into the world the genotype, phenotype and ribotype relation that today *constitutes* the self-replicating cell. Overlooked as a derivative "intermediary" in its modern instantiation as "transfer RNA," such primitive ribotypes were, in fact, the seat of the genetic code and the first "codemakers" to appear in the history of life. Thus, claims Barbieri, "there was no real discontinuity between precellular and cellular evolution. Only the acquisition of sophisticated replication mechanisms brought about by the evolution of quasi-replication mechanisms which had been developed by the ancestral ribosoids to produce other ribosoids" (1981: 573–574).

A revolutionary re-thinking of both the origin of cellular life and of its ongoing internal relations even today, these ideas were expanded upon by Barbieri in his 1985 book entitled *The Semantic Theory of Evolution* – a work that was enthusiastically received both by mathematician René Thom (1923–2002) and by philosopher of science Sir Karl Popper (1902–1994). Almost 25 years worth of theoretical refinement later, Barbieri would present the mature form of his theories in his 2003 masterwork *The Organic Codes: An Introduction to Semantic Biology*. There he would lay out the empirical evidence that has been gathered, in the interim between 1981 and 2003, for existence of a whole array of organic codes that he postulated in the earlier work, including the RNA splicing codes (97–100), the intercellular signal transduction and integration codes (101–108), cellular migration and adhesion codes (112–114), and the cytoskeletal arrangement codes (172–173).

In these codes, as in the genetic code, there is no physical or chemical necessity between, say, the release of a certain neurotransmitter and the cascade of events that follow *save* the presence of the set of conventional internal relationships that have been selected evolutionarily and are embodied in the form of the complex of mediating molecules joining the so-called "first" and "second" messengers. This set of physically realized, biological relationships *is* the extra-genetic code whereby biological specificity is ensured. Thus, argues Barbieri, we have to add the processes of *natural conventions* in addition to the processes of *natural selection* to our study and understanding of the organization and evolution of the natural world (2003: 153).

In its triadicity and interactivity, Barbieri's semantic theory of the cell and its evolution seems to fall well within the biosemiotic perspective we have been discussing above. Yet Barbieri has a challenge for the Peircean-von Uexküllian tradition of Sebeok and Hoffmeyer, in that primordially, for Barbieri, "meaning" is "completely accounted for by objective and reproducible entities" (this volume). In fact, for Barbieri, "*any* time that we discover that the link between two organic worlds [read: between two dissimilar sets of internally convergent or autopoetic relations] requires not only catalysts but also *adaptors*, we are very likely to be in the presence of an organic code, and therefore of organic meaning" (2002: 293).

This focus on the endogenous organization of organisms as the primordial site of meaning-making – and the corollary conclusion that such meaning-making is, in its first instance, mechanical and derivative, rather than experiential and primitive – leads Barbieri to posit a semiotic/hermeneutic threshold in the evolution of living beings:

> "The first semiotic structure that appeared in the history of life was the [ribonucleoprotein] apparatus of protein synthesis, and the genetic code [joining nucleotides to amino acids] was the first code, but not the only one. The evolution of semiosis was essentially due to the appearance of other organic codes, especially in eukaryotic cells, and it was these new codes that increased the complexity of the eukaryotes and eventually allowed them to produce semiotic systems capable of interpretation, i.e. *hermeneutic* systems. The model of Peirce and Sebeok, therefore, is still valid but only for hermeneutic systems. The origin of semiosis (the *semiotic threshold*) and the origin of interpretation (the *hermeneutic threshold*) were separated by an extremely long period of evolution, because interpretation is dependent on context, memory and learning, and probably evolved only in multicellular systems. The history of semiosis, in short, was a process that started with context-free codes and produced codes that were more and more context-dependent. Today, our cultural codes are so heavily dependent on context that we can hardly imagine semiosis without interpretation, and yet *these are distinct processes* and we need to keep them apart if we want to understand their origin and their evolution in the history of life" (2008: 596)

The subjective experience of animals interpreting their surrounds as highlighted by von Uexküll, and even the triadic logic of relations developed by Peirce, claims Barbieri, can only function as "descriptive sciences, not explanatory ones. . .[for in this framework] semiosis requires three basic elements – object, interpreter and sign – which are *preconditional* and therefore *primitive* entities. [As] consubstantial agents of semiosis . . .they are the starting point [whereby a sign relation comes into being] and therefore cannot be reduced any further" (2007: 109).

Thus, although the Peircean/Uexküllian tradition shows us *that* sign relations are critical to the organization and interaction of the biological world, claims Barbieri, they do not show us *how* the underlying physical mechanisms work. For that, he suggests that biosemiotics needs to turn away from qualitative organicism in its approach and instead adopt "good rational, old-fashioned machine-like models" in the investigation of the roles of codes, signs, and meaning in living systems (202: 294).

Such machine models, Barbieri stresses, do not have to be eliminative-reductionist ("for a machine is a machine not when it is reduced to pieces, but precisely when it is put together into a functioning whole"), nor does it have to be physically constructed (e.g., a Turing machine), nor necessarily a set of mathematical equations. "Natural selection," writes Barbieri, "is a mechanistic model which is entirely expressed in words. The important point is that the model has the *logic* of a machine" (2002: 289).[40]

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[40] It is precisely this assertion that, I think, is most strenuously argued against in Anton Markoš' *Readers of the Book of Life*, as discussed above (see also Markoš 2002a: 136, 2002: 221, 2005: 87). Hoffmeyer (1996: 38, 95) and Emmeche (2001: 659) have similarly voiced their opposition to this idea.

> In so arguing against the organicist orientation of the Copenhagen school, Barbieri aligns himself with the mechanistic tradition of "Descartes, Newton, Lamarck, Darwin . . .and Jacques Monod" over and against the representative group of biosemiotic precursors cited by Stjernfelt: "Saint-Hilaire, von Baer, D'arcy Thompson, Spemann . . .Brian Goodwin, René Thom and Stuart Kauffman" (Barbieri 2002: 284; Stjernfelt 2002: 79).

It remains an open and ongoing question as to whether Barbieri will be successful in his efforts to refashion the primary biosemiotic articulation from one of "signs" to "codes" – or if, indeed, contrary to Barbieri's own current position, a coherent synthesis between his articulation and the presently predominant Peircean-Uexküllian articulation can be achieved.

Untold more possibilities exist, of course, for as Hoffmeyer reminds all newcomers to biosemiotics in the introduction of his seminal work, "To be decent scientists, we must take one another's realities seriously enough to try to eliminate the contradictions" (1996: *ix*). Biosemiotics, he continues, "suggests one way of doing this" – and then he adds with characteristic humanist-scientist understanding, "There may, of course, be other ways" (*ibid*).

Epilogue: On the Future History of Biosemiotics

A heuristic formula for the development of any kind of scientific inquiry might consist in successive initial phases of: observation, intuition, articulation and experimentation – which, if felicitous, then begin to cycle into one other generatively and recursively. If this formulation can serve as even a rough guide to the progression of scientific inquiry, then biosemiotics today is surely well past phases one and two, and is working diligently within phase three with a look to the arrival of phase four, at which time it will no longer be a "revolutionary science" in the Kuhnian sense, but quite simply, part of the background assumptions and paradigm of the everyday "normal science" of biology.[41]

Whether or not this day will come, only the histories that will be written long after this history will reveal. Certainly, the study of sign processes within life processes cannot be forestalled forever, as the more we learn about the former, the more we find ourselves confronted with the latter. Eventually, the "blind faith" that these sign processes can be studied *only* in their material aspects and not *also* in their aspects as signs *qua* signs for the systems that are using them as such, will be forced to give way under the weight of empirical evidence that is even now pouring in daily from the research being done in every area of the life sciences.

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[41] Bruno Latour (1987) distinguishes these two phases in the construction of knowledge as, first, "science in the making" – which is characterized by uncertainty, debate, personality, happenstance and abduction; followed by "ready made science" – which is characterized by relatively uncontentious induction using formulae, models, vocabulary, theories, methodologies and technologies that have been vetted in the earlier phase. The layperson's notion of "science" is generally the latter; the scientist's experience, the former – but as Latour argues against Kuhn, the relation between the two enterprises is not revolutionary struggle, but evolutionary dialectic.

Yet many working scientists do not feel comfortable working at a "science" that is still in its articulation phase. For the claim that "articulation" must come *before* "experimentation" so as to arrive at "understanding" may seem strange to those scientists who are working in long-established fields where the defining and fundamental articulations have already been settled – and, indeed, who may already be on their third and fourth re-articulations, as in physics. But MacIntyre (1974) has argued well that the history of all sciences have followed this chronology of observation, intuition, and articulation before experimentation – for, indeed, how would one know what one was experimenting "on" or "for" if one did not already have in place at least a provisional articulation of what one has intuited based on observation? And success in science has long followed the path, from the pre-Socratics to Copernicus, Newton to Darwin, Einstein and Bohr to Watson and Crick.

"You won't look for something if you don't believe it's even there," notes Marcello Barbieri frequently, and in his (2003) *The Organic Codes*, he relates how

> In the 1950s, it became clear that protein synthesis required a transfer of information from nucleic acids to proteins, and people realized that such a process must necessarily use a code. The existence of the genetic code, in other words, was predicted *before* doing the experiments that actually discovered it, and the results of those experiments were correctly interpreted as proof of the code's existence. [Contrarily,] in the case of signal transduction, the experiments were planned from the very beginning as a means of studying the biochemical steps of the phenomenon, and not as a search for codes, and the biological reactions of that field were regarded *a priori* as normal catalyzed process, not as codified processes. *No code had been predicted, therefore no code was discovered.* . . .[and this is how molecular signal transduction] has been studied ever since" (2003: 233)

Moreover, the fact that researchers were "looking for" a genetic code at all has its roots in the process of observation, intuition and articulation that led Wilhelm Johannsen to propose the existence of a "gene" in the first instance. There again, an *observation* (about familial sameness) led to an *intuition* (about material transmission) that had to be *articulated* [as the "theoretical unit of hereditary" – *whatever* that might turn out to be and some possible candidates were: cell, protein, blood, and vapor, among many others]). In order to articulate his *conceptual posit*, Johannsen designated this *theoretical unit of analysis* as a "gene." Only then could researchers start conducting experiments to find out if this so-called "unit of hereditary" actually existed and, if so, what it physically was and how it worked.

The twisted ladder of the double-helix DNA molecule, could Johannsen or any of his contemporaries had somehow seen it back then, would never have suggested itself as anything other than just a spirally molecule – which, of course, on one level, is all it is. But its *function* is something more, and that is not something that can be ascertained just by looking at its material form alone. Rather, only by looking at its material form in a context of an explanation – an *articulation*, or *provisional theory* – can one begin to do the experiments that will lead to the warranted conclusion that this molecule functions as the "unit of heredity" in this particular set of material interactions that constitutes the "organismic reproduction."

Precisely analogous to the above situation is the current status of the "*sign*" as a legitimate "unit of analysis" in biology, and particularly in neurobiology. There

– as in genetics, as in pharmacology, and as in animal behavior study – of one is *not looking for* the biological construction of a "sign relation" per se within the set of material interactions that constitutes brain activity, then one can see all the chemical-electrical activity there is to be seen – but one will never know how to see it *as* any particular *kind* or *category* of "sign activity" until one has a provisional theory – or *articulation* – positing in just what a "biological sign relation" consists. Even the finest microscope can only *present* – it cannot "make sense of" or explanatorily "reveal." For that one needs a theory – i.e., is an articulation, based on the logical analysis of observed phenomena, which is then subject to informed scientific testing.

Without this, for example, neuronal activation may be mapped down to the nano-volt, for its chemical and electrical properties – which we already understand quite well today – are not going to change. But whether or not we ever even look to see if any particular neuron's activation is currently functioning as part of an indexical circuit, an iconic one, or a symbolic one – to such questions, we will never get an answer, so long as "sign processes" remain misunderstood as equivalent to "human cultural constructs" and not the fundamental biological relations that biosemiotics insists that they are.

In science, one can only get an answer to those questions that it is "legitimate" to ask – and thus the job of biosemiotics right now is to articulate its intuitions about sign processes in biology such that they become accepted as legitimate scientific to ask. Currently, many of these questions are often still avoided as being "not quite legitimate" questions to ask – even despite the repeated insistence of virtually everyone working to advance the biosemiotic project, that what is being asked for is *not* a retreat into mysticism, supernaturalism, immaterialism, or reification of some scientifically unexaminable thing or element called "the sign" per se – but, rather, the same type of rigorous, repeatable, falsifiable examinations into a set of naturally-occurring relations in the world that living beings both need (internally) and use (externally) in order to survive.

One can examine these phenomena in their aspects as sign phenomena (i.e., in their aspects as substitution relations for some non-immediately present other) and still be doing actual science – this is the biosemiotic "message" in a nutshell. But the long legacy of Cartesian reductionism that has allowed modern science to examine the inanimate aspects of the world (Descartes' *res extensa*) so successfully, has kept it closed off from the equally natural product of nature that is "knowing relations" or "cognition" (Descartes' *res cogitans*).

Thus, despite all the problems that Cartesian body-mind dualism keeps increasingly forcing upon life scientists, the majority of experiments being done today – in neuroscience, molecular biology, immunology, pharmacology, etc. – are all informed by a theory that precludes, under the very terms of its bifurcated ontology, even the possibility of coherently – much less scientifically – understanding the phenomena under investigation: phenomena like messaging, signaling, representation, communication, understanding, and sign. Biosemioticians have thought these matters through from both their biological and their semiotic sides, and have come to the conclusion that the problem is not in the phenomena, but in the unnecessary restrictiveness of the informing theories.

Biosemioticians would argue the absolutely legitimate fear of contaminating science with spiritualism, vitalism, anthropomorphism and anti-scientism of every stripe has had the unintended consequence of forcing life-science into the unnatural and reactionary position of materialist reductionism. This, in turn, has diminished it and closed off its explanatory possibilities towards system phenomena that cannot be so reduced – not because such phenomena are spiritual or immaterial, but simply because of their nature as an agent-object-action relations of a biological organism. For any system that is *alive* must maintain itself in a constant state of self-reconstruction – this means that it must simultaneously and incessantly negotiate the organization of both its own internal set of intra-system relations, as well as the organization of its macro-system level interactions with an externality that is constituted by a third set of non-isomorhic causal relations of its own. Merely to *survive* this incessant triadic existential demand (much less to *evolve* within it) necessarily introduces into the phenomena under examination the proximate and system-centric *mediating* relations of *function*, *use*, *purpose*, and *goal* – as well as the superordinate relation needed to achieve all of these relations, the relation of substitution or "standing for" – i.e., the biological relation of *sign.*

Thus, while biosemioticians are *not* challenging in any way the absolute need and manifest success of examining the material aspects of these phenomena *qua* those material (and not "material and also relational") aspects, they do believe that the continued performance of lab experiments uninformed by a strong sign theory will not advance our scientific understanding to the fullest. Rather, biosemioticians will see a neuron firing and say that is a "sign" whose vehicle is this chemical-electrical event – while mainstream neuroscientists will see the same neuron firing and say that parsimony demands we say no more than just: this is a chemical-electrical event. But to the organism that neuron is firing in, which of these two understandings is the more inclusive and veridical? And is it not this organism – this system of interactions – that we are ultimately trying to understand in all its fullness? Left *only* with what can be seen "iconically," we are back to seeing the DNA molecule before there is a coherent theory of genetic inheritance in place. The data and the experimental results will always be the same for both the biosemiotician and the non-biosemiotician in their capacities as "objective" observers. Thus, the burden of proof, quite rightfully, is now on the biosemioticians to articulate why the biosemiotic insistence that the same phenomena must also be explicated from the "subjective" standpoint of the system under examination is not only possible and warranted, and worthy of the development of new scientific conceptual tools – but is also the understanding that may prove to be more predictive, more knowledge-generating, or more explanatorily sufficient than the current biological models that are now in use.

Like Aristotle's ideal naturalist who was able to successfully capture both the material nature of a phenomenon as well as its "meaning" in the lives of the organisms involved with it, without losing the essential aspects of either, biosemiotics strives for an explanatory subjective knowledge/objective knowledge synthesis in order to explain nature's genuine subject/object synthesis that is *biology*. But

whether or not anyone currently working in the field of biosemiotics can actually accomplish this explanatory synthesis, of course, remains to be seen. To date, the majority of our efforts have been expended trying to convince our colleagues in the sciences and the humanities that such a synthesis is even necessary. And as premier biosemiotician Claus Emmeche reminds us, while the biosemiotic understanding of sign relations as genuine relations of the natural world may seem to its adherents as a "robust, sophisticated, coherent, well founded, fruitful and comprehensive scheme of thought. . .in the long run, it cannot escape being judged by its fruits, and we do not yet know the historical result of that judgment" (2000b: 224).

And thus we end this brief overview of the ongoing history of biosemiotics as we started it – *in media res.* For while Thomas Sebeok (2001a) referred to the 1970s as the "prehistory" of biosemiotics, and Marcello Barbieri (2002), writing of the 1990s, opined that biosemiotics was as yet still coming into its "adolescence" – it is difficult not to feel as we end this as-yet preliminary "history" that both the reader and I have arrived here at the present moment in 2010 just as the *real* history of biosemiotics is about to get underway.

That said, all that is now left for me to do as a historian of the project is to welcome all our readers to this exciting young interdiscipline, and on behalf of my colleagues in biosemiotics everywhere, to invite you to actively contribute to its ongoing history.

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