

# *God and the World of Signs: Semiotics and the Emergence of Life*

*with Andrew Robinson and Christopher Southgate, "Introduction: Toward a Metaphysic of Meaning"; Christopher Southgate and Andrew Robinson, "Interpretation and the Origin of Life"; Bruce H. Weber, "Selection, Interpretation, and the Emergence of Living Systems"; Jesper Hoffmeyer, "A Biosemiotic Approach to the Question of Meaning"; Robert E. Ulanowicz, "Process Ecology: Stepping Stones to Biosemiosis"; Andrew Robinson and Christopher Southgate with Terrence Deacon, "Discussion of the Conceptual Basis of Biosemiotics"*

## A BIOSEMIOTIC APPROACH TO THE QUESTION OF MEANING

*by Jesper Hoffmeyer*

*Abstract.* A sign is something that refers to something else. Signs, whether of natural or cultural origin, act by provoking a receptive system, human or nonhuman, to form an interpretant (a movement or a brain activity) that somehow relates the system to this "something else." Semiotics sees meaning as connected to the formation of interpretants. In a biosemiotic understanding living systems are basically engaged in semiotic interactions, that is, interpretative processes, and organic evolution exhibits an inherent tendency toward an increase in semiotic freedom. Mammals generally are equipped with more semiotic freedom than are their reptilian ancestor species, and fishes are more semiotically sophisticated than are invertebrates. The evolutionary trend toward the production of life forms with an increasing interpretative capacity or semiotic freedom implies that the production of meaning has become an essential survival parameter in later stages of evolution.

*Keywords:* anticipation; biosemiotics; emergence; evolutionary interpretation; ontological relation; relative being; semiotic freedom; sign; theory of meaning

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Biosemiotics is an approach to the study of living systems that takes the production, exchange, and interpretation of signs to be constitutive for life. That life processes are ultimately anchored in subtly ordered patterns of chemical interactions has been challenging biological theory for centuries because of the obvious teleological character of living beings. Because chemistry cannot logically by itself give rise to anything purposive, the teleology of living beings normally has been ascribed to the evolutionary molding by natural selection of coherent sets of information-carrying units, whether individuals or genomes. The combination of a selectionist and an informational approach to the study of living systems clearly establishes an important approach to a solution of the teleology puzzle.

And yet, something important is missing here, because the selection of information will direct the organism toward its own future only if the information has a referential capacity. The information has to be “about” something, or else it cannot help the organism in the competition for reproductive success. Information does not contain the key to its own interpretation. We need to add a theory of interpretation, and this is exactly what semiotics is about.

In the early days of molecular biology one might have thought that genetic information directly determined organismic behavior, but this idea has not been substantiated in the course of later developments. The simple fact that all cells in an organism have identical genetic information but may be widely different structurally as well as functionally already shows us that genetic information is interpreted differently in different cells. For evolutionary theory to come to terms with the teleological nature of living systems it must therefore include an appropriate theory of reference and interpretation. Biosemiotics aims to develop such a theory by treating information as expressed through natural signs.

One main argument behind the intelligent-design movement has been its persistent criticism of Darwinian theory as insufficient where complex biological structures are concerned. In making a partly similar criticism biosemiotics runs the risk of being located in the same antiscientific waters as the intelligent-design movement. However, biosemiotics actually is aimed at extending the Darwinian approach by introducing scientific means to explain the existence of exactly those teleological characters that intelligent-design theorists claim cannot be scientifically explained.

As a European scientist I had no detailed knowledge about the Discovery Institute apart from its devotion to the intelligent-design argument when, in 2007, I was invited together with a handful of very competent evolutionary biologists to attend the so-called Wistar retrospective symposium, organized by the Institute. So I accepted the invitation to take part in this confrontation between evolutionists and intelligent-design adherents. What follows is based on the paper I presented at this meeting. It

suggests a scientifically based approach to the problem of meaning departing from a post-Darwinian conception of evolution that takes Darwin's theory for granted and yet does not consider natural selection to be the sole explanation for the origin of species. The approach instead considers semiotic emergence to be a central productive instrument for the evolutionary process. Before discussing the concept of semiotic emergence, I outline the general biosemiotic approach on which this alternative is based (Hoffmeyer 1997; 2008b).

#### BIOSEMIOTICS

The biosemiotic approach to the study of living systems is a logical consequence of the profound trend toward a semiotization of nature that characterized biology up through the twentieth century. An early expression of this trend was the ethology of Jakob von Uexküll (1864–1944), who in the 1920s developed his *Umweltsforschung*—that is, research into the *Umwelt*, a term Uexküll introduced to refer to the phenomenal worlds of organisms, the worlds around animals as they themselves perceive them (Uexküll [1940] 1982).<sup>1</sup>

Later, in 1973, ethology became canonized through the awarding of the Nobel prize in physiology and medicine to be shared by Konrad Lorenz and fellow ethologists Karl von Frisch and Nicolas Tinbergen. Lorenz clearly stated the debt of ethology to the early work of Uexküll, writing that ethology “certainly owes more to his [Uexküll's] teaching than to any other school of behavior study” (Lorenz 1971, cited in Sebeok 2001, 72). Ironically, recognition of ethology as a proper scientific discipline was obtained only because Lorenz turned his attention away from the Uexküllian *Umwelt*. The question of how animals conceive their surroundings was replaced by the question of animal behavior, which was then described to a large extent as the result of inborn instincts. And so, instead of seeking a proximal explanation of behavior from the specific *Umwelt* of the animal, ethology devoted itself to the study of more distal explanations based on genetic dispositions such as instincts and, ultimately, on natural selection.

A major breakthrough in our understanding of the semiotic character of life was the establishment in 1953 of the Watson-Crick double-helix model of DNA and the subsequent deciphering of the genetic code. Up to this point the semiotic understanding of nature had been concerned mainly with communicative processes between organisms, termed *exosemiotics* by the late American linguist and semiotician Thomas A. Sebeok (1979), but it now became clear that semiotic processes were prevalent also at the biochemical level (endosemiotics). Linguist Roman Jakobson pointed out that the genetic code shared several properties with human language and that both were based on a double-articulation principle (Jakobson 1973; Emmeche and Hoffmeyer 1991). Because of its reductionist inclination,

however, mainstream biology did not at the time—and still does not—apply a semiotic terminology (an exception to this is Florkin 1974<sup>2</sup>).

Eugene Yates (1985) has pointed to the strange shift in vocabulary that gradually took place in biochemistry in the wake of the recognition of the genetic code. It seems as if modern biochemistry cannot be taught, or even thought, without using communicational terms such as *recognition*, *high-fidelity*, *messenger-RNA*, *signaling*, *presenting*, or even *chaperones*. Such terms pop up on every page of modern textbooks in biochemistry despite the fact that they clearly have nothing to do with the physicalist universe to which such books are dedicated. As Yates remarks, “There is no more substance in the modern biological statement that ‘genes direct development’ than there is in the statement ‘balloons rise by levity’” (1985, 351).

Biochemists, of course, do not normally suppose that macromolecules or cells “recognize,” “send messages,” or “present peptides at their surfaces” in the normal sense of these words, and if accused of sloppy term usage they would claim that such language is only shorthand for complicated processes that might in the end be described in decent scientific vocabulary based on information theory and natural selection. But there are serious reasons to suspect that this is not the case. Natural selection presupposes competition between individual organisms, but in the absence of the alleged “pseudo” semiotic functions we are talking about here, there could be no functional cells in the first place and therefore no natural selection. One might perhaps introduce models of chemical selection instead of natural selection, as suggested by Bruce Weber (1998), but this would hardly in itself account for the intentionality tacitly implied by the semiotic terminology. One does not “send messages” or “present” if one has no intentions of influencing somebody else, such as for instance a T-helper cell in the immune defense system. Thus, Weber and Terrence Deacon (2000) explicitly added self-organizing dynamics to the chemical selection scheme they proposed.

It will not help, either, to answer the objection by reference to information theory. The term *information* is rarely used in biology in the same objectified sense it is used in information theory, that is, Shannon information. Most biologists and biochemists probably understand the term rather straightforwardly in the sense given to the concept by Francis Crick when he proposed the so-called Central Dogma, according to which “Once ‘information’ has passed [from DNA] into protein it cannot get out again” (Crick 1988, 109). This glib formulation, however, contains great ambiguity as long as we do not know what information actually is. Crick himself was fairly explicit: “Information means here the precise determination of sequence, either of bases in the nucleic acid or of amino acid residues in the protein” (p. 109), and if the term *determination* in this citation could be taken in its usual sense of establishing or controlling the exact outcome

of a given process, it would indeed bring the use of the term *information* back into the safe area of well-established scientific ontology. Unfortunately, as we now know, many kinds of processes will interfere with the supposed deterministic control exerted by this so-called information in the DNA. Crick's information therefore must be understood as a kind of specification rather than a determination. A specification is no innocent thing when seen in the light of normal scientific ontology, however, because the meaning of a specification has no unequivocal or measurable reality. It is most often highly context-dependent and necessarily in need of "correct" interpretation (Sterelny and Griffiths 1999).

The term *interpretation* is crucial here. To interpret normally means to understand an action, a mode, or a way of behaving as having a particular meaning. The act of interpretation thus seems to be a key to the production of meaning when this word is used in a situated local sense. Would we also accept this term to cover, for example, the case of a bird's broken-wing trick? A fox, say, is lured away from the bird's nest because it "interprets" the clumsy movements of the bird as signifying an easy catch. Instead of searching for the nest it therefore follows the bird away from it until the bird suddenly stops pretending to have a broken wing and flies away. Several kinds of interpretation may be seen to take place in this example. First, the bird must anticipate that the fox will chase it if it moves awkwardly. This anticipation may be based on learning, in which case it would come close to interpretation as the word is used in the human context. Or the apparent anticipation is in fact just an instinctive behavior pattern—in which case we are still justified in saying that the evolutionary process has somehow made an anticipation in the sense that it has managed to genetically instantiate a general rule concerning the chasing behavior of predators in the birds, a rule based on the outcome of myriad individual cases. But to make a general rule out of single cases logically seems to come close to what interpretation actually means. Accordingly, I suggest the term *evolutionary interpretation* to cover such cases.

Readers with a background in the humanities may feel their sensitivities violated by this terminology. However, I am not suggesting this usage in order to reduce human acts of interpretation to ethology. Interpretative acts in the animal world are, of course, extremely primitive compared to human acts of interpretation, and these may even be said to be different in kind because they are inescapably interfused with a linguistic competence that is absent in animals. In a way my problem is the exact opposite: I am trying to come to terms with processes taking place in the natural world that seem to require description at a level not usually accepted in the natural sciences, and I therefore need to extend the meaning of *interpretation* to its logical extrapolation back into the animal world in and of which the human animal was born.

Basically this strategy depends on the conception of human faculties as graded rather than absolute. Human life depends only marginally on processes of conscious interpretation. By far the majority of all human choices depend on subconscious decisions based on the tacit interpretations of cues that would not be recognized even if somebody pointed them out, such as for instance the specter of pheromones emitted by persons of the opposite sex that apparently deeply influence how attractive we find such persons. We know fairly well today that rational decisions and emotional states are deeply interconnected. A key finding behind this understanding was neurologist Antonio Damasio's work with brain-damaged patients. He observed that his patients often were unable to make rational choices for the one and only reason that their brain damage interfered with their ability to generate appropriate emotional responses. He concluded that "Nature appears to have built the apparatus of rationality not just on top of the apparatus of biological regulation, but also from it and with it" (Damasio 1994, 128).

Already more than one hundred years ago the American logician, scientist, and philosopher Charles Sanders Peirce (1839–1914) defined a *sign* as a logical relation of something (the sign vehicle) that is referring to something else (the object) by inducing the formation of an interpretant, as he called it, in a receptive living system. To take a very simple example, smoke is a sign vehicle when or if it provokes the formation of fleeing behavior (the interpretant) in an animal that takes the recognition of smoke to mean danger (the object). Although human cultures operate on very complex chains or webs of signs of all kinds, most of the world's other species are predominantly guided by iconic or indexical signs (based on likeness and physical relatedness, respectively). The dividing line between humans and animals cannot therefore be whether or not a species possesses semiotic capacity; rather, it concerns the *kind* of semiotic capacity the species will master. Humans possess the ability to communicate and think via symbolic references, while all other organisms seem to be limited to iconic and indexical referencing. (A few apes have been taught to use true linguistic referencing, but this has come about only through the investment of enormous amounts of training, and ape young have never approached the linguistic agility that human children normally attain all by themselves by two to three years of age [Deacon 1997].)

Biosemiotics claims, in other words, that interpretation and *eo ipso* sign use, or semiosis,<sup>3</sup> cannot, for logical as well as historical (or evolutionary) reasons, be understood as activities exclusive to that single species to which we belong. Nor is semiotic activity exclusive to the animal kingdom, because all living creatures need to adjust their activities to changing conditions around them and are utterly dependent on the ability to interpret important cues in their surroundings (their local semiosphere) no matter how primitive this interpretative capacity is. And, as we saw, a root form of

interpretative activity is involved already at the basic level of the life process where the specifications carried in the genetic code of the DNA molecule becomes “transcribed,” “translated,” “read,” or “used” by the cellular apparatus, by the tissues of the growing embryo, or through the emotional response of the adult organism. Sebeok expressed this pioneering understanding as early as 1968 in his suggestion that “a full understanding of the dynamics of semiosis . . . may, in the last analysis, turn out to be no less than the definition of life” (1968; [1976] 1985, 26).

#### RELATIVE BEING

A sign is neither a thing nor a concept; it is a pure relation whereby a receptive system orders its world. But this kind of existence—existence as a relation, or relative being—is usually dismissed by science as not really real. For example, Jupiter has a number of moons circling around it, but the relation between the moons and the planet is not seen as anything real in itself because it doesn’t add anything to a strict analysis of the properties of the individual celestial bodies. The simple genitive case seems neatly to exhaust the whole relation: The moons are indeed Jupiter’s. And it is true that in principle a relation could be drawn between any two physical objects in the world, and in all but a very few cases such relations would turn out to be absolutely uninteresting.

Not all relations are of this kind, however. As an example of relative being that cannot easily be dismissed as fictitious let me (following Deely 2001) suggest parenthood. For all we know, King Frederick the Ninth of Denmark was the father of Queen Margrethe the Second. His Majesty passed away a long time ago, and we have no doubt that Margrethe will pass away too at some time in the future. Yet because of royal destiny their relation will very likely persist for a long time as a relation of parenthood, father to daughter. This kind of relative being seems to have a reality of its own that cannot be reduced to the individual persons that substantiate the relation. Such relations have been called ontological relations (Deely 1990; 1994; 2001).

Are there ontological relations in nature? The British-American biologist and anthropologist Gregory Bateson may have been the first to see the significance of this question and to answer it in the affirmative as far as the world of living things is concerned. In the Newtonian framework that has worked so well in guiding our conceptions of the nonbiological world, causative agents are always positive events or conditions—impacts, forces, and so on, Bateson said. But in the biological world events often are caused by differences in some parameter sensed by an organism (or tissue). A telling example is that of the frog, which does not see an insect sitting right in front of it as long as the bug does not move. The moment it moves, the frog immediately sees it—and probably catches it, too (Lettvin and

Maturana 1959). “Every effective difference,” writes Bateson, “denotes a demarcation, a line of classification” (Bateson 1972, 57). And further:

Insofar as living things contain communication, and insofar as they are, as we say, “organized,” they must contain something of the nature of *message*, events that travel within the living thing or between one living thing and others. And in the world of communication, there must necessarily be categories and classes and similar devices. But these devices do not correspond to the physical causes by which the materialist accounts for events. There are no messages or classes in the prebiological universe. (Bateson 1972, 61–62)

Thus, according to Bateson, in the animate world relations are truly ontological in the sense that these relations are not just descriptive devices but are in fact functional in an autonomous way.

Relations sometimes are conceived as functional even in the world of lifeless entities. The multiple relations existing between the planets of our solar system have been intensely studied by scientists of the past, and they remain a matter of great concern to individuals who believe in varieties of astrological theory. Because no likely mechanism whereby, say, a conjunction between Mars and Venus (as seen from Earth) could possibly influence the destiny of individuals or nations on Earth has been suggested, scientists reject such a belief as superstition. We have no reason to believe that those relations have any distant causal effects on the world qua relations. In this case, as in the inanimate world in general, it makes sense to talk about related things rather than relations, and maybe the general unwillingness of science to accept relations as ontologically real owes much of its strength to the ancient—and now, strangely, revived—struggles science had to fight against dogmatic beliefs connected to mystical or religious persuasions.

When we turn to the world of living things, however, relations tend to become more autonomous things. The shoulder, for instance, is a ball-and-socket joint that enables a person to raise, twist, bend, and move the arm forward, to the sides, and behind. The head of the upper arm bone (humerus) is the ball, and a circular depression (glenoid) in the shoulder bone (scapula) is the socket, and we can assume that this relation has been functionally modulated by natural selection all along the way from the evolutionary origin as appendages or fins in fish. Clearly these relations are of a kind quite different from the relations pertaining to the planetary system. The relation in fact is so central to the function of the animal that one can hardly imagine the one bone changing without a corresponding change occurring in the other bone. If this should happen by an unfortunate mutation, the resulting individual would be crippled and leave few or no offspring. However, if a mutation should occur that affected both bones in a coordinated way, conserving their internal relation, the resulting individual might manage very well in the competition. In this case, the relation as such does seem more real than the individual bones making up the

relation. And this state of affairs may well be the rule rather than the exception in biology.

Generally, as we saw, living systems are equipped with a capacity for anticipation. They must decide when to grow and when to withhold growth, when to move, when to hide, when to sing, and so on, and this way of adjusting behavior depends on a capacity to predict the future at least to some extent. Is it likely that the sun will (or will not) shine? Is it likely that little flies will pass by if I make my web here? Will the predator be fooled away from the nest if I pretend to have a broken wing? In all cases the organism profits from its ability—whether acquired through phylogeny or ontogeny—to identify trustworthy regularities in its surroundings. And most, if not all, trustworthy regularities are relations: the relation between length of daylight (or, better, the quantity of degree-days<sup>4</sup>) and approaching summer that tells the beech when to burst into leaf<sup>5</sup>; the play of sun and shadows that tells the spider where to construct its web; or the relation between clumsy movements and an easy catch that tells the predator which individual prey animal to select and thus tells the bird how to fool the predator away from its nest.

In the first two of these examples, the beech and the spider, a certain organismic activity is released as a response to pure (nonsemiotic) natural relations, so-called categorical relations, whereas in the third the bird produces a fake categorical relation (clumsy behavior as related to easiness of catch) and then takes advantage of the semiotic or ontological relation established by the predator when it lets itself be fooled by a false sign. The bird fools the predator because it somehow, genetically or ontogenetically, “knows” how the predator is going to (mis)interpret the seeming categorical relation. Observe that in this case the predator may not always be fooled; we are dealing not with normal (efficient) causality but with semiotic causality, that is, bringing about things under guidance of interpretation in a local context (Hoffmeyer 2007). The predator may misinterpret the sign (the faked clumsy behavior), but it also may not.

Anticipation is a semiotic activity in which a sign is interpreted as a relation between something occurring now and something expected to occur later, like the dark cloud that warns us of an approaching thunderstorm. From its beginnings in Augustine’s writings in the fourth century the sign has been conceived as something awakening us to infer something else. For Augustine a *signum* or “a sign is anything perceived which makes something besides itself come into awareness” (quoted in Deely 2001, 221). We see today that Augustine’s definition is too narrow in its focus on perception; elements of awareness may well be signs also without being perceived. Augustine nevertheless pointed to the core of the matter when he defined a *thing* as “what has so far not been made use of to signify something” (Deely 2001, 221), implying that things may be signs, but need not be, and also that the essence of the sign is its formal relational character of

evoking an awareness of something that it is not itself, thereby including the full triad of sign, object, and interpretant (here, the altered awareness). The evoking of such a triad is by no means exclusive for the workings of human awareness but is rather, as was later realized, a purely logical relation to be established in any system capable of autonomous anticipatory activity—that is, all living systems.

Because predictability must precede prediction, simple dyadic relations such as cause-and-effect relations must have been realized on planet Earth before more sophisticated systems could survive based on a capacity for anticipation. The anticipatory process depends on the conversion by an organism of the cause-and-effect relation to a triadic sign relation whereby the cause is “understood” as referring to the effect. And although the underlying system of dyadic relations may well be described in terms of the things related, the emergence of true triadic semiosis in the shape of living beings and their activities established kinds of causality peculiar to this new form of relative being, causalities that are far too sophisticated to be grasped through the simple dynamics of dyadic relations between things. At this state of organic evolution semiotic emergence may increasingly have become an autonomous factor in the continued history of life, operating in a dynamic interplay with natural selection, and the general trend toward a realization of ever-new forms of semiotic freedom began.

We conclude that not only is it absurd to deny the reality of relative being, because relative being rather than things (individual creatures or populations) is what evolution persistently optimizes, but by denying this reality one is prevented from developing a proper scientific understanding of biosemiosis and purposefulness. Instead, science has felt challenged to show that these phenomena are pseudophenomena (epiphenomena) and that there is therefore no contradiction between our own existence as human first-person beings and the purely material universe that created us. Persons whose intuitions contradict this understanding have had to go elsewhere to cope with their need for understanding how they could possibly belong in this universe. As I state elsewhere,

Increasingly natural science has come to look like an esoteric order of believers keeping the reality of non-believers at arms distance behind the walls of power based on a shared narrow ontology (reinforcing itself through the ever repeated memory of the preceding centuries of victorious revolt against the dogma of the Christian church), a consensus about what belongs and what does not belong to reality. How natural scientists manage to know so surely that they are part of a nature that in itself knows nothing is to me a complete mystery. (Hoffmeyer in press)

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#### SEMIOTIC FREEDOM

A recurrent theme in debates on evolution has been whether or not evolution has an inherent direction. Intuitively one may think that evolution

has tended to create more and more complex kinds of organisms, but mainstream evolutionary biologists accord no such directionality to the evolutionary process. One problem is that there is considerable ambiguity as to what exactly should be meant by complexity. If it is taken to refer to morphological complexity as determined by the number of different parts constituting the organism (or system) and the greater or lesser irregularity of their arrangement, there is no empirical evidence to support the intuition that complexity has grown greater in the course of evolution (McShea 1991).

From a biosemiotic point of view, however, morphological complexity of a living system does not say a lot about its real complexity, and it comes as no surprise that this kind of complexity reached its upper limit already in the Devonian period (which ended 360 million years ago) or even earlier. A much more interesting aspect of complexity is semiotic complexity, or *semiotic freedom* as I choose to call it (Hoffmeyer 1992; 1996). Semiotic freedom is a measure of the depth of meaning communicated or interpreted by living systems, so that organisms exhibiting a high degree of semiotic freedom are capable of dealing with more sophisticated, complicated, “deep” messages.

Organisms have a surprising capacity to take advantage of any regularities they may come upon as vehicles for signification, or signs. This semio-genic capacity leads to the formation of a kind of interactive dynamics that is called *semethic interaction* (from the Greek *semeion* = sign + *ethos* = habit) (Hoffmeyer 1994a, b). In semethic interactions behavioral or morphological regularities (habits) developed by one species (or individual, tissue, or cell) are used (interpreted) as signs by individuals of the same or another species, thereby eliciting new habits in this species eventually to become, sooner or later, signs for other individuals, and so on in a branching and unending web integrating the ecosystems of the planet into a global semiosphere.<sup>6</sup> The broken-wing trick in birds is an obvious example of semethic interaction involving two different species, but such interactions are widespread in nature and have been at play from the earliest steps of evolution. The “invention” of light sensitivity in heterotroph organisms<sup>7</sup> exemplifies the power of this dynamic pattern at an early stage of evolution:

Photopigments were first used in photosynthesis, and in locating or moving toward or away from places where the wavelength of light was suitable or not suitable for photochemistry. . . . At some point, when (photosynthesizing) cyanobacteria are presumed to have constituted a major portion of the biomass on earth, they themselves represented a field potential on which heterotrophs . . . began to feed. The heterotrophs used the same photopigments for detecting light, but not to photosynthesize; instead the pigments were used to detect light that was specific to where the autotrophs (photosynthesizing cyanobacteria) were feeding (on the light). Light distributions specifying not light as food itself, but information about the location of food, was evolutionarily instantiated in its modern sense. (Swenson and Turvey 1991, 340)

Amusing examples of semethic interactions are numerous, such as squids that survive dangerous exposure to moonlight by producing so-called counterillumination in mutualistic interaction with light-emitting spirochetes in their mantel cavity, or the fungus that contaminates male flies by turning the peculiar regularities inherent to the sexual schemata of the flies to their own advantage. Semethic interactions are probably involved in most, if not all, interspecific relations. Both predator and prey must in their opposing projects necessarily be aware of those signs that tell them about the habits of the opponent. (See Hoffmeyer 2008b, ch. 6, for these examples and others.)

The semiogenic capacity of living systems as exhibited by the myriad varied patterns of semethic interaction must have led to an evolutionary trend toward increased semiotic freedom in the sense of an increased capacity of individual organisms to interpret complex signs. Obviously, the ability to foresee important events or behaviors of others would benefit all species that depend for their survival upon a correct situated reading of decisive niche parameters. I have suggested that the concept of an ecological niche be extended to include the semiotic niche, “the world of cues around the animal (or species) which the animal must necessarily interpret wisely in order to enjoy life” (Hoffmeyer 1996, 94). Unlike morphological complexity, semiotic complexity cannot easily be quantified into an exact measure, because semiotic complexity refers to an activity that is free in the sense of being underdetermined by the constraints of natural lawfulness. I deliberately chose the term semiotic *freedom* rather than semiotic depth or semiotic complexity in order to not create the illusion that this capacity, semiotic freedom, belongs in the same space of dyadic relations as do the more traditional measures of complexity.

Although the creation of smart morphological architectures may have been the focal point of innovations in the earlier stages of evolution, it seems unavoidable that the development of social interaction patterns gradually moved the focal point toward behavioral aspects. Especially as evolution little by little created animals with central nervous systems to be players “in the ecological theater,” to borrow G. Evelyn Hutchinson’s famous phrase, the play itself must have changed character so that, increasingly, evolutionary gains would now turn on the development of efficient mechanisms for social interaction and cooperation as well as on such misinformative practices as cheating and faking, and, in short, that evolutionary games would be expected to increasingly concern the acquiring of semiotic competence:

Seen in this light the most pronounced feature of organic evolution was not the creation of a multiplicity of amazing morphological structures, but the general expansion of “semiotic freedom.” The anatomical aspect of evolution may have controlled the earlier phases of life on Earth but my guess is that, little by little, as semiotic freedom grew, the purely anatomical side of development was circumscribed by semiotic development and was thus forced to obey the boundary con-

ditions placed on it by the totality of semiotic challenges the species would have to deal with. (Hoffmeyer 1996, 000)

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Indeed, as soon as we put on semiotic glasses, the evolutionary trend toward the creation of species with more and more semiotic freedom becomes so obvious that we may wonder why it has not been suggested. Mammals are semiotically more competent than reptiles, fishes more than invertebrate animals, and so forth. One reason why this trend is not acknowledged may be that anthropomorphism is generally considered such a deadly sin that in setting up semiotic freedom, as I do here, as the pivotal point of evolution (at least in its later phases) we almost by definition must accord to human beings the status of being the foremost creatures in the natural history of the Earth. Perhaps this is also the reason why science in general is suspicious of the semiotization of nature implied by the biosemiotic approach.

I suggest that it is time to start considering the growth in semiotic freedom as a core factor in the evolutionary dynamics. Natural selection served as an important mechanism for this growth, but the gradual appearance of semiotically more capable species came to introduce new dynamics into the evolutionary drama, dynamics that stem from the opening up of a whole new possibility space for evolutionary innovations, innovations that on their side could be realized only through a process of semiotic emergence. Innovations more and more came to depend on semiotically organized cooperative patterns at all levels from single cells and tissues to organisms and species and, in the end, whole ecological settings.

#### SEMIOTIC EMERGENCE

Semiotic emergence designates the establishment of macroentities or higher-level patterns through a situated exchange of signs between subcomponents (Hoffmeyer 2008b). Although the emergence of higher-level patterns has been accused of being slightly mysterious as long as only physical interactions between entities are considered, the same outcome becomes readily understandable when based on semiotic interactions between entities at the lower level. Entities at one level may be bound together in stable functional<sup>8</sup> ensembles in numerous semiotic ways because, contrary to physically based interactions, semiotic interactions do not depend on any direct causal connection between the sign vehicle and the effect.<sup>9</sup> When functionality first arises at a higher level, any mechanism that will stabilize such functionality will be favored by selection, and in this context semiotic interaction patterns offer a much more versatile repertoire of stabilizing mechanisms than do purely physical interactions.

Let us first consider the striking difference between prokaryotic and eukaryotic life forms. Compared to the extreme openness toward foreign

DNA-“messages” exhibited all over the prokaryote world, eukaryotic organisms appear to be very isolated beings. Bacteria have evolved elaborate—and well-controlled—systems for exchanging segments of DNA with each other. Because of these mechanisms and the astronomical number of bacteria distributed all over the planet there is a fair possibility that at least somewhere in the world a starving bacterial population will by chance pick up DNA segments containing genes that might help them survive, for instance by degrading some otherwise inaccessible food item. Microbiologist Sorin Sonea (1991) suggested that we consider the world’s total mass of bacteria as one global organism. Despite the statistical character of these semiotic interactions in bacteria, they are highly controlled and rely on the well-regulated occurrence of specific receptors at the surfaces of cells as well as on the induction in the cells of specific enzymes suitable to support this kind of communication.

With the appearance of eukaryotic life forms, these horizontal mechanisms for DNA communication disappeared, and such communication became exclusive to the “family” line. Thus, in eukaryotic cells, DNA transmission is strictly vertical or temporal, limited to the events of cell divisions. The one major exception to this is the fusion of genomes that takes place during the process of sexual reproduction.

A deep difference in semiotic logic between prokaryotic and eukaryotic life is buried here. According to current theory, eukaryotic cells arose through endosymbiosis from prokaryotic life forms. Present-day mitochondria, chloroplasts, and microtubules (the intracellular organelles concerned with movements) are all, according to Lynn Margulis, descended from individual bacterial species that, long before their present relations of symbiotic cooperation appeared, were adapted to niche conditions that had prepared them for their later function in the eukaryotic cell (Margulis 1970; Margulis and Fester 1991).

Gradually, many of the genes that originally belonged to individual endosymbionts were transferred to the shared pool in the cellular nucleus (which in this process had its genetic material doubled many times—relative to the typical prokaryotic content of genes). Thus the eukaryotic cell engaged in a new survival strategy: Rather than depending on the reception of visiting genes through plasmid infection, eukaryotic cells relied on genetic self-sufficiency. Yet this strategy had the consequence that eukaryotic organisms became genetically segregated from one another and increasingly more reliant on endosemiotic resources than on exosemiotic interactions for both their survival and for the continuation of their line.

What eukaryotic life forms lost in capacity for horizontal genetic communication, however, they gained through the development of sophisticated kinds of communication based on a diversity of nondigital biochemical and behavioral signs. The evolution of eukaryotic cells implied a strong restriction upon the channels suitable for digitized communication, but it

also opened the way to the development of life forms that possessed far more architectonic multiplicity and behavioral degrees of freedom than prokaryotic organisms could ever have obtained. The transition from prokaryotic to eukaryotic life forms thus exemplifies a general principle pertaining to emergent processes: that freedom of possibility will always be constrained at the simpler level in order to allow an altogether new kind of freedom to appear and unfold at a more complex level. The emergence of multicellular life and of social life are but two more examples of this fundamental dynamic principle.

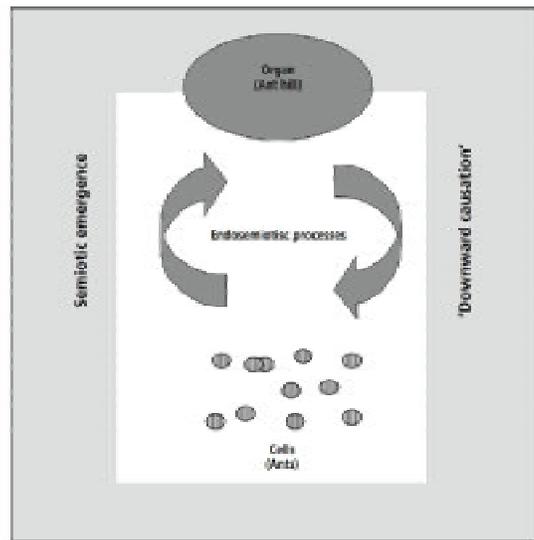
The idea of the superorganism has a long prehistory of controversy in biology, especially as concerns social insects. Both the ant hill and the bee hive have been suggested as cases of superorganisms, with the implication that the individual insects are subunits, mobile cells, in the superorganism. This discussion is impeded by the lack of a clear delimitation of the individual. Problems show up as soon as we leave the world of the vertebrates. Consider the fungus-growing-and-harvesting ant. In this case, the fungi produce sterile fruit that the ants use to feed their larvae. The subterranean fungus gardens of such ants may be twenty meters long, and the fungi are meticulously nursed. More than two hundred versions of this case of interspecies collaboration are known, and in some cases the integration is so complete that neither ant nor fungus could survive without it. In such cases one may well ask whether we have two organisms here or one new superorganism. For comparison, unicellular eukaryotes usually are considered to be single individual organisms, but inside such cells we have not only remnants of former individual bacteria such as mitochondria but often also a host of other free-living bacteria. This is the case in the protist *mixotricha paradoxa* that inhabit the intestinal tract of termites where they take care of cellulose degradation. *Mixotricha* is an odd creature indeed; it moves by dint of five hundred thousand minuscule bacteria, the spirochaetas, which cling to the surface of the eukaryote cells. These spirochaetas have a little flagellum at one end that they can rotate and thus propel themselves, and *mixotricha* apparently is in control of these bacterial flagella, using them for moving around.

Therefore it often is no simple decision whether the term superorganism is adequate. From a semiotic point of view, one may suggest the criterion that if a system's semiotic interaction with its environment presupposes a finely elaborated internal semiotic activity (a protoendosemiotics), the system deserves to be counted as an organism.<sup>10</sup>

Deborah Gordon's work with ants of the species *Pogonomyrmax barbatus* (which live in a harsh zone bordering the deserts between Arizona and New Mexico) reveals a sophisticated pattern of semiotic interactions between individual ants, and the survival of colonies of this species are so dependent on this protoendosemiotic regulation that the nomination of ant colonies to the status of superorganisms feels reasonable (Gordon 1995;

1999). Gordon herself does not draw this conclusion, however. A particularly important element in the colony's growth process is what Gordon calls job allocation, and she shows that although this task does indeed rely on a schematic interaction pattern between different groups of ants, an element of unpredictability persists: "An ant does not respond the same way every time to the same stimulus; nor do colonies. Some events influence the probabilities that certain ants will perform certain tasks, and this regularity leads to predictable tendencies rather than perfectly deterministic outcomes" (Gordon 1999, 139).

The semiotic competence of subunits, then—whether these subunits are human individuals in a society, plants in an ecosystem, cells in a multicellular organism, or ants in an ant colony—is the medium through which the behavior and integrity of the higher-level entity is maintained. To the extent that such a system's endosemiotic relations perceive and use cues and signs that indicate (are indices for) the state of the holistic unit and its needs, it seems justified to talk about these processes as endosemiotic, and, consequently, the holistic system itself deserves to be ascribed a status as an autonomous unit: a superorganism.



**Fig. 1.** The connection between semiotic emergence and downward causation. Downward causation operates through indexical sign relations—that is, the values of system parameters are interpreted by lower-level agents as indexical signs. But this state of affairs in itself depends on the formation of a large-scale pattern with a behavior that stabilizes the semiotic interaction between parts. Semiotic emergence and downward causation may thus be seen as two sides of the same coin (from Hoffmeyer 2008b).

The evolutionary formation of this kind of autonomous macroentity is the quintessence of what is called emergence (Figure 1). Figure 1 claims a connection between semiotic emergence (whereby macroentities or stable large-scale patterns are established through semiotic interactions among small-scale entities) and what has been called downward causation (the influence of large-scale patterns upon small-scale interactions) (Bickhard and Campbell 1999; El-Hani and Pereira 2000; Emmeche, Køppe, and Stjernfelt 2000), and it is suggested that this connection is taken as constitutive for both phenomena.

The semiotic relations between subunits that collectively account for the stability of the large-scale or holistic system—the ant hill, the multicellular organism, or the symbiotic system of bobtail squids and light-emitting vibrio bacteria—must be geared to respond to changes in the environment in ways that do not threaten the integrity of the large-scale system. Subunits, for their part, must receive messages telling them how to uphold the macrosystem, and probably the easiest way to do this is to distribute the needs of the macrosystem via indexical signs—N-acyl-homoserine lactone in the case of symbiotic squid-vibrio system. When night approaches, the squid makes sure that the bacterial density in its mantle cavity (and thus the homoserine-lactone concentration) is high enough for the bacteria to respond by allowing for the transcription of lux-operon genes, and thus for light emission, to start. The point is that the semiotic emergence whereby this system was gradually established in the course of evolution also demanded the invention of semiotic means for assuring the stability of the system, and these semiotic means are precisely what we understand by downward causation. Downward causation and semiotic emergence are thus two interwoven, but not identical, aspects of the same process.

That this mechanism, based on indexical semiosis, is indeed coupled to the circadian rhythms of the squid was confirmed by the finding that the squid has means at its disposal to fine-tune light emission. It may change the wavelength of the emitted light by help of a yellow filter, or it may weaken the intensity of light by opening a bag of ink (Bruni 2002; 2007). Presumably, the indexical sign process itself is too slow in its effects to compensate for momentary variations in background light (as occurs under cloudy conditions), and evolution therefore had to provide the macrosystem (the squid) with a number of additional “screws” for fine-tuning.

Semiotic emergence, in sum, is the necessary result of the inherent reciprocity of semiogenic competence—that is, that entities persistently interpret the behavior of other entities, behaviors that were themselves interpretations of behaviors of other entities, and so on. Reciprocal behaviors based on the proper “reading” of the behaviors of others produce interactions that reflect the internal intentional dynamics of the system. Semiotic interactions thus bind different kinds of entities together through

behavioral patterns that would never have had a chance to be “invented” in the absence of the semiogenic propensity.

#### A THEORY OF MEANING

“How can it be the case that one of the ‘people in the world’ is me?” asked Thomas Nagel in *The View from Nowhere* (1986, 13). The obvious incapacity of a biology that claims to deal only with knowledge that can be described in a third-person language (where by implication “I”s, “me”s or “you”s are not admitted) to even approach an answer to such questions does not seem to bother leading evolutionary biologists. Perhaps they have decided that natural selection will ultimately explain the construction of “me”ness out of “it”ness, or they assume that first-person phenomena are nothing but epiphenomena, illusions. Most people intuitively reject this scientific attitude and consequently refuse to see science as a source for any deep understanding of the human condition, turning instead to religious “explanations.” Personally I find this to be a highly regrettable situation, not least because the stubbornness with which science has for so long neglected this problem seems unfounded, even ideological. The (to me) undeniable existence of “me,” and thus of “I”ness in the world, is the deepest challenge to any evolutionary theory, and the persistent evasion of this challenge by present-day neo-Darwinism with its hardwired genetically based focus comes close to scandal. Natural selection cannot talk away the logical incomparability of first-person and third-person existence, and the experiential world cannot be claimed illusory for the simple reason that an illusion cannot be defined in nonexperiential terms. The alleged illusionary character of the experiential world is a contradiction in terms.

Charles Darwin did break the hold of Cartesian dualism by indirectly establishing a cosmology that allowed humans to belong in the world without having to invoke any supernatural causes or beings. Furthermore, he had no trouble accepting the idea that animals possess feelings and exhibit “strivings” (his word), and his conception of the human situation vis-à-vis nature was not very far from the biosemiotic conception that I am presenting (Hoffmeyer 2008b). But when Darwin’s theory was fused with molecular genetics in the twentieth century, a burden was placed on the shoulders of “natural selection” that slowly annihilated the original vision of Darwin. Now even thoughts and feelings had to be understood as genetically based components in the behavior of an animal—a kind of behavioral spasm or at least involuntary reflex, like the movement of a compass needle—and gone with this new perspective was the possibility of conceptualizing animals as autonomous intentional agents or subjects in some modest sense of this word. So, although Darwin himself placed the human being safely and understandably within the masterpiece of nature, the neo-Darwinist threw us out again, telling us that although our genes might

belong to the reality of nature, our thoughts and feelings were well outside the reach of science. Consequently, those previously least deniable aspects of our own biological experience—because they could not be reduced to a molecular explanation—came to be viewed with increasing suspicion, as if they were epiphenomena without proper autonomous ontological reality.

Fortunately a range of new approaches inside science has reopened the ontological question and raised doubts about what I call the ontology of natural law. By this expression I refer to the belief that the laws of physics describe all possible things and behaviors in this world. That natural laws characterize many aspects of the world we inhabit cannot be denied. But the deep question is another, namely: Was the universe an orderly place from the beginning, or is the lawful behavior of things in the world that now seems so pronounced the result of an emergent process? In other words, is the world as such lawful, or is the lawfulness of the world the very problem that science should explain?

The key term here is *emergence* (see also Kauffman and Clayton 2005; Deacon and Sherman 2007; Weber 2007). Mainstream science regards emergence theories with great skepticism, fearing, I suppose, that such theories are smuggling supernatural intervention through the back door. There is a deep irony to this suspicion, because the ontology of natural law is itself deeply dependent on Christian metaphysics. The belief that a benevolent God would not have created nature as an unruly and lawless place seemed obvious to most Christian thinkers and stems at least as far back as Thomas Aquinas in late medieval times. This, of course, is the one idea that made natural science possible in the first place, for without an orderly universe there would be no natural laws for science to study. Sharply put, the heresy of emergence theory seems to be its rejection of the Christian metaphysics that justifies the ontology of natural law.

Let me confess outright that I do not believe (and Christian thinkers need no more believe) that the world is a fundamentally lawful place. I find it to be more consonant with modern scientific conceptions—building on nonequilibrium thermodynamics or nonlinear systems dynamics, complexity theory, and biosemiotics—that the world was indeterminate in the beginning and that the orderliness we find is the result of an ongoing process of emergence that has been operative through several billions of years. That increasing segments of the scientific society are approaching the stance of emergence theories does open a door to a conciliatory process between science and religion, because it lends forceful support to a negation of the kind of totalitarian thinking that is widespread in science and easily freezes to the dogmatic statements of belief we know from Richard Dawkins and many other prominent scientists.

We may not think that we can ever answer Nagel's question adequately, but a first premise for approaching such an answer must be that we can somehow explain the existence of "me"ness in the world. An evolutionary

theory that fails to give us tools to meaningfully confront this leaves us as objectified biological robots, or zombies. I firmly believe that I am not such a zombie, and neither is the reader. A decent biology must search for the evolutionary root forms of what it is to be an "I," a first-person singularis.

An important consequence of scientific movement in the direction of emergentist conceptions is that the sharp fact/value distinction separating science and humanities or theology cannot be upheld. Adopting an emergentist conception of the world automatically also opens the way to the study of nondeterministic processes, and this implies that there is no longer a logical need for outright rejection of the reality of human experiential worlds or free will. Science may not be a good tool for analyzing the content of human experiential worlds, but it does allow such worlds to exist. Biology, furthermore, should feel compelled to produce theories to explain the evolutionary advantages of possessing this capacity for experiencing the world and not just for behaving in it. It was precisely the need to confront this challenge that led me (and others, I suppose) to explore the potentials of a semiotic approach to the study of life on Earth.

The semiotic approach to the study of the biological world does not only break with the ontology of natural law. It probably commits one more sin relative to a traditional scientific outlook, one that even emergence theorists may not always be happy to embrace. It claims that from the moment semiosis first began to manifest itself in the first living units, or cells, a new dynamic principle was superimposed upon the already established dynamics of emergence as exhibited by complex chemical systems. From now on what happened to living entities would be greatly influenced by an interpretative activity that, as I said, is free in the sense of being underdetermined by physical lawfulness. Translated to biology, this means that cells would now engage in intentional activities: Their activities would not simply refer to the outer world but would do so only in a contextual setting of their internal self-referential system (the genomic system). Living entities became intentional systems—subjects, in a sense—because they had established channels for an integration of other-reference (through surface receptors) with self-reference (Hoffmeyer 1998). At first they were only marginally intentional, but this new dynamic principle, semiosis, would have a self-perpetuating logic to it, so that semiotic freedom started to grow. This growth may well be the inner core of organic evolution.

This understanding establishes a basis for a new theory of meaning that reflects the deep dynamics of life itself, because meaning is nothing more and nothing less than the formation of interpretants in the Peircean sense—that is, the formation of a relation between a receptive system and a supposed object that results from the action of a sign that somehow itself is related to that same object. A captain turns his ship after having noticed the standing of the compass needle. He does not by himself know where north is, but his noticing the direction of the needle (the sign) provokes his

nervous system to initiate motoric processes in his body (the interpretant) that is related to “north” (the object) in a way that reflects the relation of the needle’s direction to “north.” Interpretants are dependent, of course, on natural laws (in this case the relation between the magnetic needle and the geographic north), but not in a determinate way, because the contextual situation in which the interpretant is produced greatly influences its formation (a hidden magnet may change the captain’s choice of course for the ship). Contextuality is significantly influential even at the cellular level, as when for instance one lymphocyte responds to a given neuropeptide gradient by moving upstream while an identical lymphocyte with another prehistory may instead start dividing itself upon recognizing the same neuropeptide gradient.

Meaning, according to this theory, remains a local and situated phenomenon. But this does not detract from the power of meaning. On the contrary, one may say that exactly this local situatedness of meaning as connected to the concrete life processes of each individual living organism implies that meaningfulness over time comes to play an ever more important role. The evolutionary growth in semiotic freedom is precisely the outcome of this globally distributed swarming variety of infinitely many semiotic processes that in every case involves the formation of chains or webs of interpretants. Whether this result, the gradual increase in semiotic freedom, should then be seen as an overarching meaning derived from the emergent process of evolution on Earth may be a question of taste. Semiotically seen, such a claim would be unsubstantiated to the extent that we have no reason to suppose that we as living creatures are units in one grand interpretative process whereby some receptive system (the planet?) responds to some universal cue by producing this interpretant, the growing semiotic freedom.

#### NOTES

1. Uexküll’s work is reviewed in Sebeok 1979, ch. 10, and Kull 1998. For a more comprehensive presentation of the short history of biosemiotics see Favareau 2007.

2. Florkin unfortunately built his semiotic understanding upon the structural linguistic tradition from Ferdinand de Saussure (1916) which in its whole approach is based on the cognitive capacities of the human species. In the Saussurian tradition human language is taken as the primary model for semiotic activity, and if semiosis is admitted to take place in the animal world at all it is seen as a degenerate version of human semiosis. Later biosemiotics has taken its inspiration from the semiotic understanding founded by Charles S. Peirce wherein human language is seen as just one peculiar instantiation of a much broader semiotics pertaining to evolution at large. Florkin indeed was aware of this problem, saying that he found it “advisable to avoid the application of the specific concepts of linguistics (words, phrases, etc.) to biosemiotics” (p. 13), but his whole approach nevertheless stayed inside the narrow confines of linguistic semiology, with its tacitly implied nominalistic disregard for extralinguistic reality.

3. Technically *semiosis* denotes the sign process itself whereas *semiotics* is the study of sign processes.

4. A degree-day is computed as the integral of a function describing the variation of temperature over time.

5. That this relation may be neatly described through traditional efficient causation based on the biochemistry of beech trees does not contradict its semiotic role as a releasing factor in the anticipatory process. Nothing in this world will take place in the absence of efficient causation, but semiotic causation is exhibited through the system's ability to appropriate efficient causation for its own "purpose." To use Peirce's example, a judge may well condemn a man to prison, but this works only because the sheriff actually puts the man in prison, acting as the efficient cause. Semiotic causation is dependent on efficient causation, but efficient causation without semiotic causation is generally destructive to life—as in cancer.

6. I use the concept of semiosphere to designate "a sphere like the atmosphere, hydrosphere, or biosphere. It permeates these spheres from their innermost to outermost reaches and consists of communication: sound, scent, movement, colors, forms, electrical fields, various waves, chemical signals, touch, and so forth—in short, the signs of life" (Hoffmeyer 1996, vii). The term was originally introduced by Yuri Lotman and used in a more specific cultural sense, as follows: "The unit of semiosis, the smallest functioning mechanism, is not the separate language but the whole semiotic space in question. This is the space we term the semiosphere" (Lotman 1990, 125). John Deely accepts my use of the word and suggests "signosphere as a term more appropriate for the narrower designation of semiosphere in Lotman's sense, leaving the broader coinage and usage to Hoffmeyer's credit" (Deely 2001, 629).

7. Heterotroph organisms, such as animals, cannot make organic compounds from inorganic compounds and therefore have to procure such organic compounds by eating them. This is contrary to the ways of autotroph organisms such as plants that survive by photosynthesis or bacteria that get energy by taking in and degrading energy-rich inorganic compounds.

8. The term *functional* here refers to an emergent higher level.

9. Thus any volatile compound, pheromone, may be taken up and used by the evolutionary process as a vehicle for the sign process whereby a certain behavior is released in a given insect no matter the exact chemistry of that pheromone. This absence of a direct involvement of the sign in the biochemistry and physiology of behavior of the receptive organism removes the hard limitations on causal mechanisms that would otherwise have to be obeyed. In semiotic interaction the causal machinery of the receptive system is itself in charge of producing the behavior, and it thus needs only to acquire a sensitivity toward the sign as an inducing factor.

10. In my book *Signs of Meaning in the Universe* (Hoffmeyer 1996) I did suggest a swarm-semiotic model of the brain functioning involved in creating a mental life. This proposal does in some sense accord ontological reality to swarm-dynamic systems of the kind we find in social insects.

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