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Editors' comment

When Umberto Eco pointed to Juri Lotman's claim: "The opposition of exact sciences and humanistic sciences must be eliminated" (Eco 1990: x) and John Deely (1990: 3) wrote: "For the first time in perhaps three hundred years, semiotic makes possible the establishment of new foundations for the human sciences, foundations making possible in turn a new superstructure for the humanities and the so-called hard and natural sciences alike", neither meant exactly the same thing. However, the search for relationships between living organisms and sign processes would belong to several research programs.

This is far from the first time in the history of *Sign Systems Studies* that the 'biosemiotic turn' in semiotics has left its marks on these pages. Our late and deeply-missed friend and teacher, Thomas A. Sebeok, a member of the editorial board of this journal, who passed away suddenly at the end of 2001, characterized this 'turn' with the telling title of his last collection of essays, *Global Semiotics*. This turn is a series of steps encompassing several senses of the word 'global', the most important being that semiotics can no longer deal exclusively with sign systems as if they were wholly self-contained within an exclusively human sphere of signification, because this sphere has ramifications in the larger world of natural history and embodied meaning.

This is "the first year of 'semiotics without Sebeok'", as John Deely has written. It seems illogical that the influence of one person can be omnipresent, *passim*, particularly in a field as large and diverse as semiotics. However, the behaviour of a tiny ganglion in an organism can be felt by every single cell, unconsciously as cells are.

The international conference *Biology and Linguistics* that took place in Tartu in February 1978, (organised by biologists and semioticians of St. Petersburg, Tartu, and Moscow), and the international workshop *The Linguistics of Biology and the Biology of Language* in

Mexico 20 years later (organised by Mexican and American linguists and biologists),[1] — as far as these were from each other (both in a periphery, in a sense) — belong to the same trend. A few other meetings — in Russia, Denmark, Estonia, and of course in Glottertal, Germany, at the beginning of 1990s developed a network of people and a research agenda towards a semiotic biology. However, we still tend to assume that the series of international meetings under the title *Gatherings in Biosemiotics*, started jointly by Danish and Estonian biosemioticians, marks a crucial point in the contemporary history of the field (Emmeche 2001).

We have edited the present volume with the aim of giving a more detailed picture of this turn in semiotics, showing the diversity within the semiotic globe of approaches by the growing community of biosemioticians, many of whom were present at the "Gatherings in Biosemiotics 1" meeting in Copenhagen, May 24–26, 2001.

At the meeting in Copenhagen, Myrdene Anderson made an informal comment on the title we had chosen for this new series of meetings, Gatherings in biosemiotics, a comment that seemed a little discouraging at first. She pointed out that the term 'gatherings' has many connotations in English, one of which alludes to the kind of things which might otherwise be called stores, reserves or cache or even remains or leftovers. This was not at all meant as an unkind remark, in fact Myrdene assured us she appreciated that such a connotation should be association with the project. We must admit that for our part this possibility was unintentional. However, on further reflection it appears that Myrdene may be right that this connotation may not be so bad after all.

Everybody who cares to read the papers presented at this first Gatherings in Biosemiotics, now assembled and supplemented with the additional articles in this volume, must agree that the project of finding a strong unified semiotic perspective on the life sciences is still in a very initial and explorative phase. In other words, we are still fumbling around, gradually assembling pieces of insights from here and there, and trying to see how the basic structure might best be raised. If we consider biosemiotics to be a new field, it is a field that has not yet been decently fenced or cultivated. The scene is still open

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[1] See http://itzamna.cifn.unam.mx/ComputationalGenomics/history/w98/.

for creativity at the most fundamental level, what endures and what is discarded remains to be seen.

The versatility of approaches taken and the commitment exhibited by the speakers were perhaps the main causes for the rather unequalled pleasure most or all participants took from being present at the occasion of the first gatherings meeting. In addition, many of us were pleasantly surprised to find that so many other serious researchers shared our vision, i.e. the vision of a semiotic transgression of dominating explanatory strategies in theoretical biology.

Still, the interface between nature and culture remains to be an unexpectedly difficult thing.[2]

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Claus Emmeche
Jesper Hoffmeyer
Kalevi Kull

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[2] We like to see the current issue as a marking of the *sexagenarian* Jesper Hoffmeyer, a leader in the biosemiotic search. [Note added by C. E. and K. K.]

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The chicken and the Orphean egg: On the function of meaning and the meaning of function

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Abstract: A central aspect of the relation between biosemiotics and biology is investigated by asking: Is a biological concept of function intrinsically related to a biosemiotic concept of sign action, and vice versa? A biological notion of function (as some process or part that serves some purpose in the context of maintenance and reproduction of the whole organism) is discussed in the light of the attempt to provide an understanding of life processes as being of a semiotic nature, i.e., constituted by sign actions. Does signification and communication in biology (e.g., intracellular communication) always presuppose an organism with distinct semiotic or quasi-semiotic functions? And, symmetrically, is it the case that functional relations are simply not conceivable without living sign action? The present note is just an introduction to a project aiming at elucidating the relations between biofunction and biosemiosis.

Biology has celebrated some major triumphs in the period beginning with Darwin's publication of *Origin of Species* in 1859 all the way up to 2001, when newspaper headlines proclaimed that the human genome had now been charted. Now that biology has shown us what life is (from a scientific standpoint), what shall we do with biosemiotics?

The biosemiotic project involves looking from a completely different angle at natural biological processes of which, to be sure, we have already gained knowledge about through the traditional science of biology and the research fields it includes (molecular biology, cellular biology, ethology, ecology, neo-Darwinian evolutionary theory, etc.). From these disciplines, we have now gained an enormous amount of knowledge of living organisms. At the same time, however, there are gaping holes in this knowledge. It has a dual nature, i.e. on the one hand it comprises a large body of positive facts and theoretical generalizations, even coherent and well-confirmed theories (such as cellular theory and evolutionary theory), but on the other hand it takes the form of *non-knowledge*. The latter applies, in particular, to the knowledge we have gained of humans as a species by mapping the human genome. This non-knowledge exists at least at two levels.

First of all, there is non-knowledge in the form of holes or white blots on the previously existing theoretical map of biological fields that may be filled in, possibly in the near future. The hope is that more research funds and research hours will be able to fill these holes. Obviously, for example, now that we have the complete human genome[1] we would also like to map out the complete chimpanzee genome, since the chimpanzee is our nearest biological relative and we hope to gain a better understanding of that kinship. All we need to do is begin the task of DNA sequencing a chimpanzee — a major undertaking, to be sure, but one that is fully feasible. In this way, we can continue doing the same with other species. Even today, we have detailed genetic maps of biologists' favorite model organisms (the fruit fly, a nematode worm, the coli bacteria, the yeast cell, and even, in part, the mouse).

Secondly, our biological non-knowledge exists at a level on which we are approaching the limits of what we can expect to know if we simply use existing methods with no breakdown in our theories, i.e. if we simply continue placing more small pieces into the existing puzzle. With regard to certain questions, if non-knowledge at this level were transformed into knowledge, we would probably need to look at them through different theoretical glasses or use a different paradigm, in the precise sense Thomas Kuhn uses this word. Here, a paradigm is not just another theory that may assign a slightly different meaning to the concepts that were previously used, but almost another world, at least

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[1] The news in 2001 that the human genome has now been charted should be taken with a grain of salt, since the picture is hardly complete. Rather, there is a complete collection of sketches, although they are highly detailed. For the technical details, see *Nature* 409: 745–964 (15 February 2001), a large issue devoted to this topic including, among other things, the preliminary collection of sketches.

for the researcher, i.e., a different set of theoretical tasks, some different values used to determine what constitutes good questions and even for which things a person, as a scientist, can research in the first place. It is on this latter level, in particular, that biosemiotics tackles the problem, using the following fundamental assertion: The traditional paradigm in biology — which encompasses a number of experimental methods, normal scientific working procedures, neo-Darwinism and its mathematical population models, etc. — alone is not and cannot be sufficient to answer the following key question:[2] *How did meaning originate in biological systems? And what is it (if not meaning, i.e. the creation of signs, and semiotic processes in general) that makes biology something special, something that on certain points fundamentally differs from the types of systems studied, for example, by physicists and chemists?*

Here we shall undertake a thorough examination of the idea of the biological creation of meaning as something central to all living things by taking a closer look at the way in which people normally answer the riddle of what it is about organisms that is special, i.e., we will look at the answer provided by "mainstream" biologists or conventional anti-reductionist biologists such as Ernst Mayr (who did not like to see his field, evolutionary biology, reduced to chemistry as applied to biology) and compare it to the answer given by leading biosemioticians, in the tradition from Jakob and Thure von Uexküll and Thomas A. Sebeok up to biosemioticians such as Jesper Hoffmeyer and Kalevi Kull. Let us reveal right away that traditional biological understanding[3] mentions two crucial characteristics of living systems that make them radically different and irreducible to physics and chemistry:

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[2] Jesper Hoffmeyer's 1996 book (which was discussed in detail in the journal *Semiotica* 120(3/4) (1998), and is a good introduction to biosemiotics) asks this question most clearly. A Danish introduction focusing on the status of scientific theory in biosemiotics is Emmeche 1997. K. Kull (1999) provides a historical overview of the more recent ideological history of biosemiotics.

[3] This includes, for example, John Maynard Smith, who has made significant contributions to evolutionary theory. See, for example, Maynard Smith (1986, 1999a, 1999b). The 1999a article attempts to "explain" information functionally. This is not the place to discuss why the classical attempts to reduce functional descriptions in biology have failed. An introduction to the discussion can be found in Schaffner (1993). Maynard Smith's 1999b article contains a rather lengthy analysis and subsequent discussion that would lend itself well to semiotic treatment.

(1) biosystems (organisms) contain genetic information;
(2) biosystems (organisms) have functions.

The former, of course, is a cryptosemiotic concept, for even here biologists admit indirectly that it is necessary to use semiotic concepts to describe biological systems. It is just that biologists do not attribute any particular significance to this: after all, they typically say, "genetic information" is just a metaphor for certain molecular processes that are organized in a certain way. Here the biosemiotician steps in and interprets the occurrence of such metaphors more realistically, namely as a sign that when one apparently cannot understand a key biological process, such as the hereditary transfer of traits between generations, without having to use informational metaphors, it is probably because the processes themselves, for which the metaphors are meaningfully used, actually have the nature of semiotic processes — sign production, sign transfer, and sign interpretation.[4]

As we know, the second point — that organisms have functions — is particularly well known in biology. No biologist can get by without directly or indirectly referring to the (functional) role some part or another of the organism plays in the whole organism.[5] On the other hand, many philosophers and some theoretical biologists, such as John Maynard Smith, have speculated that this all-pervasive interest in functions is what makes biology different from the science that deals with inorganic nature, such as those branches of basic physics that only study physical processes.

But do we not run into the concept of function here, too, one might ask? Certainly it is not complete nonsense to ask what function solar wind has for the earth's atmosphere? The standard response here is that the question is understandable, to be sure, in so far as it can be reworded into a question of the causal role a phenomenon such as solar wind can conceivably have on earth's atmosphere as a physical system, but to the extent that it can be answered as such — purely physically causal — there are nonetheless some significant differences between the limited role the concept of function can play in a subject

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[4] I have programmatically described (as a philosophical position) this *semiotic realism*, which such an interpretation expresses, as the opposite of what today would be called a more social-constructivist interpretation (Emmeche 1988, 1990).

[5] A classical text on the concept of function that is close to the standard understanding among biologists was written by the evolutionary biologist F. Ayala (1970).

such as geophysics or astrophysics and the key role it plays in biology. Of course, the difference is so great it is really just a matter of using the same term for two different concepts. In physics the assertion or question of function (such as the one mentioned above) can be rewritten without loss of meaning to the purely causal[6] question of direct cause-and-effect contexts in the traditional classical mechanical sense, in which a cause precedes an effect in time, but both cause and effect exist on the same ontological level, i.e., they are of the same nature, as in the example of the relationship between the sun and the earth's climate. This is a matter of material physical processes on the macroscale. As shown by the past 30 years of discussions on the concept of function in the philosophy of biology[7] it is far more complex to state the connection between causality and functionality in biology.

Essentially, the reason for this difficulty is that in biological systems there is an inner connection between the informational (which, without hesitation, we will call here the semiotic aspect of a living system) and the functional aspect. This is a connection that has been largely overlooked in the past and we will examine it in greater detail now.

Traditional biologists know quite well, implicitly at least, that there is a connection between the functional and the informational aspect: No organism exists that does not consist of a *whole* of its *parts*, whereby the parts enter into *functional* relations with one another and with the whole. Even in the simplest conceivable organism, such as a simple, free-living cell, this is dependent on the cell's organizing its parts, not exclusively but in part with the help of a genetic memory (a semiotic code), which makes sure the (functionally) "correct" parts are produced in the cell's autocatalytic network of processes. In this case, it is primarily protein synthesis, whereby without the genetic memory a mere jumble of "dysfunctional" proteins that are useless to the cell would be produced.

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[6] Most often, as here, "purely causal" questions are considered to deal with the kind of causal context that is most closely related to "effective causality" as Aristotle understood it, for example when the cause of the collapse of a wall is said to be the energy from the steel ball suspended from the crane. The fact that there is also an ultimate or purposeful cause — namely that the wall is to be removed to make room for something else — is typically considered secondary.

[7] A recent survey of the debate is presented by the editors of the 1998 anthology in which Ayala 1970 is reprinted.

As we know, from a chemical standpoint proteins are a rather normal kind of large molecule (polymers characterized by peptide bonds, which combine the individual building blocks, amino acids, into long chains). It is one thing, as a chemist, to use chemical theory and experimentation to identify a molecule as a protein, and not a sugar, a lipid, a nucleic acid, or something else. But it is something quite different, as a biologist, to characterize a particular protein as an enzyme, or a neuropeptide, or a hormone, or a histone (which is a class of proteins involved, among other things, in the packing of chromosomes).[8] If it is found that a protein is a histone or an enzyme, for example, then this is also, in part, a functional description of the protein. It says something about the relationship between part (protein) and whole (the cell as an organism). This is rather banal, as far as it goes, and on the concrete level of molecular biology it is nothing new, but the semiotic and biotheoretical implications of this fact are far-reaching:

As we shall now show, this means that *function* and *sign*, both seen biosemiotically as phenomena that describe living organisms, are directly related to each other, even in the narrow sense, i.e. both ontologically and epistemologically, or in other words: both as (ontological) properties of nature and (epistemologically) as conditions for our knowledge of nature.

Ontologically, sign and function are related like the chicken and the egg: It is a bit absurd to ask which came first, the sign in nature or functions in nature: biosemiotically, both arise simultaneously in the same lengthy historical process, with the creation of the first

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[8] "As a biologist", i.e. by virtue of biological knowledge and competence. Obviously, chemists are not excluded from biology or from speaking of functions in a biological sense when they describe the function of an enzyme in a metabolic pathway ("reaction step"), but when they do so, they are doing it on the basis of biological concepts and in the capacity of biologists. Against this argument (concerning the difference between a chemical and a biological description of a molecule) one might object that in practical research, for example in molecular biology and its biotechnological applications, there is no sharp distinction between when a one is a chemist and when one is a biologist. This is absolutely correct, but the fact that the methods of chemistry and biology are used together here in this interdisciplinary field does not mean that the meaning of any biological concept can be derived, so to speak, from chemical theory. The fact that chemistry and biology have gone a relatively long way toward epistemic integration precisely in the field of molecular biology (cf. Collin 1990), does not necessarily mean that the chemical and the biological domains are the same, ontologically speaking.

organisms, which of course have cellular structures, here on earth at least. Of course, a stolid biologist could choose to interpret the chicken/egg duality in the light of the biological difference between a single-celled and a multicelled organism. In this case, the question of the chicken and the egg is not quite so absurd: In this case, from the phylogenetic perspective, it is namely the egg that “came first”, since we must assume that multicelled organisms (“individuals”) are a (not uncomplicated) product of a long evolutionary process (cf. Buss 1987). But the evolutionary sequence of single-celled and multicelled organisms is not the point here at all. The point is, 1): that in our basic understanding of what living beings are, we must operate with a *concept of the organism* that presupposes that the organism is *both* a semiotic phenomenon — a system of sign processes — *and* a functional phenomenon — a whole made of parts, where the parts have functions relative to one another and relative to the maintenance of the whole, and 2): that these two aspects, the mereological[9] and the semiotic, are closely linked.

With regard to the organism, as understood not just as a concept, but as a real ontological entity, *the mutual functional relationships of the organism are semiotic.*[10] For now, let us stick to single-celled organisms and look at a part of the cell, such as an enzyme. It has a function of catalyzing a chemical process, let us say, between two other molecules (there can be many other enzymatic functions, such as

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[9] Mereology: the study of parts and wholes, usually refers to a mathematical or at least formal theory thereof, such as that of Lesniewski or Goodman; developed by the former in the hope of forming an alternative to set theory as a foundation for mathematics. For the relationship between mereology and semiotics, see Stjernfelt (2000), although he does not deal specifically with the biosemiotic aspects.

[10] One might well ask what knowledge we are actually expressing when we claim that the relationships between x_1, x_2, ... x_n as parts of a system Y are “semiotic”. What characterizes the non-semiotic relationships of something if we have otherwise adopted an almost pansemiotic Peirce-inspired perspective? However, we would be going too far here if we took up the question of a “lower semiotic threshold” (which has been dealt with in Nöth 2000a, 2000b, and elsewhere); it is sufficient to state that even a Peirce-based semiotics need not be pansemiotic (and maintain that *any* conceivable or real relationship in itself has the nature of a sign). For example, purely dyadic relationships, which occur in physical processes, have the category of “secondness” (*sensu* Peirce), such as action and reaction. Such processes can be called *kinesis*, as opposed to *semiosis*, which is of the category of thirdness: a living organism is subject to the kinesis of the physical laws of nature, but as an organism it can be understood only as a phenomenon of thirdness, i.e. as a semiotic phenomenon that is dependent on active signs, “sign action”, sign production, and sign interpretation (Emmeche 1991).

breaking down molecules into smaller parts, but that is secondary here). Of interest here is not the enzyme as chemistry (for example, its structural formula seen in isolation or its three-dimensional structure seen in isolation), but the circumstance that *when* the enzyme is found in a cell with such and such other molecules, *then* it "acts" in such and such a way, i.e., it reacts with these molecules, thereby acquiring meaning to the cell (in this case: to reduce the activation energy required to establish a bond, for example, between two other molecules that are substrates for the active site on the enzyme, thereby increasing the rate of the process).[11] In other words, using the enzyme *cytochrome c* as an example, the function of this enzyme is the same as the cell's "structural attribution of biological meaning" to the *cytochrome c* molecule.

What does this have to do with meaning, one might ask? After all, it is we who can see that it has meaning (functionality) to the cell. Certainly the cell itself cannot understand that? Correct, but we will avoid the nominalistic temptation of seeing signs only as something that can be of a mental nature (signs in human language or understanding). Although the cell does not realize, perceive, or understand anything, the cell is still a semiotic system in the sense that it is a

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[11] This 'when *X*, then *Y*' form is reminiscent of both 'if ... then' in logical inference and 'if ... then' conditions expressed in connection with physical laws of motion. One might believe, then, that there is no difference between physical laws of nature expressed as regularities of the form "If a body is dropped above the earth it falls to earth with a uniform acceleration" (Galileo's Law of falling bodies) and the causality found in the functional relationship in the organism between part and whole, if both are merely regularities that can be expressed as 'if ... then' conditions. However, this empirical interpretation of natural law has been greatly criticized, for example by a (Popper-inspired) 'propensity' interpretation, which does not hesitate to attribute to nature forces, capacities, dispositions, etc. See Chalmers' discussion in Chapter 14 of the new 3rd edition of his theory of science. What Chalmers forgets is that the generality of these dispositions (etc.), which are attributed to the individual particles or objects, is better understood on the basis of Peirce's ontology, where generalities and forms (including process forms) are real properties inherent in nature: they are "habits". (I am grateful to Peder Voetmann Christiansen for introducing me to this aspect of Peirce's philosophy). But even though the physical nature can generally have habits and be regularly controlled by "final causation", it is nonetheless a rather special form of final causation that occurs in organisms, which is related to the history-of-symbols nature of the genetic memory in the species' lineage: DNA acts here as a boundary condition (Polanyi 1972), life is complex because these boundary conditions are historical (cf. Küppers 1992), and from a semiotic standpoint we could add that such boundary conditions or "constraints" are phenomena that have all the characteristics of being causes (Juarrero 1998).

system of meaning with its own autonomous self-catalysing, self-organising dynamic — a dynamic, as mentioned above, that is so complex as to presuppose genetic memory as a sign system. But the important thing here is not so much the latter digital and relatively stable DNA code found in the cell's nucleus in eukaryotic organisms, as it is the sign processes of a far more general kind: Saying that *cytochrome c* means something to the cell is the same as saying that it has a function. It is not just any molecule. We could very well synthesize small proteins and artificially introduce them into the cell. They would be without importance or they would be dysfunctional or, with certain fortuitous strokes of luck, they would actually fulfil some function in the cell.

To say that *cytochrome c* or any other molecule fulfils a function for the cell as an organism (or for multicellular organisms: an organ, or an organ part that fulfils a function) is the same as saying that the part operates appropriately in the whole (an idea entertained by Kant). It is the whole, with its special emergent structure, that establishes the framework for this appropriateness and even though the basic laws of nature are still in effect ("effective", or "brute causation"), it is the cell as a complex system that manages or shapes the manner in which the natural laws operate on the individual parts: the whole operates as a constraint, as a limiting condition from the macro level down to the micro level, from the whole to the part.

The protein *cytochrome c* is specific and the biological specificity is precisely the difference *cytochrome c* makes to the cell. After all, if *cytochrome c* had not had precisely this particular form (at least in its active sites), it would not bring about the reaction between the components with which it interacts. It would be dysfunctional (as it can become if the gene for *cytochrome c* mutates, which can be fatal to the cell).[12] *Cytochrome c* mediates precisely this reaction and not all kinds of other ones — therein lies its meaning. This "meaning", in the semiotic sense, of the individual enzyme is structural, understood in such a way that the cell's molecules form a system of dissimilarities

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[12] More precisely, cytochrome c functions as one of the important electron transporters in the respiratory chain, which (by oxidative phosphorylation) produces the main part of the energy-rich ATP, which is so important to the cell. This is an important and general function, as a result of which the overall structure of the cytochromes is evolutionarily conserved across species, from bacteria to elephants.

(like the elements of language in Saussure[13]), but these dissimilarities are not of a mental or immaterial kind. The material elements of the system have a certain *agency*[14] of their own, or a local semiotic capacity to act, if you will, and consequently the cell's molecular system of signs is self-organizing and self-interpreting, i.e., these signs are characterized better by the Peircean concept of sign as sign action than by the Saussurean concept of sign as an abstract system of differences. To a great extent, the cell is an interpretation system that is controlled by what Peirce called "final causation", the type of causation in nature that has to do with organization, habit formation, memory phenomena, information, appropriateness and purposefulness, evolution — all phenomena of the category of Thirdness (Santaella Braga 1999).[15]

But epistemologically, too, there are close mutual conceptual conditional relations between sign and function, at least within the framework of a Peirce-inspired biosemiotics: The assertion here is that it is simply impossible to understand the concept of sign, without a concept of function (of some kind or another). And, as just indicated, the inverse is also true: It is not possible to understand the concept of function in biology in general without a good understanding of what an organism is and such an understanding presupposes a concept of information, whether it be in the slightly superficial molecular biology version as (DNA-) sequence information or in a more thoroughly thought-out Peircean version, where information *is* sign. As Bateson (1972) said, "information is a difference that makes a difference" ("to an organism" implied) and this is 'straight Peirce', even though he probably would have stated it in a more complex, but more precise, form such as "sign (representamen) is a difference that makes a difference (interpretant) by making the latter stand in relation to something else, namely that to which the sign refers (object)". We might add:

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[13] For a detailed treatment of the relationship between Peirce and Saussure as a basis for biosemiotics, see Emmeche, Hoffmeyer 1991.

[14] This agency or "energy" is an indication that the material itself is active. With regard to proteins it is dictated, among other things, by thermodynamic processes in the protein's molecular self assembly, after the protein is synthesized as a long peptide chain and folds itself together into what resembles a ball of yarn, for example, although it is helped in part by other proteins, particularly the chaperones.

[15] The same volume of *Semiotica* 127(1/4) is a special edition on this theme, with numerous articles on biosemiotics, including another contribution by L. Santaella Braga on Peirce and biology, then and now.

"Function is the difference that the presence of a part of the organism makes with respect to other parts and to the whole".

The part refers to the whole and can be understood (functionally) only within this whole. That is an old mereological insight. When we recognize *cytochrome c* as a part of the organism, we are not just interested in a recognition of this protein as a part, similar to the recognition that a stone is part of a gravel heap or that 1/7 is a part of the rational numbers. It is not the abstract part-whole relationship in itself or a physical version of such a relationship that is crucial here. The crux of the matter here is that the relationship between the parts of an organism and the whole organism is a mereological relationship of a particular specific nature: It is also an "intrinsic semiotic relationship", that is, it is in its very nature semiotic. And, it should be noted, its semiotic character is not merely something attributed to it, just as our consciousness is not just due to the fact that other people attribute consciousness to me, but I am actually conscious and it is part of the concept's *sine qua non* that being conscious is not derived from anything else.[16] Apart from this formal similarity, the intrinsic semiotics of the cell has nothing to do with consciousness in the human sense.

We now realize that there must be an internal relationship between sign and function, that is to say when the two concepts are used in conjunction with organisms and with what are essential features of organisms.[17] We have also more than hinted at what is meant by internal relationship, but let us express it a bit more formally. In the philosophical usage of the term, if something, let us call it *S*, is *internally related* to something else, let us say *F*, then there is an essential property (a *sine qua non*) of *S* whereby *S* is actually linked to

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[16] It should be mentioned that not all philosophers agree with this: there is an important line of demarcation in modern philosophy of mind between those who believe that consciousness is an intrinsic property (such as Searle and Nagel) and those who more or less behaviouristically try to explain consciousness under the designation "the intentional stance", etc. (such as Dennett).

[17] It is not our intention here to discuss essentialism, but the framework of evolutionary history assumed here, in itself, places certain limitations on a "full blown" essentialism. Essentialism in biology refers to the now abandoned idea that the properties of an organism are of two essentially different types: the *essential*, which defines for example whether the organism belongs to the species red clover or white clover, and the *accidental*, which does not have quite the same nature of reality. Darwinism disposed of essentialism, for it saw all properties as possessing the same degree of reality, and variation was not just something accidental and negligible, but the very material on which selection operated.

F by this relationship, symbolized here by *-R-*. Thus, *S* simply would not be *S*, if it were not related to *F* in this manner, i.e. if *S-R-F* were not valid. Specifically, it would mean that a sign would not be a sign (in the biosemiotic sense) if it were not a sign with a function, which normally means "with a function for the organism". The traditional biologist could accept this part of the argument, since it is hardly surprising that a process involving information, signals, or signs in an organism must serve the best interests of the organism, i.e. it must be functional for the organism.

At the same time, however, we would maintain that the relationship is symmetrical, i.e. if *S-R-F* is valid then so is *F-R-S*, or in plain language, if sign is internally related to function, then function is also internally related to sign. A thing would simply not be a function (for the organism) if it did not have the nature of a sign. Stated in this way, the assertion does not appear to be immediately obvious to the traditional biological viewpoint, since it is easy to imagine certain functional parts of an organism, without their obviously being signs and, as mentioned, biologists do not normally use semiotics as a conceptual tool. What does it mean, for example, to say that the liver of a vertebrate animal is a sign? — "Of what?" one might sceptically ask. And what have we gained by such an assertion?

Or, with an example from the single-celled level: The Golgi apparatus in eukaryotic cells, as seen under the electron microscope, looks like a stack of flat bladders (membranes) stacked one on top of the other. There are still some dark sides regarding the function of this structure, but a picture has developed[18] of a membrane structure that is linked to the rest of the cell's transport system, a kind of halfway house between the endoplasmic reticulum, where proteins are synthesized, and the secretory vesicles, which (in the periphery of the cytoplasm, at the outer membrane of the cell) take proteins out of the cell by means of exocytosis (membrane fusion). In addition to being part of the transport system, the Golgi apparatus performs a biochemical modification of the proteins that are on their way out into the surroundings (for example, "ripening" of glycoproteins by removing certain oligosaccharides and adding others). Thus, the Golgi apparatus clearly has functions for the cell, but why would this make it a sign?

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[18] More details can be found, for example, in Alberts *et al.* 1994.

Here, the biosemiotician must either sacrifice the idea of the internal relationship, in its strong, symmetric form, which means that not all biofunctions are or can be interpreted by us as being real signs, or the biosemioticean can hold onto the symmetry; protest that we should not use an all-too narrow concept of sign, and instead interpret the relationship as follows: If a relationship is merely dyadic, or merely comprised of dyadic relationships, as indicated by the notation *F-R-S* then, to be sure, the relationship need not have the nature of a sign. But if *F* and *S* do not stand for just anything, but for function and sign, and if, in conjunction with organisms, function is already a mereologic relationship, then *F-R-S* will not formally be a dyadic, but rather a triadic quantity: Any biofunction is something (a process or a structure) that has meaning for the organism as an interpretant system (what theoretical biologist Stanley N. Salthe and others call a "system of interpretance"[19]), and in this broad meaning of the statement *F-R-S* any functional process or structure in a cell is "biologically meaningful", in that it makes a difference to the cell as a whole, as a system, that would be affected immediately (often in a rather fatal direction) if the process were blocked or the structure destroyed. Thus, the Golgi apparatus and everything at all we can understand in a biofunctional sense has the nature of a sign, where "sign" need not be a communicative sign in the normal sense, but may instead be purposeful processes, with the special causal structure these processes have.

But even if biofunctions may be said to have the nature of signs, is it not crazy to claim that the Golgi apparatus is a sign that (according to the classical definition of sign) "stands for" something else? Yes and no. This "stands for" relationship is obviously not a symbolic or conventional relationship, but as we know there are also sign process forms other than the symbolic. As mentioned, the Golgi apparatus (if it is to be understood at all biologically and not just described physically and chemically) refers to other structures in the cell and here it is the assertion of biosemiotics that this reference relationship is triadic. The shape of the Golgi apparatus and the processes that occur in it are not of importance to the endoplasmic reticulum and the exocytotic vesicles alone. They are important to the cell as a whole. The mereological relationship is not just formal, but also causal,

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[19] Even though Salthe (1998:391) has a broader (physicosemiotic) understanding of what can comprise a "system of interpretance" than the biosemioticist, the term is applicable here. See also the overview on his homepage at www.nbi.dk/~natphil/salthe/

namely a case of what in some contexts is called "downward causation".[20] It is the whole that "assigns" meaning to the parts. Just as a protein is an enzyme only when it works within a meaningful whole, the same is true of the Golgi apparatus. Seen in itself, as a "pure" spatial structure, it could just as well have been an accidental pattern in nature or a bizarre sculpture on the nanoscale (nanoart!). But it is the organization of the cell as such that co-defines the boundary conditions under which the Golgi apparatus operates. It is part of the cell's quasi-cognitive scheme of protein synthesis and transport. It may have a diagrammatic character (which must be the subject of a more detailed semiotic analysis at a later time).

Such a biosemiotic understanding of the concept of function can also include cases in which the function is not yet known: The sequences of DNA (genes) that code for proteins or RNA molecules are easily seen as having the nature of signs, but what about the non-coding parts, such as the repetitive sequences (whose function is not known) or other parts of the so-called junk DNA which, as we know, forms the bulk of our genome? In this case, the function is not known and one might believe that the assertion concerning the internal relationship between function and sign applies only to those parts of the organism or cell where the function is known. However, the sequences mentioned above can be seen as instances, sinsigns,[21] of the same type, legisign, i.e. they are sequences of the same pieces of non-coding DNA found in the previous generation. The way in which DNA is copied (template replication) assures the preservation of the sequence information and, thus, a simple sinsign/legisign relationship (just as a cookie cutter as a general type imparts its shape on each individual cookie instance). This is important to the relationship of general interest that organisms are internally related to one another through bonds of kinship. For example, I am related to my parents, since I would not be me if I did not have precisely those parents.

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[20] See Emmeche *et al.* 2000.

[21] The first of the three trichotomies in Peirce's 10-sign classification is division according to the sign's own character; whether it is a quality in itself (qualisign), an actual, existing individual thing or individual event that is a sign (sinsign), or a sign of a general type of such individual events or things (legisign). For example, the individual "A" is a sinsign of the general type (legisign) A.

A person who was apparently identical to me but had other parents would not really be me.[22]

But does everything in the cell have the nature of a sign? This may seem a bit hard to swallow for traditional thinking but to the extent that we can, first of all, stick to the biosemiotics of living organisms and not discuss the possibilities of sign processes in physical nature — physicosemiosis[23] — and, secondly, identify in organisms the triadic relationships and interpret them as instances of the abstract semiotic relationships and processes, which Peircean semiotics conceptualises, the answer must be "yes".

One clever person has said that the chicken is simply the egg's way of creating a new egg and there has been no shortage of sociobiological elucidations of this bit of wisdom. The egg as the active and acting, that which uses something else as a functional tool. Or the egg as the original, as in the elucidation of stolid evolutionary biology we saw earlier.[24] But any child knows that chickens and eggs belong together, in the same temporally continuing process, whose detailed embryological sign functions molecular biologists are still working to map out.

Life itself arises from the physical, but it cannot be fully explained by the physical from which it has arisen. The ancient Phoenicians, Egyptians, Hindus, Japanese, and others believed the world was egg-shaped and that the world as we know it was hatched from an egg laid by the creator.[25] In some myths, including one attributed to Orpheus, a bird is seen as the one that lays the mundane egg in the primordial sea. If we assume that Orpheus actually existed, then as a poet he certainly refrained from asking whether that bird itself had hatched from some egg. Modern science, too, refrains from asking certain questions. But perhaps we cannot completely let go of the Orphean egg. When it comes to fundamental problems in modern biology and natural science as well as in general semiotics, there are always some things that simply have to be assumed and that refer to one another.

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[22] This example is taken from Wagner 1999.

[23] See, for example, Deely 1990, Salthe 1998, or Christiansen 1988.

[24] Or, as an extension of this: the egg as a part of the code duality, which must be described in relation to a lineage of organisms within the same species. See Hoffmeyer 1996.

[25] "Egg, the mundane egg" in E. C. Brewer (rev. by I. H. Evans): *The Wordsworth Dictionary of Phrase and Fable* [1959], 1970, 1994, published by Cassell & Co.

Organisms are always pivotal. The Orphean egg is laid by a bird — it makes a splash, and slowly the dust begins to lift a bit.[26]

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Курица и яйцо Орфея: о функции значения и о значении функции

При исследовании связей между биосемиотикой и биологией центральным является вопрос: связаны ли внутренне биологическая концепция функции и биосемиотическая концепция действий знака? В статье биологическая функция (как процесс или его часть, которая имеет определенную цель по отношению к деятельности и самопроизводству организма как целого) анализируется в связи с пониманием семиотического (проявляющегося в знаковых действиях) характера жизненных процессов. Предполагают ли сигнификация и коммуникация в биологии (например внутриклеточная коммуникация) всегда какой-либо организм вместе с его отдельными семиотическими или квазисемиотическими функциями? И наоборот, разве нельзя даже помыслить функциональные отношения без живого действия знаков? Настоящая работа, являясь лишь введением к более широкой теме, ставит своей целью разъяснение взаимоотношения между биофункциями и биосемиозисом.

Kana ja Orpheuse muna: tähenduse funktsioonist ja funktsiooni tähendusest

Uurides biosemiootika ja bioloogia vahelisi suhteid on keskse aspektina küsitud: kas bioloogiline funktsiooni kontseptsioon on seesmiselt seotud biosemiootilise arusaamaga märgi toimimisest, ja vastupidi. Artiklis analüüsitakse bioloogilist funktsiooni (kui protsessi või osa, mis omab teatavat eesmärki organismi kui terviku toimimise ja taastootmise suhtes) seoses arusaamaga eluprotsesside semiootilisest (märkide toimimises avalduvast) loomusest. Kas tähendustamine ja kommunikatsioon bioloogias (näiteks rakusisene kommunikatsioon) eeldab alati organismi koos eraldiseisvate semiootiliste või kvaasisemiootiliste funktsioonidega? Ja kas, vastupidi, on nii, et funktsionaalsed suhted pole üldse mõeldavad ilma märkide elava toimimiseta? Käesolev töö on vaid sissejuhatuseks laiemasse teemasse, mis taotleb selgitada biofunktsioonide ja biosemioosi vahelisi suhteid.

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Umwelt and semiosphere

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Abstract. In the paper an attempt is made to treat the basic concepts of biosemiotics and semiotics of culture in a wide intellectual context. The three leading paradigms of the current intellectual discourse are distinguished, which could be conventionally designated as "classical", "modern" and "postmodern": Peirce's semiosis stands for the classical, Umwelt for the modern and semiosphere for the postmodern semiotic space.

I must start with an apology: although several biological and philosophical terms and constructions will be discussed, my paper is related to neither of those fields. One of the reasons is that I am a complete ignoramus in biology and allergic to philosophy. Thus, I will focus on the perspective of cultural semiotics, analysing the mentioned phenomena from the aspect which is close to Michel Foucault's archaeology of knowledge (Foucault 1970, 1972).

Before treating Jakob von Uexküll's Umwelt, we should briefly consider the intellectual context, where this concept appeared (so-to-say the Umwelt of Umwelt). In Darwinist world-view the key concept was *environment*: organism, life, evolution are its derivatives. It can be understood as if there was an environment, where an organism happens to be (the most exciting word in this sentence is *to happen* — one should not think that life exists outside the environment, because environment itself produces life). So, in the beginning was the environment. The Darwinist conception was an organic product of the mentality of the given era: analogically, Newton's physics treats the relationship between object and space, Marxist philosophy the relationship between social system and social environment. Moreover, such paradigm seems to be fully natural so far and in correspondence with the common sense. Anyway, until now it has been the basis for most critical remarks towards the Yuri Lotman's conception of semiosphere. Even the classical cybernetics proceeds also from the same idea. The key question for Norbert Wiener was the adaptation of the system with its environment (but at the same time, through the mechanism of feedback the system could actively influence environment as well).

In such perspective Jakob von Uexküll's Umwelt seems to be completely strange and extravagant: for him primary is organism which produces its Umwelt; everything has its own Umwelt according to its specific measures (Uexküll 1928). One could pass Uexküll's conception as the eccentricity of a provincial semidiletant, but we can find here certain interesting parallels with other fields. Here it would be sufficient to mention Einstein's cosmology and Heidegger's philosophy. For Einstein, time and space are not basic and independent entities, to what matter has come somehow. Time-space is the function of the matter, and that applies to Heidegger as well: not the existence is "located" in time and space, but it creates them itself (I mean here above all *Sein und Zeit* and his works in the field of art philosophy, as, e.g., *Die Frage nach dem Ding*; Heidegger 1993, 1976).

I would like to point out that we are not dealing here with just terminological differences — we cannot just replace environment with Umwelt; the difference between these notions is not even conceptual, but paradigmatic: a completely different idea of life, organism, evolution, biology itself evolves — biology becomes a discipline of semiotic cycle, since it can be shown that in the conception of Umwelt inevitably appears the problem of meaning.

Yuri Lotman's cultural semiotic works initially proceeded from the paradigm which is very similar to that of Uexküll's. In the function of organism he had text, the analogy of Umwelt was context. Unlike earlier linguistic and semiotic ideas (e.g. Saussure's and Jakobson's) the context for Lotman does not precede text, being its preliminary condition, but, vice versa, text produces its context in the widest sense, including all the participants in the communicative act (Lotman

1982, 1990; M. Lotman 2000). But it seems that such extreme paradoxicality (cf. the circumstance that an author does not create text — text creates an author) did not disturb Lotman: he does not conceal it, but tries to make it even stronger.[1] In his late works he formulates the conception of semiosphere, the basis of which is so-to-say the crisis of identity: for its *own* existence every semiotic entity (sign, text, mind, or culture as a whole) needs *the other*. It applies to the synchrony as well as diachrony: sign, text, culture can exist only among other signs, texts, cultures and they must be preceded by other signs, texts, cultures.

In his earlier works Lotman formulates the three most important functions of text, reason, and culture. These are: (1) communicative, i.e. the transmission of already completed messages (it is important here for an author to know how to formulate his message adequately and for a reader to know how to understand it adequately); (2) memorial; (3) creative: the production of new messages. In his late works it reveals that it is impossible to carry out any of these functions without *the other*. Although Lotman refers here, on the one hand, only to Ilya Prigogine and, on the other hand, to Kant and Leibniz (Lotman 1997; Prigogine, Stengers 1984), another intellectual context is obviously here even more important — so-called dialogical school. Of course, Mikhail Bakhtin's ideas were always essential for Lotman, but here it would be perhaps more useful to refer to Martin Buber, as well as to Emmanuel Lévinas, especially, since he was not familiar with their works (particularly with the latter one's). In my opinion, Buber and Bakhtin were more profound thinkers, but I would like to deal here with Lévinas, since he is philosophically more accurate. Lévinas shows that there is a mistake in Heidegger's system: an isolated existence is not possible in ontological, as well as in existential level: for its own existence an existent needs the other. Meeting the other

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[1] Somewhat similar conclusions were also made by French structuralists Roland Barthes and Michel Foucault, who declared the death of the author. The difference from Lotman's conception was not only conceptual, but, above all, psychological. For French scholars the history of culture is primarily a constant decrease, creation is consumption (cf. above all Georges Bataille's "Literature and evil"; no wonder that a creation kills its creator; Bataille 1990). For Lotman, it is rather a myth of Galatea: Pygmalion does not have to die.

becomes crucial event for existence, or more correctly, it evolves just then (Levinas 1976).

But here, inevitably, a question arises: who is the other? If we approach him with certain presentiments, suppositions a priori, etc, then it would be not a real meeting, but projecting qualities, experiences, etc of one's own. A real meeting would be possible only if we were dealing with an internal readiness to meet absolutely the other (i.e. also with somebody for whom it would not be meeting or event at all).

I would like to make a remark here. On the occasion of Lévinas we are not dealing with only intellectual, but as well with psychological boldness, since his conception was formed during the war, when he was a German prisoner, and published in 1947, when he knew that all his relatives in Lithuania were terminated namely by those who were not willing to meet the other. But even this experience and perhaps in the first place this experience decided his firmness. What Lévinas intends to say here is that we live in the world without guarantees and meeting the other is always not only risk, but deadly risk, but it is the risk, which is existentially important for us (it is not accidental that meeting with the other is on Lévinas' occasion preceded by death). Even if we do not agree with Lévinas in so-to-say conceptual level, we must appreciate his intellectual courage.

Nevertheless, Lévinas' phenomenological language which seems to be mighty and adequate enough to define the existential necessity of the existence of the other can not in principle transmit the content of meeting. In order to that we must return to Buber, who summarized it with a simple phrase: "you and me". As Émile Benveniste showed, such words as "me", "you", "here" and "now" differ from usual words which signify objects not because they are different words, but because they belong to a principally different sign system. Benveniste tried to mark this differentiation by using such terms as semiotics and semiology, as well as speech and language. Namely, deictic words are the ideal form of semiotics of speech, differently from semiotics of language which is oriented towards objects and situations (Benveniste 1966). It is a very important differentiation, although in my opinion not quite adequate: deictic signs belong to the field of speech as well as symbolic ones. But here is another aspect which was overlooked by Benveniste: we are not dealing here just with speech (i.e., e.g., with monological speech), but necessarily with dialogue. Beyond the situation of dialogue deictic words are just meaningless.

For Buber and Bakhtin “me” and “you” appear to be the products of dialogue and dialogue turns out to be an existential notion: without “you”, who is in dialogue with “me”, there is no “me” either. (Buber 1970, Бахтин 1975, 1998). Therefore, “me” and “you” are not constants, but variables; although for him also the participants of dialogue are indivisible entireties.

The participants in a dialogue are not impartial personages — “they”, but “you” and “me”, i.e. the only adequate sight to a dialogue is from inside. As for such words as “you” and “me”, then their peculiarity is that they do not mean anything a priori, they have no significatum at all. “You” are the one, whom “I” call “you” and “I” am the one for whom “you” are “you”. This situation can not be interpreted in terms of deterministic logic, since we are dealing here with an obvious paradox: “you” are the precondition of “my” existence, i.e. “you” must exist before “me”. At the same time “you” fully depend on “me”. Hence Buber makes a conclusion of existential essence of dialogue. Buber and Bakhtin relate space to dialogue. The space of dialogue does not exist a priori, it is being created in the course of dialogue.

One of the most important special features of Tartu semiotic school is that simple semiotic systems are not treated as prime elements, from which more complicated systems are formed, but vice versa: elementary semiotic systems are abstractions, simplicity means here simplification. From the viewpoint of semiosis, semiosphere as a whole is the initial unit which is divided into simple subordinate systems. In this respect Tartu semiotics differs in principle from Peirce’s semiotics, the centre of which is (single) sign and its qualities; sign in Tartu semiotics is not something which has been given immediately, but the product of analysis.

While originally the conception of secondary modelling systems (as the name itself reflects) at least potentially enabled to treat natural language as an initial system, then Yuri Lotman in his works of the 1980s treated the verbal, so-called usual communication as a polyfactorial multilingual activity. In this sense each verbal text as well contains several messages which have been created in different languages. Minimal pair of languages would be what Lotman called (not quite accurately) symbolic and iconic; the first of them is described by the grammar of natural language, the other by rhetorics. Rhetorics for Lotman is, first of all, a tool for translating (visual) images into verbal text. In the case of a narrative text also the narrative structure as a specific language must be added here. But it would be incorrect to assume that the logical structure of language, images and narrative are primary entities which exist before language and beyond text. Imagological structure depends not only on the imaginable objects, but as well on the language to which they have been coded. The same applies as well to narrative (Lotman 1992).

Every act of communication includes an element of dialogue, translation and creativity, whereby dialogue begins already in the addresser, the speaking subject is not elementary from the communicative aspect. Even the translation inside the human brain comes close to artistic translation.

Thus, semiosphere is not just new concept, but as Umwelt demands new paradigm, new logic, which is based not on determinism, but on dialogue.

We can summarize the whole thing with the following schema (which is, of course, schematic):

cosmology:	Newton	Einstein	Prigogine
life:	environment	umwelt	semiosphere
philosophy:	Hegel/Marx	Heidegger	Buber/Bakhtin
discourse:	“classic” narrative	“modern” narrative	dialogue

Classic narrative is based on causal and temporal relationship; modern abandons causality as well as temporality, and as a result, e.g., a spacial form (described by Joseph Frank 1963) evolves (e.g., James Joyce and Marcel Proust).

We might add to this (schema) dissenting ideas of truth: it is a priori in Newton’s world, relative in Einstein’s world, and, e.g., in the paradigm of analytical philosophy it is better not to speak about truth at all, but to avoid falsehood and nonsenses: one could reach truth through the combination of unfalse sayings. And finally, in dialogical logics truth is not only a posteriori, but cooperative as well: it arises in dialogue and can be preserved only in the environment of dialogue, i.e. every petrified formulation is deadly for truth.

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Umwelt и семиосфера

В статье делается попытка анализа базовых понятий биосемиотики и семиотики культуры в контексте интеллектуальных стратегий. Выделяются три ведущих интеллектуальных дискурса современности, условно обозначаемые как “классический”, “модерный” и “постмодерный”: пирсовский семиозис маркирует классическую трактовку семиотического пространства, *Umwelt* Я. Юкскюлля — модерную, семиосфера — постмодерную.

Omailm ja semiosfäär

Artiklis tehakse katse käsitleda bio- ja kultuurisemiootika baasmõisteid laias intellektuaalses kontekstis. Eristatakse kolm juhtivat paradigmat nüüdisaegses intellektuaalses diskursuses, tinglikult võiks neid tähistada kui “klassikaline”, “modernne” ja “postmodernne”: Peirce’i semioos tähistab klassikalist semiootilist ruumi, Umwelt — modernset, semiosfäär — postmodernset.

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Semiosphere: A chemistry of being

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Abstract. The concept of semiosphere coined by Lotman in analogy of Vernadsky's biosphere can be considered as a starting point for the new model in the semiotics of culture that enables us to conceptualise the human culture in its great diversity, as well as a certain single system as a part of this diversity. Present article will clarify some points of dissonance between Lotman and Vernadsky, as well as consider the dual influence of Vernadsky and Prigogine on the workings of the semiosphere in relation to the cultural dynamics. As a conclusion, the article entertains the idea that if we take the comparison with Vernadsky a bit further, the concept of semiosphere could be reinvented rather as a main transformative force of the (human) environment.

Introduction

The title of the article is motivated by the fact that the concept of semiosphere introduced by Yuri M. Lotman, and the dynamics of its development reflect the influence of the two theories of chemistry: the biogeochemistry of Vl. I. Vernadsky and the theory of dissipative structures proposed by Russian-Belgian scientist Ilya Prigogine and Isabelle Stengers. We will consider the dual influence of Vernadsky and Prigogine on the workings of semiosphere in relation to cultural dynamics. As a conclusion, we propose the idea that if we take a comparison with Vernadsky's theory of biosphere and its transition into noosphere a bit further, the concept of semiosphere could be reinvented as the main transformative device of the human environment. On the other hand, there is no doubt that the concept of semiosphere coined by Lotman in analogy of Vernadsky's biosphere can be considered a starting point for the new model in the semiotics of culture that enables us to conceptualise the human culture in its great diversity, as well as a certain single system as a part of this diversity.[1]

Metaphor of biosphere in the concept of semiosphere

Lotman suggests that biosphere is "the totality and the organic whole of living matter" (Lotman 2000: 125) and by analogy he formulates the definition of a semiosphere as a "semiotic continuum" (Lotman 1984: 6), a heterogeneous space, enclosed in itself, that is in constant interaction with other similar structures. The points of contact between different systems (which in their own turn are part of a heterogeneous space of a higher order) enable the emergence of new meaning (i.e. the deviation from the algorithm of the given system).

Thus, analogy with Vernadsky enabled Lotman to formulate the position that counts for the general mechanism of cultural semiosis: "the unit of semiosis, the smallest functioning mechanism is not a separate language, but the whole semiotic space of culture in question" (Lotman 2000: 125). It also implies that any semiotic system presupposes the existence of at least two different participants that are at once similar and different. In conclusion, the definition of semiosphere entails the notion of asymmetry (dissymmetry) and heterogeneity in the semiosphere, the notion of boundary, and an assumption that any text is preceded by another text (for Vernadsky multiplication is not a single act of reproduction but a sequence of what he calls the Redi principle: *omne vivo e vivum*)[2] as well as the

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[1] It can be argued, however, that the ideas inherent to the concept of semiosphere are recognisable in Lotman's thought already in 1960s. The evolution and paradoxes of these ideas are analysed in Lotman (2001).

[2] In his letter to Uspensky, written in 1982, Lotman testifies: "Once in our seminar in Moscow I was brave enough to declare my belief that a text can exist (i.e. it can socially be recognized as a text) if it is preceded by another text, and that any developed culture should be preceded by any other developed culture. And now I find Vernadsky's deeply argued idea with great experience of investigation in cosmic geology that life can arise only from the living, i.e. that it is preceded by life" (Lotman 1997: 630; English quotation in Kull (1999: 120–121).

priority of the semiotic space in relation to the single acts of communication.

Directly related to the workings of biosphere is also the concept of semiosphere proposed by Jesper Hoffmeyer (1997). Yet we must draw a clear distinction between the two notions. The semiosphere proposed by Hoffmeyer *is* biosphere: semiosis coincides with the processes of life,[3] whereas for Lotman, a semiosphere is an abstract space of semiosis, of texts and languages. A further distinction between the two theories is related to the structure of the semiosphere: as we already saw, Lotman's semiosphere can be considered only on the background of other similar structures, and that we can grasp a semiosphere as a semiotic system itself consisting of several semiospheric structures. Hoffmeyer, however, clearly states that:

> We already have the excellent term 'Umwelt' to designate the subjective aspect of the [semiotic] niche, and I would therefore recommend that we reserve the term semiosphere as a designation for the totality of semiotic processes going on at our planet. In this way, the term will remain related to well-known terms such as hydrosphere, atmosphere, or biosphere. And there will be only one semiosphere on Earth. (Hoffmeyer 1998: 470)[4]

Despite the fact that Lotman refers to Vernadsky, his use of the term biosphere has several remarkable differences as compared to Vernadsky's concept. We can only guess that the reason lies in the fact that Lotman used Vernadsky's concept rather as a working metaphor that enabled him to formulate his own ideas about the global semiotic sphere. Yet, the clarification of these differences may shed some new light on the concept of semiosphere as well.

The modern usage of the term 'biosphere' begins with Eduard Suess, a professor of palaeontology and geology at the University of Vienna. However, his view is somewhat ambivalent and can be interpreted in two ways: either the biosphere is the sum total of living organisms; or it is a geosphere, created and organised by the processes

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[3] Hoffmeyer even goes so far as to say: "[F]rom a biosemiotic point of view, the biosphere appears as a reductionist category which will have to be understood in the light of the yet more comprehensive category of the semiosphere." (Hoffmeyer 1997: 934)

[4] The further elaboration of the two semiospheric concepts on the background of the concept of Umwelt see Kull (1998). See also Yates (1998) for the discussion about semiosphere and biosphere in Hoffmeyers concept.

of life. Teilhard de Chardin uses the term 'biosphere' in the first sense (Levit 2001: 53–54). Lotman's remarks indicate that he also tends to rely on this interpretation. However, for Vernadsky, a biosphere is a "self-regulating system that embraces both the totality of living organisms (living matter) *and their environment* [my italics — *K.K.*] to the extent it is involved in the actual processes of life, that is, including the troposphere, the ocean, and the upper envelopes of the earth crust" (Levit 2001: 57).

Vernadsky first used the term in 1911, after he had met Suess in Vienna, to denote the object of biogeochemistry that deals with atoms and their chemical properties in life processes, focusing on the "cyclical processes of atom exchange between living matter and inert matter in the biosphere" (Vernadski 1977: 111). The processes of atom migration are also a fundamental source of change in the biosphere. According to the principles of biogeochemistry formulated by Vernadsky, the evolution in the biosphere is an irreversible process that proceeds "in the direction of increasing the level of self-regulation and stability" (Levit 2001: 61). One of the basic methods to achieve this is "to increase the intensity and the complexity of biogenic migration of atoms" (Levit 2001: 65), i.e. the basic determinant in the evolution of the biosphere is the growth of the atom exchange caused by the life processes.

According to Vernadsky, by the beginning of the 20th century, biosphere had reached in its evolution a transitional period from biosphere to noosphere. In this stage, the central stabilising force would not be living matter but human thought, more precisely, scientific thought. In this respect, the latter is a function of the biosphere and thus a geological phenomenon. Therefore, in noosphere, the functions of the biogenic energy created by living matter would be taken over by "the energy of human culture" (Vernadski 1977: 95) — a term coined by Vernadsky to denote the transformative force created by the activity of human mind.

Organisation of living matter and the structure of the semiotic space-time

In the introduction we stated that based on Vernadsky, we can establish semiosphere as the main transformative force of the human environment, instead of yet another synonym for "'culture' in one of the three hundred senses of the latter" as Sebeok concludes, asking "whether anything of substance has been gained by Lotman's substitution of his glittering, kindling locution for the overburdened traditional nomenclature" (Sebeok 2000: 532).

Indeed, Lotman's concept aims to grasp the totality of human culture as, in his view, Vernadsky's notion embraces the totality of living matter. Thus, as we already noted, Lotman ignores the aspect of inert matter in the organisation of Vernadsky's biosphere. As a consequence, it renders the semiospheric model of culture pan-semiotic or, rather, pan-textual[5], cutting it off from the "inert" yet real space human beings inhabit (in opposition to the "abstract space" of semiosphere [Lotman 1984: 6]). We have to consider semiosphere only in the context of other semiotic formations: "in reality no semiosphere is immersed in an amorphous, 'wild' space, it is in contact with other semiospheres which have their own organization (though from the point of view of former they may seem unorganised)" (Lotman 2000: 125).

Yet the vital points of consonance Lotman finds in Vernadsky in a way presuppose the coexistence as well as a sharp distinction between living matter and inert matter. Ignoring the distinction made by Vernadsky in his concept of semiosphere, Lotman also fails to take into account the fact so fascinating for Vernadsky: that living matter in biosphere is embedded in its environment, yet it is clearly distinct from it from either structural or energetic point of view so far as to say that it constitutes an independent space-time that functions according to the laws of its own and that yet reconstitutes the whole of the biosphere, i.e. including the inert environment. Here an explanation of

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[5] Pan-semiotic is the term used in the context of pragmaticist semiotics to describe the aspirations to subsume a semiotics of culture, or just plain semiotics, under a semiotics of nature, or biosemiotics [...]" to give way "to a unified doctrine of signs embedded in a vast comprehensive life sciences" (Sebeok 2000: 533). Sometimes, the term semiobiosphere or biosemiosphere is used in this context (respectively, Ponzio, Petrilli 2001; Merrell 2001).

Vernadsky's notion of the state of space is needed before we can proceed.

Vernadsky borrowed the term from Curie, stating that the space is structured not only according to the laws of geometry, but it also has different physical states that are characterised by the symmetry in the system. The state of space in the inert matter is completely describable in terms of the Euclidean geometry. Molecular dissymmetry of living organisms, however, defies the description in terms of the geometry; as a result, the space of living organisms is different from the space of inert matter. The dissymmetry of the space in living matter conditions also the asymmetry in time and thus the processes related to living matter are irreversible (Vernadski 1977: 133; see the further analysis of Vernadsky's space-time theory in Levit 2001: 17–32). Directly related to the asymmetry of the space-time of the living matter is the so-called Pasteur-Curie principle: "Dissymmetrical effects can be brought about only by a dissymmetrical cause" (Vernadski 1977: 129, 133; quoted in English in Levit 2001: 20), i.e. for the dissymmetry to occur, it presupposes a space whose organisation is also dissymmetrical.

Thus, the important features of living matter in the biosphere are: 1) it is clearly distinct from inert matter in the biosphere; 2) it is characterised by dissymmetry in its state of space; 3) it is subject to the Redi principle that life must precede life as well as to 4) the Pasteur-Curie principle that dissymmetry presupposes dissymmetry; 5) the processes in biosphere, related to the living organisms, are irreversible (because of the dissymmetric properties of the space-time of living matter).

As we saw above, the evolution of biosphere is directed towards "increasing the level of self-regulation and stability", whereas the central stabilising force is the transformative energy produced by the living matter. Life has spread through the biosphere during a process of gradual adaptation whose limits are unknown but are increasing with time (Vernadsky 1998: 103, 118). Now we confront a new factor in the evolution in biosphere:

> Man, in particular, being endowed with understanding and ability to direct his will, can reach places that are inaccessible to any other living organisms. Given the indissoluble unity of all living beings, an insight flashes upon us. When we view life as a planetary phenomenon, this capacity of *Homo sapiens* cannot be regarded as accidental. (Vernadsky 1998: 118–119)

Semiosphere and the transition into noosphere

Although Vernadsky did not use the term noosphere until 1936, the previous paragraph from *The Biosphere*, originally written in 1925, certainly gives an idea of the concept. The rise of civilization is a geological necessity, its continuous development is related to the dissymmetry of time in living matter whose function is scientific thought; according to Vernadsky:

> A civilization of 'cultural humanity' (being a form of a new geological force created in the biosphere) *cannot disappear or cease to exist*, for it is a great natural phenomenon corresponding historically, or more correctly, geologically, to the established organization of the biosphere. Forming the noosphere, the civilization becomes connected through all its terrestrial roots to its terrestrial envelope (*biosphere*), which has never happened in the previous history of mankind to a comparable degree. (Vernadsky 1977: 33; English quotation in Levit 2001: 77)

Noosphere, therefore, is not a layer *in* the biosphere but it *is* the biosphere, where the central role belongs to the "energy of human culture" (Vernadsky 1977: 95), to the "scientific thought".[6] Given Lotman's notion of biosphere, it is not surprising that he clearly denies the similarity between semiosphere and noosphere. He states that "we must be cautious not to confuse the concept of semiosphere with the term noosphere, which is a stage in the evolution of the biosphere [...] The existence of noosphere is material and spatial, it encompasses a

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[6] Teilhard's concept of noosphere is probably more familiar in the west. Above we referred to Teilhard's concept of biosphere as an aggregate of terrestrial living organisms. In the same vein, Teilhard's noosphere is a "thinking layer" (Teilhard 1967: 202), one more envelope around and over the biosphere, its appearance marking not the next stage in the evolution of the biosphere but the rise of the split between the intelligence and its material matrix leading to the death of the Earth. "However convergent it be, evolution cannot attain to fulfillment on earth except through a point of dissociation." (Teilhard 1967: 300). Therefore, noosphere is only a transitional stage in the further development of supreme consciousness, "the end of all life on our globe, the death of the planet, the ultimate phase of the phenomenon of man" (Teilhard 1967: 300). For Vernadsky, scientific thought is a function of the biosphere, thus inseparable from it and it cannot in any way overcome biosphere. So it must emphasised that Lotman relies solely on Vernadsky; even if he acknowledges the abstract nature of the semiosphere, he does not mean that semiosphere could overcome biosphere or Earth in a singular point, where human culture, "mankind, *taken as a whole*, will be obliged [...] to reflect upon itself at a single point" (Teilhard 1967: 315).

part of our planet, whereas the space of semiosphere is of an abstract kind" (Lotman 1984: 6).

However, as we elaborate the comparison between Lotman and Vernadsky further, we could re-establish the semiosphere as a function of human thinking, the main transformative force of the human environment that could be in complete accordance with the living matter, stated by Vernadsky as a definitive source of transformative energy in biosphere with its specific space-time characteristics. According to Lotman, semiosphere is characterised by a specific structure of space and time whose organization is established through the workings of the semiosphere itself and it is through this transformative activity that Lotman partially comes to terms with the "outside" reality: "The outside world in which human being is immersed in order to become culturally significant, is subject to semiotisation, i.e. it is divided into domains of objects which signify, symbolise, indicate something (have meaning), and objects which simply are themselves" (Lotman 2000: 133).

This is obviously largely due to the idea of the specific space-time of living matter expressed by Vernadsky.[7] Thus, for Lotman "conscious human life, i.e. the life of culture, also demands a special space-time structure, for culture organizes itself in the form of a special space-time and cannot exist without it. This organization is realized in the form of the semiosphere and at the same time comes into being with the help of the semiosphere" (Lotman 2000: 133). Thus, the relation between semiosphere and non-semiotic reality is partially established through the semiotic activity of human culture upon the surrounding, non-semiotic environment. Yet it is through this activity that the environment is semiotised and therefore transformed. Therefore we could state that the abstract sphere of texts and languages, semiosphere is *the main transformative device of the (human) environment.*[8] In this respect Lotman comes very close to the

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[7] As noted by Alexandrov, "Lotman's use of Vernadskii can be seen as a valid attempt to locate human culture within a narrative continuum that includes the natural world" (Alexandrov 2000, 342).

[8] As stated by Ivanov (1998: 792): "The task of semiotics is to describe the semiosphere, without which the noosphere is unthinkable. Semiotics is the discipline that has to help us to orientate in the history." He also elaborates the idea that artistic texts form a part of the defence mechanism of the noosphere (Ivanov 1991). Therefore it is not only the internal methodological demand of the distinct disciplines engaged

idea of "semiotics as a post-modern recovery of the cultural unconscious" expressed by Deely (2000).

Chance and necessity in the semiosphere — a thermodynamic metaphor

The concept of semiosphere offers first of all a spatial description of culture, even if it encompasses the dynamics of relationships between its substructures or its relation to other similar structures. When we seek the aspect of time in the specific space-time of the semiosphere, we face the process of history. It is here that Lotman turns to the thermodynamics of the systems far-from-equilibrium, more specifically, to the theory of dissipative structures by Ilya Prigogine, but, first of all, to his book *Order out of Chaos* co-authored with Isabelle Stengers. What seems to be of central importance for Lotman, from the point of view of cultural dynamics is that Prigogine and Stengers reveal the stochastic and the lawful, chance and necessity as two sides of the same coin.

The second law of thermodynamics states the arrow of time determined by the growth of entropy. Yet the law only applies to closed systems near equilibrium: in open systems that exchange matter and/or energy with their environment, entropy appears to be the source of order through the mechanism Prigogine and Stengers describe as "order through fluctuations".

As we saw above, the dialogic mechanism responsible for the generation of new meaning in semiosphere presupposes at least two semiotically different participants. We can conclude that the system is able to engage in dialogic processes only if its structural identity is established. Now we come to the notion of semiotic individuality, inherent in the concept of semiosphere, that presupposes, according to Lotman, the notion of border and certain amount of homogeneity, i.e. semiosphere as a semiotic individuality consists only of one code, one language. Therefore, it is "closed" system in a sense that it is distinguished from and cannot have contact with non-semiotic or alien semiotic systems. However, we must remember that the homogeneity

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with individual texts and systems, but the social applications of semiotics that render semiotic as the science about semiosphere vital (Ivanov 1998).

of semiosphere is conceivable only insofar as we stick to the self-description of the given system.

Semiosphere comes to terms with the "outside" (semiotic or non-semiotic) reality only through the process of semiotic transformation: alien reality is semiotised and therefore the process of transformation presupposes the process of translation. According to Lotman, this transformation occurs only on borders of semiospheres, which are at least double-coded systems of translation filters. Therefore, border determines both the identity of the system as well as allows it to come into contact with its environment: to receive outside messages, new information. However, translation mechanisms of each culture also determine its stability or vulnerability in relation to outside influences: according to Prigogine and Stengers in open systems additional flow of energy and/or matter can disturb the initial thermodynamic equilibrium of the system. In the course of the process, system can reach a state far-from-equilibrium when the whole system is extremely sensible both to the fluctuations (disturbances) within the system as well as to the influences from the outside environment.

Depending on whether the size of the initial fluctuation region lies below or above some critical threshold the fluctuation either is repressed or spreads through the whole system. In either case the basic mechanism of the process can be understood in terms of communication: "the faster the communication takes place within the system, the greater the percentage of unsuccessful fluctuations and the more stable the system"[9] (Prigogine, Stengers 1984: 187). The mechanism of communication is also at work in the amplification of a single fluctuation through the positive feedback. As a result, the fluctuation can break the initial organisation and take the system to the bifurcation point where the future development of the system can take several directions, yet it is impossible to determine the path finally taken: the system can either dissolve or reach a new organisation of a higher order. As it appears, "the more complex the system is, the more numerous are the types of fluctuations that threaten its stability" (Prigogine and Stengers 1984: 188) — and the more complex must be the communication mechanisms within the system[10].

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[9] This quote refers to something we could probably call a thermodynamic definition of socialisation.

[10] The structures of such higher order are called dissipative structures by Prigogine and Stengers because it takes more energy to keep their structural stability. Here we

In the point of bifurcation, the stable system of cause-and-effect is broken, and it is here that we can see the stochastic and lawful, chance and necessity as the two sides of the same coin: in the history of the system periods of stable evolution alternate with periods of rapid growth and qualitative leaps. Lotman (1999b, 1999c) develops the argument on the background of the history of human culture, noting that the bifurcation points are those moments in history when the tension between contradictory poles reaches its highest point and the whole system is taken out of balance. In these moments, neither the behaviour of individuals nor the masses is predictable. We must conceive the curricula of history not as a trajectory, but as a continuum that may be resolved in a multiple ways: these are the moments of revolutions or rapid social upheavals. As Lotman remarks: "It is not coincidental that exactly in these moments words, speech, and propaganda become historically significant" (Lotman 1999b: 134). In retrospect, the choice made seems determined and chance becomes necessity.

Prigogine and Stengers (1984: 176) also point out that "near a bifurcation, fluctuations or random elements play an important role, while between bifurcations the deterministic aspects would become dominant". Thus, under certain circumstances, "the role played by individual behaviour can be decisive" (Prigogine, Stengers 1984: 176). The choice of the possibility actually realised depends on chance but even more on the consciousness of the subjects involved in the process. Therefore it is not accidental that at these exact moments everything said or silenced acquires a particular historical relevance.

We referred to the role of semiotic borders in cultural systems: during the historic upheavals or longer periods of destabilisation, it is often the outside influence that will lead processes to some kind of resolution. The process of autocommunication will eventually stabilise the cultural order with new codes and new hierarchies. However, in case when two systems are relatively similar translation filters may fail and the element of alien culture may enter given culture unnoticeable. Thus the process of creolisation will begin that may lead to further cultural homogenisation. Such processes are also noticeable in

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can also see a certain parallel between Prigogine and Stengers and Vernadsky according to whom the evolution of the biosphere was directed towards the increase of the energy needed to maintain the stability of the system (in addition, we could draw certain parallels between Vernadsky's notion of living matter and the notion of active matter proposed by Prigogine and Stengers).

Estonia during the 1990s up to the beginning of the 21st century in the confrontation of 'nostalgic revolution' of the monolithic national values with cultural diversity and the policy of multiculturalism.

Conclusion: a chemistry of becoming

An analogy with Vernadsky enabled Lotman to formulate the position that counts for the general mechanism of cultural semiosis: the notion of asymmetry (dissymmetry) and heterogeneity in the semiosphere, the notion of boundary, and an assumption that any text is preceded by another text as well as the priority of the semiotic space in relation to the single acts of communication. The asymmetry of the substructures of the semiosphere provides a necessary condition for the dialogue that is a basic mechanism of any semiotic act; whereas the basic source of meaning generation, i.e. the source of possible fluctuations in the system breaking its algorithm, is the heterogeneity of the different elements in the system. The points of contacts between the elements ("semiotic monads" [Lotman 1999a]) made possible by the structure of semiotic border enable the emergence of new meaning. Therefore the heterogeneity of every cultural system is the source of instability as well as the condition for the (exponential) growth of information in the system. In his recent article (Prigogine 2000) Prigogine entertains the idea of a networked society that has emerged as a result of the recent developments in information technology, he also makes a remark: "I feel that there is some analogy between the present evolution towards the networkes society and the process of self-organization I have studied in physics and chemistry" (Prigogine 2000: 893). Semiospheric model could be seen as a powerful device that could help cultural theory come to terms with the complexities of the information society with its further notions of "hyper", "multi", and "inter" (cf. Kotov 2001).[11]

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[11] In a way we could even conceive of hypertextuality as a more general characteristic of the conceptual system of the human culture whose ambitions in knowledge building are closely related to the system of libraries (cf. O'Donnell 1998). A remark made by fantasy writer Terry Pratchett goes in vein with the meaning-creational potential of the hyper-interaction of different texts within the semiosphere: "Books shouldn't be kept too close together, otherwise they interact in strange and unforeseeable ways."

It could be argued that the notion of semiosphere was inherent to Lotman's thought already in the 1960s. Nevertheless, the reliance on either Vernadsky or Prigogine and Stengers implies a certain moral stance whose core might be described as the recognition of the transformative force of the sign processes: either in the constitution of specific space-time or at the moments of conscious decision-making. Its theoretical stance implies a never-ending semiosis, whose basic mechanism is a dialogue between structurally different systems, the mechanisms of mutual translation that are the source of new meaning, but also of instability in the system. In this context, semiosis is both the stabilising as well as the destabilising mechanism of the (human) universe.

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Семиосфера: химия существования

Понятие семиосферы у Юрия Лотмана можно считать исходным пунктом новой модели анализа в семиотике культуры. Концепция, сформулированная по образцу биосферы Владимира Вернадского позволяет рассматривать культуру, с одной стороны, во всем ее разнообразии, с другой же, каждую отдельную систему как часть этого разнообразия. На оформление концепции семисферы кроме теории биосферы Вер-

надского существенным образом повлияла и теория диссипативных структур Ильи Пригожина, и настоящая статья как раз пытается рассмотреть влияние обеих теорий на концепцию Лотмана. Кроме того описывается, каким образом с помощью модели семиосферы можно описать культуру инфоэпохи, которая постоянно преобразовывает себя и свою среду.

Semiosfäär: olemise keemia

Juri Lotmani semiosfääri mõistet võib pidada uue kultuurisemiootilise analüüsimudeli lähtekohaks: Vladimir Vernadski biosfääri mõiste eeskujul formuleeritud kontseptsioon võimaldab vaadelda ühelt poolt kultuuri kogu tema mitmekesisuses, teiselt poolt aga iga üksikut süsteemi osana sellest mitmekesisusest. Semiosfääri kontseptsiooni kujunemist on lisaks Vernadski biosfääri teooriale olulisel määral mõjutanud ka Ilya Prigogine'i dissipatiivsete struktuuride teooria. Käesoleva artikli üks eesmärke on vaadelda nende teooriate koosmõju Lotmani kontseptsioonile. Teiseks heidame valgust sellele, mil moel semiosfääriline mudel võimaldab kirjeldada infoajastu kultuuri, mis pidevalt kujundab ümber end ja oma keskkonda.

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Beyond self and other: On the neurosemiotic emergence of intersubjectivity

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Abstract. The explosive growth over the last two decades of neuroscience, cognitive science, and "consciousness studies" as generally conceived, remains as yet unaccompanied by a corresponding development in the establishment of an explicitly semiotic understanding of how the relations of sign exchange at the neuronal level function in the larger network of psychologically accessible sign exchange. This article attempts a preliminary foray into the establishment of just such a *neurosemiotic*. It takes, as its test case and as its point of departure, recent discoveries from the neurobiological research on viuso-motor transformations and on the widespread cortical phenomena of selectively tuned, single-neuron response to argue for a vision of "intersubjectivity" whereby the *ens rationis* arising as a function of the neuronal semiosphere may be abstracted, constructed, and shared mutually across agents.

Introduction

Empathy, asserts Hoffmeyer (1996), holds the semiotic antidote to the alienation engendered by the conflation of our organic code duality into narrative agent duality. "Lacan's reflection theory holds the key", he posits, as "the mutual empathy between mother and child provided the protection necessary to cope with the unleashing of the awful isolation inherent in the idea of *not*" (Hoffmeyer 1996: 133). Such empathy, continues Hoffmeyer, must be felt and not just reasoned into existence — "the child must, therefore, be capable of empathizing with 'the other' even before it can talk" (*ibid*: 132).

Yet at what point in the organization of a semiotic system, it may reasonably be wondered, does the ability to "empathize" take place? If intersubjectivity is, at it appears to be, a prerequisite for language use (and not vice-versa), how many orders of pre-linguistic, biosemiotic interpretation must a creature experience before the dynamic relata of "self" and "other" become robust enough to be brought into relation with each other so as to result in something as seemingly subtle and abstract as intersubjective identification?

Theorists as diverse as Lacan (1977), Bourdieu (1977), Vygotsky (1978) and Tomasello (1999) all attribute the emergence of intersubjective experience in humans (which manifests most commonly at between nine to twelve months of age) as the logical endpoint of an accumulative process of socialized objectification — i.e., the epiphanal and irreversible realization that one, too, is an "object" as well as a "subject" of experience. According to this view, social forces, primarily through language use, finalize irreversibly the invariant self-splitting and objectification of the (presumably) primal "unity" that nature has endowed — the autonomous locus of experience or *self.*

But does not this picture of the emergence of objectivity (by which agents are then supposed to reason syllogistically to intersubjectivity) leave us bumping up again — even way down here in the primal semiotic — against a fundamental dualism between an incorrigibly dichotic "self" and "other?" Moreover, does not such symbolic and syllogistic reasoning ("x is y to me, therefore I must be y to x") presuppose both linguaform conceptual reasoning as well the very intersubjectivity it is supposed to engender and explain?

For even allowing for the legitimacy of such socio-centric proposals as Wittgenstein's (1953) assertion that meaning is a function of use or Vygotsky's (1978) notion of personhood arising out of dialogue, it would be impossible to imagine what fundamentally organizing principles would allow such dialogic meaning-building and system-building to occur in the first place, were it not for our particular situatedness "always already" in a pre-linguistic, superordinate meaning-building system of *biosemiosis*. It is this biological network of sign relations and organization, I will argue, that, at sufficiently complex levels of organization and recursivity, provides for the mutual intelligibility of shared experience that is the necessary prerequisite for socialization, language use, and the ability to negotiate and to co-construct meaning to take place.

Thus, given that some common ground of lived, non-verbal experience must bind agents in a mutually intelligible system of relation and signification before anything like entry into a symbolic world (such as may be collaboratively constructed through language and through the communal exploitation of intersubjective identification) can occur — what invariant biological mechanisms and vehicles for sign exchange in human beings, we may ask, constitute the likewise *lived embodiment* of this experiential "common ground?"

A candidate mechanism that is currently being considered among researchers in the field of the neurobiology of cognition is a class of cells located deep within the brain called "mirror neurons". These neurons — which are located in an area of the brain long associated with both motor control and with language use — instantiate congruent neural firing patterns both during one's own performance of certain highly specific, goal-oriented activities, as well as when one is witnessing passively those same sets of activities being performed by someone else.

This article thus attempts a threefold purpose: (1) to argue for the necessity of applying to such traditionally formulated research findings an explicitly neurosemiotic perspective, (2) to provide a condensed overview of the majority of mirror neuron research extant in the manner that it is presented in the neuroscience literature itself, and (3) by way of illustrating the potential explanatory benefits of applying (1) to (2), to challenge the prevailing notion in the field that the phenomenon of intersubjectivity made possible by the mirror system is the result of rational, deliberative *convergence* (i.e. — agents matching others' external display with their own internal representations and reasoning syllogistically to arrive at a similarity relation).

I will be argue, rather, that the neuroscience data on mirror neuron activity suggests instead that *intersubjectivity per se* may be the natural, pre-reflexive result of a biosemiotically *emergent* process — and that one's own unitary lived experience of a neurally primitive motor representation that is *mutual across agency* provides the fundamental iconic grounding upon which both subsequent "self" and "other" representations are hypostatically abstracted.

On the necessity of establishing the discipline of neurosemiotics

Commenting on Krampen's proposal to establish the investigation into phyotsemiotics a decade earlier, John Deely, in 1991, termed "surprising...the fact that twenty years elapsed between Sebeok's statement on the dimensions of semiotics [issued in 1968] and the concrete advancement of such a proposal" (Deely 1990: 98). Equally if not more surprising, perhaps, is the fact that a full decade and a half after the publication of Patricia Churchland's (1986) groundbreaking *Neurophilosophy*, and despite the explosive growth over the last quarter century of neuroscience, cognitive science, and "consciousness studies" generally conceived, an explicitly semiotic approach to neural information processing is as yet nowhere to be seen.

Conspicuous most notably by its absence at a time when current neurobiological research findings are being profitably explored in terms of dynamic systems theory (Kelso 1995; Port, Gelder 1995; Clark 1999), developmental systems theory (Weber, Deacon 2000) and even neurophenomenology (Maturana, Varela 1988; Varela *et al.* 1991; Gallagher 1996, 2001; Thompson 2001; Zahavi 2001), the establishment of a specifically Peircean *neurosemiotic* is as long overdue as it is inexplicable, particularly in light of certain otherwise irresolvable paradoxes, mysteries, category errors and confusions that have plagued discussions of the relations of brain states to mental entities since the time of Descartes' infamous *cogito.*

Accordingly, the use of explicitly semiotic terminology has been and remains assiduously avoided in the practices and explanations of traditional Western science in general — a stark methodological rebuttal to Hoffmeyer's proposal that intelligence lies "not in the sign, but in the interpreting body [... and thus] the exploration of this inner semiosphere ought to be the aim of modern biology" (Hoffmeyer 1996: 125). Such a systematic exploration remains still yet to be undertaken a full 300 years after Locke's call for the formulation of an explicitly semiotic *science of representation* — "the signs the mind makes use of" (Locke 1959: 461).

Nowhere is this disinclination more evident and, perhaps, more curious, than in mainstream Western neuroscience, wherein the very terms central to its whole agenda — terms such as "signal", "response", "message", "communication", and "command" — are understood by its practitioners as mere metaphoric shorthand denoting mechanistic, asemiotic configurations and processes.

Yet as the research we will be reviewing in this article amply illustrates, the explanatory power of traditional reductionist and mechanistic hypotheses "breaks down" in cognitive neuroscientific endeavors earlier and more critically than in, say, classical Newtonian physics — where for everyday, non-technical purposes, the problems of "meaning" and of "knowing" are not central to the stated endeavor.

"Messages" are thus "sent", "received" and "acted upon" in the mechanistic explanations of traditional neuroscience — but the question of "who" (or "what") experiences, systematizes, understands and acts upon the aggregation of these "messages" and their "information" *at the level of the integrated organism* is either acknowledged as an perpetual mystery ("association cortices" are sometimes invoked as a kind of *deus ex machina* in hypotheses about human mentation, as if brute congregation alone was somehow sufficient for contemplation — a presumption whose veracity has been disproven repeatedly by five decades of experiments in computer science) — or is summarily dismissed as a fallacy of epiphenomenalism (...and is thus "dismissed", paradoxically, by the "epiphenomenon" it sets out to refute)! What is missing from these otherwise highly successful theories of biological *sign transmission*, then, is a correspondingly coherent theory of biological *sign meaning*.

Here, as elsewhere, perhaps the single greatest obstacle to the articulation of such a theory is the persistent and colloquial reduction of the biologically rich category of "sign" to its by no means representative instantiation in human symbolic consciousness as something that is thought to be, in its essence: mentalistic, conceptual, psychological or linguistic. Signs *per se,* of course, are by necessity none of these things, nor could the very possibility of sign use itself ever be grounded in those relations. Yet because sign relations and sign activities make possible such powerful *symbolic* relations within those aspects of human beings' lived experience that *are* mentalistic, conceptual, psychological and linguistic (aspects that are by no means exhaustive of that lived experience), the everyday conflation of sign use with psychological processes precludes any rational explanation of how biological activity can *be* sign activity prior to its subsequent incorporation in a system of psychologically processed events.

This unfortunate conflation of "sign" with "symbol" exacerbates an already too dichotic understanding of the relationship of mind to brain, relegating all sub-psychological processes to biologic mechanism and idealizing all psychological processes to the realm of immateriality. Across such an ontological divide, one cannot reasonably talk about erecting bridges — one can only chalk out the lines of demarcation and become resigned to taking sides.

Such artificial balkanization of experience, however, poses acute problems for the explanations of traditional cognitive neuroscience. Accordingly, an interesting kind of "double-talk" often characterizes its literature. Thus we find that it is hardly heterodox within the discipline to speak of the living activity of neuronal cells as a series of 'signals' (never "signs"), whose individual purpose is 'communication', whose aggregate function is 'information processing', whose distal 'object' is some external or internal stimuli, and whose (proper significate?) 'effect' is, in fact, a multiply mediated response to multiply mediated stimuli. C.S. Peirce, we may assume, would have found this neuronal arrangement evocative.

Unfortunately, the abiding fear of anthropomorphization that attaches to an inadequate understanding of semiotic theory has made the use of explicitly neurosemiotic terminology anathema to the theorists of traditional neuroscience. Such fear is, of course, both counterproductive and unwarranted, for the role of the neurosemiotician — like the role of the cognitive neuroscientist — is not to "anthropomorphize" the individual activity of communally mindless neurons but to understand how the communal activity of individually mindless neurons actively anthropomorphizes, in a very "minded" fashion, *us*.

To begin examining this process at (or near) its beginning, then, let me first attempt to illustrate how even a cursory acquaintance with the evolution of the basic circuitry which comprises the human brain and nervous system reveals the inherently *semiotic* nature of the specialized *neuronal* cell, as that evolution (and those cells) are depicted schematically by one of the pioneers of modern neuroscience in Figure 1.

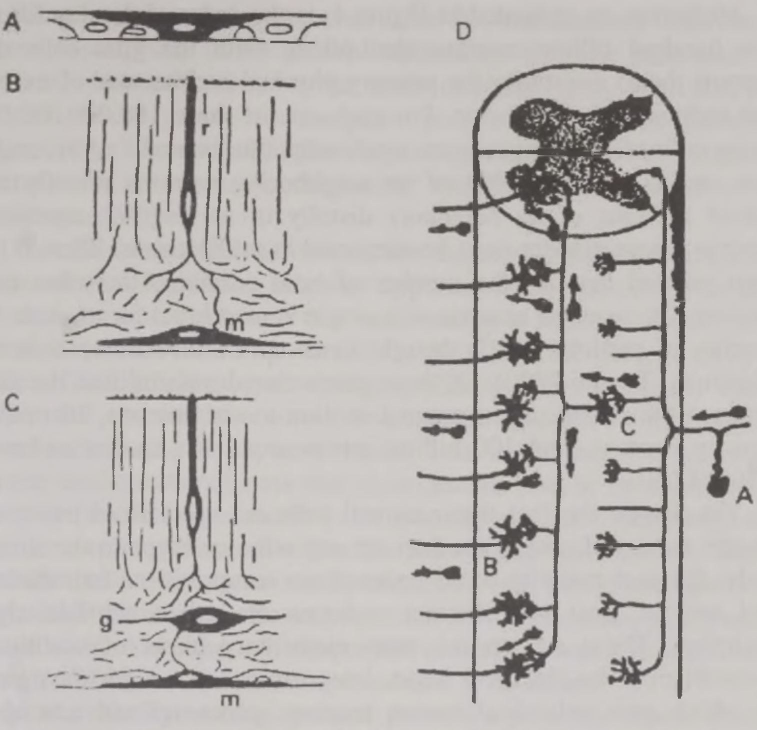

Figure 1. Stages in the semiotic evolution of the nervous system. (A) The motile cell of a primitive sponge responds to surface contact directly with a reciprocal wave of contraction. Feeling, being and doing are unmediated at the level of the organism. (B) The contractile function in the more evolved sea anemone has now been segregated into two specialized elements: (r) is a non-contractile sensory receptor cell that is acted upon directly by forces in the environment, but is itself wholly incapable of acting upon that environment and its forces in return. Mediation occurs as stimulation of the external environment's stimulation of (r) triggers the muscle contractile element (m), allowing (m) to act directly upon an environment that it is incapable of directly receiving input from. (C) Further mediation occurs in the sea anemone as a motor neuron (g) is interposed between the non-contractile sensory cell and the non-(externally) sensory muscle element. This motor neuron neither acts upon the external environment nor is acted upon it. Rather, its relation with that environment is wholly mediated by the polar elements of the network of which it is a part. (D) Mediation increases exponentially with the evolution of the vertebrate nervous system. The far majority of communicating cells (the inter-neurons) now connect directly neither to sensory nor to effector cells, but exclusively to other non-externally interactional, intercommunicating cells. (Illustration adapted from Ramon y Cajal 1911, via Llinas 2001.)

Mediation, as indicated in Figure 1, is the order of the day for the one hundred billion neurons that (along with the glial cells that support them) constitute the primary physical architecture of exactly one individual human brain. For each one of these 100,000,000,000 living cells receives input from, sends output to, is modified by, and in turn modifies up to 1000 of its neighboring neurons directly and untold millions of its neighbors distally in an ongoing mediation process whose activity must be measured in milliseconds. Thus, it has been pointed out that the number of total possible interactive connections between the neurons of a single human brain far exceeds the number of particles (10^{79}) thought to comprise the known universe (Edelman, Tononi 2000). Of these interactional possibilities, the ratio between the statistically average 1 million motor neurons, 10 million sensory neurons, and 100 billion interneurons is a mediation-heavy 1:100,000:10.

Yet despite the fact that neuronal cells are specialized into a far greater variety of subspecies than are any other cell type in the animal body, the vast majority of all neurons are comprised of four distinct loci and at least two distinct varieties of incontrovertible sign-exchange. These are, in the most elementary terms of traditional neuroscience, the electrical *input, integrative,* and *conductile* signals by which each individual neuron receives, processes and acts upon digital activation information (at the loci of the dendrites, cell body, and axon, respectively) and the chemical *output* signal by which each neuron communicates the highly variable results of this information processing to its neighbor through the analog release of neurotransmitters into the synaptic cleft (at the loci of the synaptic terminals).

An extraordinarily simplified — though still, I think, helpful — description of the gross mechanics of interneuronal "communication" runs like this: minute changes in the ion gradient diffusing down the living neuron's cell membrane result in a voltage change relative to the outside environment which, upon reaching threshold, produces an electric current which then stimulates the neuron's own synaptic terminals to release chemical neurotransmitters into the synaptic cleft. This, in turn, modifies the ion gradient that will diffuse down the cell membrane of the neurons whose receptors comprise the adjoining half of that synaptic cleft, which results in a voltage change, etc., etc. until at some point in the process the circuit is completed or the threshold state is not reached.

What is apparent, I hope, even from this one hundred word bare-bones description, is the critical realization that the processes of neuronal communication — far from conforming to the electrical conduit model proper to computer programming or to electrical engineering — constitute, rather, a paradigm example of the semiotic interrelation known as "code-duality" (Hoffmeyer, Emmeche 1991, Hoffmeyer 1996).

That "code-duality" is, indeed, the organizing principle enabling neuronal communication becomes apparent when one considers that the environmental surround that each neuron is situated in (and with which it interacts with most directly at the site of the synaptic cleft) is a Heraclitian world of ever-changing chemical and molecular interaction and constitution, whose *analog representation* (what neuroscientists call its "synaptic potential") is constituted by whatever unique configurational state that environment is in at the moment of synaptic (which is presumed to be quantal) release. Conversely, the electric current generated within the neuron and which travels down the axon (referred to, semiotically enough, as an "action potential") as a result of this analog release possesses all the attributes of a purely *digital code:* it is either wholly present or wholly absent, its amplitude is not variable, it does not decay over time or distance.

Most critically: *analog synaptic potentials generate digital action potentials which generate analog synaptic potentials which generate digital action potentials.* This ongoing process of semiosis wherein the interactive, consequential interplay between digital and analog cell activity constitutes new *signs* and new information at every nodal (synaptic) point is, I believe, the starting point upon which the establishment of a discipline of neurosemiotic must be built.

This is very much *not* the currently popular model of neuronal information processing wherein a presumably unitary "bit" of "information" is literally *in* the signal of the action potential in the same way that the analog action of a human finger hitting a letter key on a computer keyboard is "in" the micro-pulse of digital electrical current that results ultimately in the appearance of that letter on a computer screen. Such a model, no matter how complex, will never be able to account for the phenomenon of how or where (or, Turing forbid, by "whom") the digital representations of analog experience are ultimately read. For while our computer models already come with meaning-using, sentient beings built into the network of sign-exchange (the programmers and the end-users), our brains — under the asemiotic interpretation of neuronal communication and lest one posit the infinite regress of homunculi within homunculi within homunculi — do not.

Thus it is still very much understandably the case that contemporary neuroscience, so incredibly adept at discovering and describing the physio-mechanical aspects of biological sign-exchange, yet lacks even one generally accepted, much less fully explanatory, theory of the very principles by which the emergence of mental representation from neuronal electro-chemical signal transduction is even *possible*, much less actually accomplished. Neuroscientist Eric Kandel, in the most recent edition his seminal *Principles of Neural Science,* states both at its outset and at its conclusion that despite the exponentially increasing brain research literature extant, "the neural representation of consciousness and self awareness [... remains] biology's deepest riddle" (Kandel *et al.* 2000: 16).

"After all," continues Kandel, "to study the relationship between a mental process and specific brain regions, we must be able to identify the components of the mental process that we are attempting to explain" (*ibidem*). I maintain throughout this article that it is precisely because of contemporary neuroscience's refusal to identify and to include the *sign* as one of the "components" to be investigated in the emergence of even the most primitive of mental representations, that the most semiotically sedimented and emergent representation of all — that of the "consciousness" of a subjective, internally referential "self" — has been averred to be incorrigible by some philosophers (Horgan 1999, McGinn 1999), and has earned David Chalmers' (1996) definitive appellation as "*the* hard problem" of consciousness and mind.

For if, as these philosophers have repeatedly asserted, mental representation *itself* follows laws incommensurable with the laws of physical systems — and if the material objects of the world likewise entertain no efficacy in the causation of mental events — then the problem of how a representational consciousness as such can arise in a physical system (without recourse to a "ghost in the machine") truly *is* incorrigible.

In Peircean semiotics, however, we find a way out of this impasse with the twin recognition that: (1) 'representation' — as well as the capacity for *signification* of which representation is but a part — is *not* a process originating from, nor exclusively the domain of, the human mind and that (2) the nature of such ‘representation’ in a specifically human psychological context does not reduce to a linear, unitary process whereby one presently existing state or thing (such as the rich, subjective experience of “pain”) isomorphically “stands for” or corresponds to one other presently existing state or thing (here, the neuronal event “C-fiber stimulation”) and so on down the line in the manner of a graphical computer interface until at last one reaches the static, underlying, and finally causal “program code” — but that ‘representation’ is a fundamentally creative process of interactionally achieved, massively co-constructed mediation *across* networks of relation (CP 4.3)[1] in a complex, open system which ultimately allows the human organism to transcend the brute indexicality of physically present, coextensive and discrete relata and to participate interactively across its own organizational levels — levels which include the intrinsically *dynamic* elements of neuron, body, sign and world.

The totality of this systemic and incessant sign activity we reify as “mind”. An ongoing, dynamic process of sign-exchanging cells embedded in sign-exchanging brains embedded in sign-exchanging bodies embedded in sign-exchanging worlds, the eternal interplay of self-organization and symmetry-breaking that characterizes the moment-to-moment experience of this recursively interactive system constitutes, in a very real sense, the very essences of “knowing” and of “the mind”.

Properly seen, body, brain, mind and cell are but levels of the same one endlessly interacting complex system — and if we can view or treat them as distinct, it is more a testament to our own particular species-specific *Lebenswelt* — or the culture of what Terrence Deacon (1997) calls *symbolic reference* — whereby we conceptually carve out of the sensory plenum of experience, elements of *quality* or iconicity (firstness), elements of *relation* or indexicality (secondness), and elements of *synthesis* or *mediation* (thirdness) (CP 1.378).[2]

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[1] CP here refers to Peirce (1931–1935); the numbers correspond to book and paragraph, respectively.

[2] Of the more prominent neuroscientists working in the field today, three in particular — Terrence Deacon (1997), Gerald Edelman (1994, 2000) and Antonio Damasio (1994, 1999) — all explicitly advance the notion that “representation” in the body and in the mind exists as a *process* as opposed to as an entity or as a collection of neuronal and/or mental particulars. Yet while all three of these scientists acknowledge “representation” as the recursive self-organization of interactions emerging out of,

In the Peircean conceptualization of brain activity that I will be arguing for, experience dependant and dynamically re-entrant *neuronal activity* constitutes (to paraphrase Colapietro's analogy with language) "the [indexical] process in which paths are blazed from the object to the sign to the interpretant", whereas *consciousness* or *subjective awareness* constitutes "the [symbolic] process in which these paths are traversed" (Colapietro 1989: 19). Under this conception, the very biological semiosis that manifests the multitude of local electro-chemical sign-exchange into the global functional organization of our biological 'selves' finds its explicitly symbolic realization (through its active embodiment in a community of other sign-users) in the conceptual semiosis that manifests itself as our mental 'selves'. This opens up the way towards a *dynamic* view of the self that is *at once* iconic, dialogic and triadic.

Such a triadic understanding of the interrelationship between sign, object and interpretant is long overdue in the disciplines devoted to the explication of "human consciousness," both in the often overly idealistic and immateriality-oriented social sciences, as well in the correspondingly reductionist and mechanistic neurosciences of cognition — although it is primarily to the latter that this article will address itself. For against the long-held *neural conduit metaphor* — wherein "information" flows through the circuitry of neurons in much the same way as electricity flows through a computer motherboard (i.e. — in ways in which neither the signal nor the vehicle of its transmission are understood to be themselves interactive participants in the creativity of semiosis) — the massive data collected over the last half century regarding experience-dependent dendrite growth, milieu-responsive axon branching, epigenetic neural self-organization and the ongoing plasticity of synaptic weighting (Kandel *et al.* 2000) reveals the neural systems of living beings to be precisely what both its outward physical appearance and Sebeok's general theory of semiosis suggests that it would be: neither a carbon-based telephone exchange nor a peptide-bound motherboard for transporting bytes of pre-encoded data for the utility of some distal "user" — but a living,

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embedding, and becoming themselves embedded again within other interactions (for Edelman, on the neuronal level; and for Damasio, on the neuroanatomical), only Deacon explicitly recognizes and acknowledges that the very processes whereby representation emerges, is exchanged, and causes other representations to emerge *ad infinitum,* is essentially an embodiment of the semiotic triadicity of Peirce.

interactive, massively re-entrant semiotic *web*, the history of whose organization incorporates its past, is active in the present and extends outwards to the future — "a web of experience woven out of signs and used to catch various objects in our *Umwelt* for the sake of our survival and flourishing" (Colapietro 1993: 179).

Thus, in its capacity to free us from a purely dyadic ontology of neuronal sign processes consisting only of signals and their carriers, the naturalistic re-introduction of *sign-objects*, *sign-interpretants* and *sign vehicles* into the provenance of neurobiology allows us to transcend the Sausserian dyadism underlying the assumptions of much contemporary neuroscience, whereby mental activity *m* is "signified" by the presence of neural activity *n.* Such an assumption presumes, of course, that the elements of "signifier" and "signified" are somehow dichotic and discrete and may thus be correlated only "conventionally" or "arbitrarily". This is, obviously, an exceedingly curious position for any study of biological organization to take, and has resulted in a *neural nominalism* which is far more ubiquitous in the literatures of neuroscience and consciousness than is generally remarked upon.

For until such time as researchers working in the mainstream of the brain sciences understand that neural activity *is* sign-activity and until such time as theoreticians conversant with the laws and properties of semiotic interaction can contribute to that understanding by dispelling once and for all the ingrained popular misconception that sign activity means mental activity performed by a psychological agent, the serious collaborative dialogue between neuroscience and biosemiotics will remain forever stillborn.

Bearing this last point in mind, though not expecting any overnight paradigm shifts in the fields of either biosemiotics *or* cognitive neuroscience, I would nonetheless like to attempt something of a preliminary *rapprochement* between these two fledging disciplines — each of which has much to offer the other and each of which, I believe, are investigating much the same phenomena — by applying an explicitly biosemiotic perspective to the findings of traditional neuroscience in an effort to illustrate the mutual enrichment to be had by both fields via the incorporation of such a neurosemiotic.

Evolutionary and ontogenetic tuning of neurons for selective response

The fact that both individual neurons and the networks of which they are a part can be selectively "tuned" by evolutionary and by ontogenetic experience (i.e. — that they "take habits" in the Peircean sense)[3] was postulated most famously by Donald Hebb in 1949, and has been demonstrated conclusively since by Palm (1982), Grey and Singer (1989), Tsumoto (1992), and Perrett *et al.* (1982, 1989, 1990), among a multitude of other researchers.[4]

Kobatake and Tanaka's (1994) work on feature recognition at the level of the single neuron is representative of a vast corpus of research into the tendency for certain individual neurons to become *exclusively selective* or "tuned" to respond to highly specific (and even individual) colors, shapes, movements and particular biological stimuli such as fingers, faces and mouths (Livingstone, Hubel 1987; Perrett, *et al.* 1989; Hubel 1988; Kandel *et al.* 2000; Zeki 1993, 1999). A striking example of this neuronal "taking of habits" is illustrated in Figure 2.

Sensorimotor neurons — neurons that mediate both one's perception and one's effecting of the external world — likewise demonstrate high degrees of specificity, as the automaticity with which any conditioned response or sustained deep learning (such as speaking a language, driving an automobile or playing a musical instrument) will immediately attest. In practice, the massively accumulating data on the learning, planning, storage and exponentially recursive "feed-forward/feedback interaction" of motor action sequencing and synchronization "schemas" all but explicitly acknowledges the *semiotic* components inherent in such deeply interactive patterns of organization.

Gibson's (1950) widely influential notion of "motor affordances", for example, holds that the *recognition* of the shape of an object and

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[3] Such adaptive, spontaneous "tuning" through habituation, of course, is also at the basis of connectionist, or *neural networking*, models of information processing, self-organization, and learning, many of which attempt to build into mechanical systems the Hebbian postulate of experience-driven cell networking and self-assembly. For an excellent overview and discussion of the shortcomings and potentials of connectionist and other AI/AL research, see Emmeche 1994, and Levy 1992.

[4] See, for example, the Face Recognition Research Homepage at http://www.cs.rug.nl/~peterkr/FACE/face.html for just a partial listing of the hundreds of researchers currently working in this particular sub-field.

its physical "opportunities for interaction" (its curves, protuberances, angularity, etc.) by a set of selectively tuned sensory neurons is what "triggers" (in the mechanistic terminology acceptable to contemporary neuroscience) a *correlated* set of selectively tuned motor neurons to produce a corresponding reach and grasp (Gibson 1950, Arbib 2002).

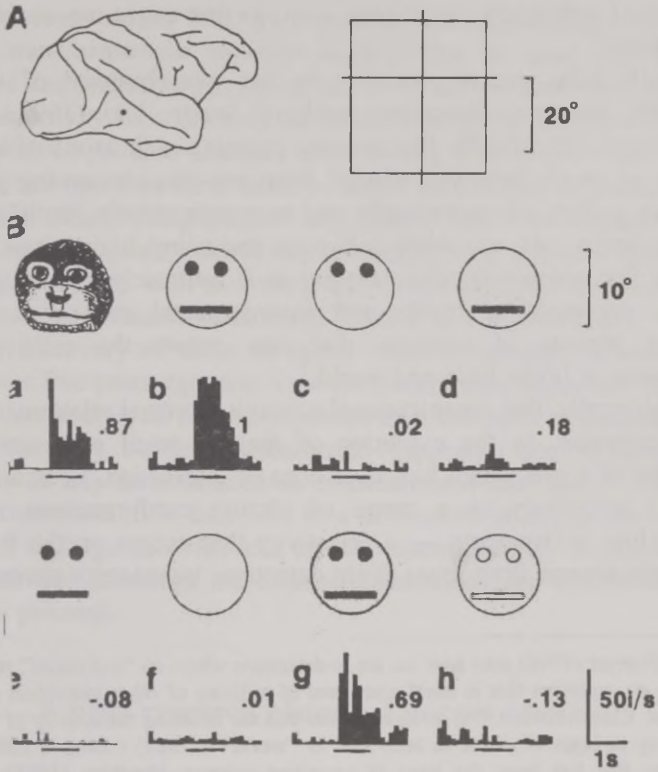

Figure 2. Selectively tuned single neuron response. Recordings made off of a single neuron in the inferior temporal cortex reveal selective responsivity to the critical features of face recognition (a, b, g). Incomplete or inverted images (c, d, e, f, h) failed to activate the neuron to firing threshold. (From Kobatake and Tanaka, 1994.)

Habituation of this type, I wish to argue, has at is basis *signification*, the process whereby detection of a certain stimulus in a living organism comes to elicit a specific response. On the neuronal level, such detection is far from straightforward, as the neurons where such "selective tuning" have been found to occur may be buried deep within multiply embedded networks and pathways which, in turn, *themselves* have been organized both evolutionarily and through ontogenetic experience via the habituated detection, response and learning of contingent causalities — or, as one might reasonably say, semiotically.

Significantly, recent research in the neurobiology of vision, especially the groundbreaking work of Semir Zeki (1993, 1999) demonstrate conclusively that sensory percepts such as visual images are not so much "received whole" from pre-given incoming photon impulses as they are semiotically and co-constructively "built" across heterogeneous and massively intercommunicating brain areas. Thus we find that sensory signification *per se* is intimately bound up with motoric processes of bodily and environmental interaction in an ongoing process of semiosis that cuts across the sub-systemic distinctions of brain, body and world.[5]

Semiotically, this organizational network of visual relations is only to be expected, as the evolution of the eye itself rests upon the evolution of a cell which has, over eons of interaction, been tuned to respond selectively to a range of photon configurations in the surrounding environment — a selectivity that ranges on the level of the single neuron from gross (light detection, wavelength perception)

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[5] Hoffmeyer (1996) asks how we are to determine where an "individual" starts (or ends!) in an organism that is itself composed of millions of other individual cellular organisms. Clark (1996, 1999) in turn, argues that the situating the activity of "mind" exclusively in brain (and not in body and in "world" as well) creates a misleading dichotomy that has been the bane of cognitive science. Hutchins (1995) further unlooses the bounds of inquiry by arguing that cognition *per se* is distributed across brain, body and world, while Jarvilehto (1998) finally, questions the validity of positing any body-world distinction at all. Thus, the issue of *mereology,* as Stjernfelt (2000) and Kull (2000) have recently pointed out, is one which any comprehensive semiotic investigation is going to have to ultimately confront.

On the neurobiological level, I will be proposing in a future paper that one felicitous way of dealing with such questions may be via an extension of Hofstadter's (1979) notion of "self-organizing modularity" which finds its neurobiological counterpart in Edelman and Tononi's (2000) notion of neuronal "functional clusters" and their "dynamic core hypothesis" — the neural version, in effect, of Bateson's "difference that makes a difference" — that accounts for the emergence of relatively discrete entities from a plenum of recursive interaction.

to extremely fine-tuned (individual shapes, movement trajectories, and even highly specific faces, fingers, mouths and hands). Such cells in the aggregate interact with a vast distribution of other selectively specialized cells in the human brain to actively co-construct or "build" a visual image that is not the product of brute mechanical reception and transmission, but of semiosis.

Even more recent findings regarding the neurobiology of visuomotor transformations strongly suggest that at least part of the semiotic and empathic grounding out of which the very experience of *intersubjectivity* emerges may lie in the activity of a certain class of selectively responsive neuronal cells having both sensory and motor capabilities and that have been evolutionarily tuned to instantiate a congruent neural firing pattern both during one's own execution of highly specific, goal-oriented, object-manipulating activities (grasping, tearing, biting) as well as during one's mere passive observation of those exact same activities being performed by someone else.

The discovery of these so-called "mirror neurons" in humans a little over five years ago may have profound implications not only for our understanding of the sub-personal architectonics of empathy and intersubjectivity, but for a fundamental reappraisal into the continuing viability of any neuroscience of consciousness and mind "asemiotically" conceived. It is thus first to a discussion of the mirror neuron research findings and then to a critical examination of the paradigms in which these findings are currently embedded and interpreted that we now proceed.

A brief research history of mirror neurons

Confirmation of a mimetically oriented observation/execution system in the brain took place in 1996 during the course of a 15 year-long investigation into the neural substrates for hand and mouth movement in macaque monkeys begun by Giacomo Rizzolatti and his colleagues at the University of Parma, Italy in 1981 (Rizzolatti *et al.* 1981).

Rizzolatti, Fadiga, Gallese, and Fogassi's seminal 1996 article *Premotor cortex and the recognition of motor actions* summarized much of the preceding decade's research on the response properties and behavioral modulation of mouth-related neurons in the macaque, emphasizing in particular the discovery of Pellegrino *et al.* (1992) of a subset of rostral ventral premotor (F5) neurons critical to the processes of visuomotor transformation, neurons which Rizzolatti et al. were later to distinguish and to taxonomize as *canonical* and *mirror* neurons.

Research by Kurata and Tanji (1986), Petrides and Pandya (1994), and Sakata *et al.* (1992) offer convergent evidence to Rizzolatti and his colleagues' discovery that ventral premotor area F5 contains organizations of neuronally assembled *motor schemas* for the execution of highly specific hand movements in its dorsal area and for the execution of highly specific mouth movements in its ventral area. The neurons that comprise these assemblies have both motor (efferent) and sensory (afferent) properties and appear to discharge selectively to visual information received from the anterior intra-parietal sulcus (AIP) rostral to the oculomotor region of the lateral intra-parietal area.

Afferent discharge of the *canonical* neurons, it was discovered, occurs at the presentation of particular 3-D objects when there is a match between the object's "affordances" (those features of an object relevant to interaction, such as cavity, curve and protrusion) and the type of hand or finger grip encoded for by the neuron. Efferent discharge of canonical neurons occurs during particular goal-related hand movements such as holding, grasping and manipulating objects with *either* hand or mouth and many of these discharges are specific for particular types of hand prehension, such as precision grip, finger prehension, etc. "Taken together," claim Rizzolatti *et al.* (1996a: 131), "these data indicate that AIP and F5 form a cortical circuit which transforms visual information on the intrinsic properties of objects into hand movements that allow the animal to interact appropriately with objects".

Rizzolatti *et al.* (1996a) corollary discovery was that F5 in the macaque also contains a subset of sensory-motor neurons that discharge congruent neural firing patterns both during the actual execution of certain goal-directed hand and mouth movements, as well as during the passive witnessing of those exact same hand and mouth movements whenever they are performed by someone else.

Rizzolatti and his collaborators christened this newly discovered class of neurons *mirror neurons* and discovered that in order to be triggered, these neurons require an interaction between an agent and an object of a goal-directed action. The simple presentation of objects, or their manipulation in "meaningless" or non-goal directed ways by hand (whether witnessed or performed) will not evoke the neuron to discharge (*ibidem*).

In this now widely-cited series of original experiments, depicted in Figure 3, the macaques were presented with three experimental conditions — first, observation of the experimenter's specific grasping action upon an object followed by their own execution of that same specific action; secondly, observation of the experimenter grasping the same object using a slightly different grasping configuration or using a pliers that duplicates the original grasp upon the object, followed by their own repeated performance of the original object-grasping action; and third, performing the original action in darkness (i.e., — without the accompanying observation of the object or of their own hand). Individual action potentials were recorded off of single neurons using tungsten micro-electrodes through the dura (which was left intact) simultaneous with videotaping of the behavioral events.

As the histograms of single neuron activation demonstrate, activation of the mirror neuron is unique to specific agent-object, goal-directed events (a series of control experiments were performed which ruled out interpretations that this phenomenon was the result of food expectancy, motor preparation for food retrieval, associative training, or reward). In fact, subsequent recordings taken off of a nearby but different F5 mirror neuron in the same monkey, depicted in Figure 4, show that this mirror neuron did not discharge at all to the agent-object interaction configuration that selected for exclusively by its neighboring neuron (c), whether executed or observed. Rather, this mirror neuron discharged only during others' display of — and one's own execution of — counterclockwise *but not clockwise* rotations of hands that were grasping food (Rizzolatti *et al.* 1996a).

The discovery of highly selective brain circuitry oriented to goal-directed, agent-object interaction in monkeys — circuitry which on this early level of neuronal organization is activated identically by observation and experience — led to their investigation for a similarly mimetic observation/execution "matching system" in humans.

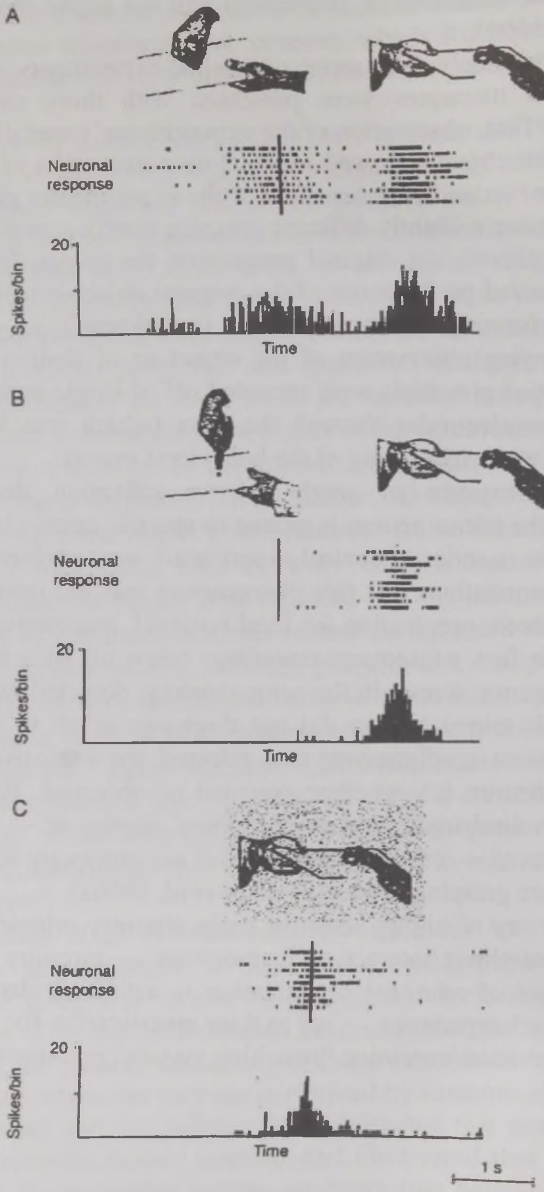

Figure 3. Experimental evidence for the activity of mirror neurons in the macaque. Please see text for details. (Illustration adapted from Rizzolatti *et al.* 1996a).

Presenting evidence based on cytoarchitectonics, electrical stimulation studies and sulci embryology, Rizzolatti and Arbib (1998) offer convergent evidence to studies indicating that Area F5 in the macaque monkey brain finds its functional and anatomical homologue in the Broca's area (Brodmann areas 44 and 45, the so-called "language production area") in the human brain (Galaburda, Pandya 1992; Passingham 1993; Bonin 1944).

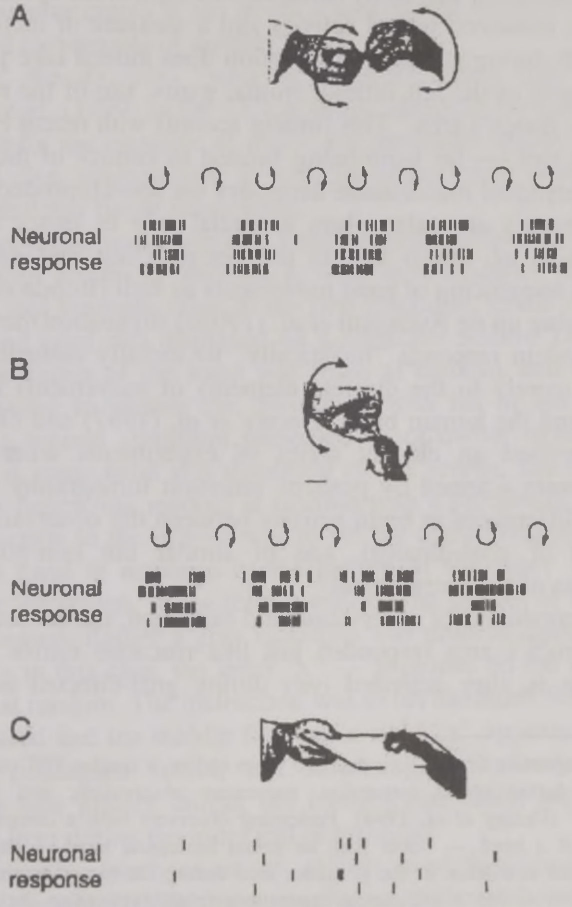

Figure 4. Extreme mirror neuron specificity. Details in text. (Illustration from Rizzolatti *et al.* 1996a).

Noting that both monkey and human precentral sulci develop prenatally from the two separate primodia of the superior frontal sulcus (SF) and the inferior frontal sulcus (IF), sharing many homologous functional and anatomical frontal lobe areas as a result. Rizzolatti *et al.* (1996b) used positron emission tomography (PET) to localize areas where increases in uptake of radioactive fluro-deoxyglucose are most pronounced in the human brain during object observation, grasping observation and grasping execution.

The findings of this study revealed that significant uptake increases (reflecting enhanced neural activity and a measure of increased local work load) during grasping observation does indeed take place in the posterior part of the left inferior frontal gyrus, site of the rostral-most part of the Broca's area.[6] This finding accords with recent PET studies indicating that — far from being limited to control of the oro-facial and oro-laryngeal musculature necessary for speech production — the human Broca's area also plays a crucial role in motor association (Dronkers *et al.* 2000) and in the pre-planning and execution of organized sequencing of hand movements as well (Bonda *et al.* 1994).

Following up on Rizzolatti *et al.* (1996a) suggestion that the mirror neuron system responds "holistically" to socially embedded actions (and not merely to the discrete elements of movement) in both the monkey and the human brain, Decety *et al.* (1997) and Grezes *et al.* (1998) devised an elegant series of experiments wherein human subjects were scanned by positron emission tomography in order to map the differences in brain activity between the observation and the execution of goal-directed, and of similar but non-goal-directed, movements of the human hand.

In all conditions of observation and execution, mirror neurons in the human Broca's area responded just like macaque mirror neurons in F5 — that is, they activated *only* during goal-directed action-object

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[6] It is important to note here that two years earlier, a similar PET experiment was performed during object inspection, movement observation, and motor action "imagining" (Decety *et al.* 1994). Presenting observers with a computer-generated schematic of a hand — rather than an actual biological hand — this experiment reported some activation in the premotor area during the motor action "imagining" condition, but neither significant premotor nor frontal activation during movement *observation*. Rizzolatti *et al.* (1996a: 138) cite this study as supportive of their hypothesis that "non-biological stimuli are ineffective in exciting F5 mirror neurons ... [accounting for why, in the above experiment] the cortical matching system was not activated."

observations *or* executions, and did not, significantly, during observation or execution of the object-less, non-goal-directed hand gestures with which the subjects had no semantic understanding or associations.

Similarly, Strafella and Paus (2000) confirmed the discovery of Fadiga *et al.* (1995) that the simple witnessing of someone else's hand movements increases motor-evoked neuronal activity in the hand muscles of the passive witness, This, in turn, offers yet more convergent evidence to the brain imaging studies of Grafton (1996) and Iacoboni *et al.* (1999) demonstrating increased activation of the ventral premotor cortex at the Broca's area during passive observation of the hand movements of another.

Finally, the *de facto* "semiotic" mirror neuron experiments of Iacoboni *et al.* (1999) at the UCLA Brain Mapping Institute were the first to test for the response of motor and pre-motor mirror neurons to artifactual sign presentation, as well as to the mere observation of motoric hand and finger sequencing.

In these experiments, subjects were required to observe and then to imitate motor actions in response to what were designed to be iconic, indexical, and symbolic cues. In the first condition, iconic stimulation, an animated hand was displayed on a computer screen. The index or the middle finger of the hand was lifted at random, and the subject was instructed to imitate the movement with his or her own right hand. The second condition presented a somewhat more indexical stimulus. A static hand was displayed on the screen, and its index or its middle finger was marked at random with a prominent black "X". The instruction to the subject was to lift the corresponding fingers of their own hand in response to the pattern of stationary but marked fingers on the screen. In the third condition, no images of hands at all were presented. Rather a gray rectangle was presented and a solitary symbol — in this case, the letter "x" — appeared on the left or right side of it at random. The instruction was to lift the index finger if a left "x" appeared and the middle finger if a right "x" appeared. Iacoboni and his colleagues found, not surprisingly, that mirror neuron activation was greater during the iconic observation and execution condition than during the indexical or symbolic.

Additionally, Iacoboni *et al.* (1999) used functional magnetic resonance imaging (fMRI) to pursue the question of how individuals equipped with such automatic observation/execution mirroring mechanisms in the brain, may preserve a sense of *self* during action observation, given the existence of a shared motor-neural pattern which is activated identically by self-execution and by other-observation.

The researchers found, perhaps not surprisingly, that reafferent proprioceptive signals from the parietal operculum — "feedback" between the organism and its ongoing interaction with its object — modifies the reception of the input from Broca's area, embedding the signals from the mirror neurons into the larger integration of brain activity of which these signals are but one constituent.

Constructing representema: the sign vehicle of the eye

Having now reviewed, in the determinedly asemiotic manner of the neuroscience literature itself, some of the major neurobiological research findings of the last half decade, how are we to begin the application of an explicitly Peircean semiotic to the dissipative electrochemical activity of these intercommunicating neurons? More critically, having seen how selective response properties may become, over evolutionary and ontogenetic time, exclusively "associated" with objects and activities that these neurons themselves will never directly experience or "see", is there yet any reason to believe that the organization of this activity constitutes anything *other* than an electrochemical "bucket brigade", a transfer of streaming brute ion configurations that receive their semantic "meaning", if at all, only at the "input/output" (sensory and motor) "ports" of the self? Conversely, is it reasonable to assert that that the organization of this densely intercommunicative neuronal semiosphere *itself* partakes in no way of the organization of sign-activity that constitutes 'consciousness' and the "meaning"-making mind?

If we understand *semiosis* to be an organizing principle of *all* manner of sign-exchange, then the operational processes enabling *signification* from receptor cell to interneuron to effector cell and the processes enabling signification across the meta-systems of biological organization (cell, pathway, network, organ, system, body proper) and across levels of awareness (network signification, body signification, mental signification) reveal themselves as systemic parts in a lawful, interactive continuum — a view of mind and body that allows us to transcend the intransigent dualism of a contemporary neuroscience "which performs its analysis with an axe, leaving as the ultimate elements, unrelated chunks of being" (CP 7.570).

To understand, then, how the objects of consciousness are related to the sign-exchange activity of the neuronal semiosphere, we need first to understand how the signs of the neuronal semiosphere relate to each other as well as to the objects both of consciousness and of the external world.

We thus begin our explicitly semiotic investigation into the neuronal signification process as virtually all biological investigations must at first begin — that is to say, *in media res*. The phenomenon under investigation is already always "in full swing" and in our preliminary attempts to fix the points of the process under investigation, it would be fundamentally antithetical to attempt to determine *a priori* whether and to what extent any given neuronal activity is functioning within its web of dense relations "iconically", "indexically", "symbolically", or — as is most likely — multiply and variously in the manifold of different spatio-temporal networks of which virtually every neuron is a part.

Situated within this web of neuronal interaction, the *relata* of semiotic interaction — as everywhere, are in no way ontologically "fixed" — icons, indices and symbols do not exist in neuronal semiosphere as entities *per se,* but only as any given instance of neuronal activity (whether in isolation or as part of a larger, transiently existing or stable configuration) is "taken" to be so through the *interpretant* (or significate effect) of its particular instantiation.

Thus, activity whose distal object might be some perturbation outside the body is, through the vehicle of the sensory sheet, interpreted as a sign *variously* (that is: iconically at one point, indexically at another, symbolically at yet another) throughout the resulting cascade of interneuronal activity. For "first of all and most radically, a sign is neither a thing nor an object but the pattern according to which things and objects interweave to make up the fabric of experience" (Deely 1990: 55).

The research on the neurobiology of vision discussed above demonstrates the validity of this neurosemiotic understanding most compellingly: the eye, like the entirety of the sensory sheet, is a *sign-vehicle,* the proper significate effect of whose cell by cell activity is not brute "interpretation" in the dyadic sense ($\exists$ x; x = y), but an entire cascade of top-down and bottom-up, context-dependant and context-creating semioses across levels of interpretative and meta-interpretative activity and systems.

"The object seen" (no less than the concept "the self") exists not as a unitary given "presented" to consciousness in the manner of computerized information exchange, but is instead a rich construction of internally biological, externally physical and historically situated, conceptually-mediated elements *none* of which enjoy a privileged or *autonomous* causality in structuring or determining the resultant symbol which is then "presented" "seen" or "brought to mind."

Biologically, then, objectification (and the "object world" which the activity of objectification brings forth) is thus a *product* of the processes of signification and not the other way around. Deely articulates this subtlety most incisively when he reminds us that "an organism does not deal with pure sensations, it deals with objects; and *objects are sensations organized according to the nature, wants, needs, and desires of the organism having the sensations*" (Deely 1999: 10, emphasis mine).

This object in Peircean terminology is the *immediate object* — "the Object as the sign itself represents it, and whose Being is thus dependent upon the representation of it in the sign" (CP 4.536) and is the built object of neuronal sign-exchange, providing "objects" (and therefore relata and future *grounds)* of semiosis for all of the internally sequestered processes of an inherently mediated and cloistered nervous system (processes including, but by no means limited to, symbolic "consciousness," "ideation" and "awareness" at its farthest upper reaches). It is related to its *dynamical object* — "which is the Reality which by some means contrives to determine the Sign to its Representation" (CP 4.536) — through its situation in the history of an organism's evolutionary and ontogenetic experience.

Brion (1999) captures the essence of the sign's relation to its dynamical object in terms that are deeply resonant with the research findings of evolutionary and developmental neurobiologists:

> Because the sign does not stand for the object 'in all respects', then the sign abstracts from the object. 'To abstract from', however, entails selection. Selection entails choice. Choice requires criteria of selection. Criteria of selection necessarily rest on values. That is, the relationship of the sign to the object is value-determined. Thus, the Ground carries out its function as the locus of [signification] — when it is suffused by — a set of values. (Brion 1999: 45)

Neurobiologically, these "values" — for survival and for thrival — operate as the biases and selection pressures driving neuronal organization (Damasio 1994; LeDoux 1996; Deacon 1997; Schumann 1997; Edelman, Tononi 2000). Such organization, in turn, constitutes the primary sign-exchanging network that not so much "links" — as makes semiotically continuous —the external and the internal milieus.

Thus, deep within the interactive tangles of the dense neuronal semiosphere, we can seen how the semiotic *object* of neuronal activity may be best understood not as some pre-given entity of the outside world miniaturized and made eternal by the video camera of experience, but "that specific item within its context to which all interpretants [or significate effects] of that sign are collaterally related" (Savan 1976: 16). With this notion in mind, and to gain a fuller appreciation of how a semiotic understanding of the mirror neuron research described above may fundamentally challenge our understanding of the nature of *intersubjectivity*, we must next turn to an examination of certain of the relations that these "built" objects can stand in through reference to their own activity as signs.

Constructing representema: The sign vehicle of the I

Theorists of the embodied mind (Varela *et al.* 1991; Allott 1992; McNeill 1992; Hutchins 1995; Armstrong *et al.* 1995; Clark 1996; Goodwin 1998) remind us that our biology crucially determines our way-of-being in a largely biological world. Our highest-order categories and concepts themselves, claim Lakoff and Johnson (1999), are but conflations of our sensorimotor experience, and because we as human beings are embodied the way we are, there are perceptual and conceptual categories that we must — and others that we may not — share with other each other and with other species. It is hardly controversial to assert, then, that perception and conception thus are inextricably and bidirectionally linked.

Moreover, human brains are remarkably unfinished creations at birth (Deacon 1997; Kendel *et al.* 2000) and among the perceptions which serve as input for our earliest conceptual schemata (and their attendant neuronal self-organization) are the ongoing symbolic interactions — what Bourdieu (1977) calls the *habitus* — of a reality which both begins as and which then artifactually reifies itself into a system of ever more generative signs. "By being included in the process of behavior," writes Vygotsky, "the psychological tool [which is the artifactual vehicle of the *sign*] alters the entire flow and structure of mental functions" (in Wertsch 1981: 137).

Taking it as axiomatic, then, that cultural transmission and genetic inheritance together orient the individual towards a cognition of negotiated meaning in an ecology of dialogic signs, we can situate the deeply internalized, seemingly ubiquitous concept of "self" as a product of the uppermost *symbol* level of our "biological inner semiosphere." This is a level which, by definition, includes and yet exceeds (in abstraction and in semiotic freedom) the supporting *iconic* and *indexical* levels of the never-ending sign-exchange activity mediating cell, brain, body and world.

Such activity and its resulting properties of causation are non-linearly interactive *across* levels of organization — and in their *interdependent* creation of the symbol known linguistically as the "self," the cultural sign-exchange and the biological sign-exchange exist in intimate symbiosis. "Self" is thus an emergent process of nested iconic, indexical and symbolic *localization:* it is the carving out of experiential boundaries inherent in the differential causalities of interaction — Bateson's "difference(s) that make a difference" — both on the level of cell network architectonics a well as on the level of what Terrence Deacon (1997) refers to as our *virtual* and *symbolic* selves.

For just as Zeki's (1993, 1999) vision studies indicate that our visual "representations" emerge as complex co-constructions of massively distributed, non-linear processes of interaction which culminate in — but in their constituent parts no way fully constitute — the experienced visual image, so too, does our far more semiotically sedimented sense of "self" emerge from constituent iconic, indexical and symbolic interactions none of which *alone* contain the full, rich sense of "self" so familiar to our symbolic consciousness. Precisely like a visual representation, this mental representation isn't "given" — it is built.

So, too, I will argue that in reference to the mirror neuron data, the richly constructed symbolic concepts of "self" *and* "other" in their fullest, subjective phenomenological senses *require* the full hierarchically referential complement of icon, index and symbol for their realizations, a complement which may be formalized ontologically as *being, relation* and *law.*

We have also seen that in order to determine what "kind" of sign any given neuronal sign activity constitutes, we need to ascertain how that neuronal activity *functions* as part of its particular representational process. I thus propose that on the neuronal level, as everywhere else, the *iconic* distinction — not necessarily between a fully semiosic "self" and "other," but simply between any given discrimination *being x* and *not being x* — underlies and supports all ascending distinctions, as more increasingly complex hierarchies of organization necessarily rely on preceding ones for their realization and support.

Like Heidegger's *Dasein,* however, the "what" (as opposed to the "that") of firstness is inaccessible and remains so until such time as it is brought into the system of relations capable of indexicalizing or symbolizing it — at which point, of course, it can no longer be apprehended "in itself" — which is simply to say "in isolation" from the referential system, the system of ongoing semiosis.

Similarly, I wish to argue, the fully seismosic "self" (the self that can know itself *as* "a self") is likewise inaccessible except through its realization in a vast web of living, semiotic interaction. Because the self is comprised of — and thus cannot exclude — the *being, relations and laws* of its own situational historicity, of its constitutive relations, and of its physical embodiment, these relations constitute the very vehicles by which experience of "the world" and experience of "the self" must be navigated and thereby known.

Self-representation — the representation of "a self" *to* a self, even before the further mediation of linguaform awareness — is accomplished through a massively collaborative interaction of sign-exchange across countless nodes of mediation between cell, brain, body and world. Neuronally, biologically and symbolically, "self" is therefore *cumulative*, not *primal* — an *achievement*, not a *given.* It is, at its utmost minimum, the mediation or bringing into relation of a sign (iconic self) with another sign ("indexical self") whose operation of semiosis upon it result in what Peirce calls the "mere vicinity" of the egocentric symbol "I" (CP 4.69).

Thus again do we find the 'objects' of the inner semiosphere to be a nexus of collaterally related interpretants, corresponding to what Edelman and Tononi (2000) regard on the neuronal level of organization as 'dynamic functional clusters'. Yet, this does not mean that the often maligned "first person view" that results is either an "illusion" or a category mistake. Rather, it is a *fact* of neuronal, biological and semiotic organization. As the philosopher Thomas Nagel (1986) so eloquently reminds us, there *is* a particular and singular, nonlinguistic perspective "from here".

What is important to remember, however, is that even our most seamless, immediate and apparently monolithic perspective is, in fact, a *built* perspective. For, just as on the symbolic level, dialogic relations of *action* ("x does y") and *interaction* ("x does y to z") characterize the long, post-natal process of human differentiation *and* individuation, so too on the upwardly organizing neural level, do specifically iconic patterns of neuronal activity (reflexes, fixed action patterns, selectively tuned single neuron response) become repeatedly associated in their co-occurrence with still other iconic patterns of neuronal activity, forming indexical relations which join these icons together into networks of functional relation (Pulvermuller 1999; Edelman, Tononi 2000; Llinas 2001), — the *lawfulness* of which forms the basis of proprioceptive "self-awareness" and ultimately of the symbolic order.

Neurosemiotically, the ceaseless interaction of these recursive iconic, indexical and symbolic levels of organization provide the substrate for the emergence of a meta-system propensity towards "thirdness" — a propensity which, in our species, finds its apogee in language and in the communal manipulation of publicly negotiated and therefore multiply perspectival signs. It is at this point in its organization that the internally "realized" self — what we now see as the fully *dynamic* and *triadic* self (both in its relations with others and in its relations with its own levels of organization) — comes into its own.

The proposal is thus made to consider the "self", both neurobiologically and in its semiotic multiplicity as a being that is simultaneously and interactively iconic, dialogic, and symbolic. I have argued that to equate the "self" as coterminous with biological proprioception, with the first-person perspective, or with a node in a social matrix is to impoverish the conception of "self" by several significant orders — for the self to *be* a self must be all of these at recursively at once and more. The full "self" as we understand it in our daily lives, is a dynamically determined self at every moment and the relations of which it is inextricably a part (itself, other, language) are likewise dynamically and perpetually co-construed. It is therefore as much a product of social interaction as of neurotransmission, for both the interpersonal and the extrapersonal aspects of this self are deeply rooted in a massively non-linear, re-entrant ecology of signs.

This is why, in undertaking the establishment of a discipline of neurosemiotic, it is all the more critical to distinguish the various levels of sign activity, lest we are misled, on the one hand, to positing an eliminativist reductionism that dismisses some of the most vital aspects of our being (such as 'self', 'consciousness' and 'intersubjectivity') as merely epiphenomenal or even downright illusory (a dismissal we may subsequently dismiss as "the illusion illusion" or "the fallacy fallacy") — or, on the other hand, to conflating what is proper only to the milieu of linguistic, socially mediated, symbolic interaction to the brute iconic and indexical significations taking place on the level of the somatic or neuronal cell.

Convergence versus emergence theories of intersubjectivity

Merleau-Ponty writes in *The Prose of the World*, "The spectacle begins to furnish itself a spectator who is not I but who is reproduced from me. How is it possible? How can I see something that begins to see?"

It would appear that in their conceptualization of the mirror neuron system as 'an observation/execution matching system," the majority of neuroscientists currently examining this phenomenon are indeed conflating iconic, indexical and symbolic levels of semiosis, inadvertently smuggling down onto the neuronal level processes proper to the cultural and the symbolic, or, conversely, reducing what should properly be understood as the *emergent* phenomenon of "intersubjectivity" down to the computational level of an internal asemiotic algorithm.

To take just two examples: Gallese and Goldman's (1996a) "mirror simulation theory" as well as Rizzolatti and Arbib's (1998) "primitive dialogue theory" advance the notion that "theory of mind" (i.e. — the recognition that the mentation of others is similar to, but distinct from, one's own) is instantiated by the mirror neuron system's *matching* one's own executed actions with the witnessed actions of another. Such "matching," whether in monkey or in human, is supposed to "automatically" result in the cognitive event articulable as: "Agent P's action is similar to mine, therefore Agent P and I are similar."

Leaving aside the homuncular problematic inherent in such asemiotic "matching" of a present and a non-present event (events of "witnessing" and "doing" which are, moreover, experientially disjunct), I maintain that such *convergence theories* of intersubjectivity assume the very higher-order relational and symbolic capabilities that the existence of the mirror system proposes to explain. Mutuality, under these conceptions, arises *after* enacted self-with-object interactions and observed other-with-object interactions have been syllogistically and symbolically compared.

For not only reasoning from syllogism, but even the very *ability* to put one's own experiences into such symbolic relations, I would argue, presupposes higher-order categorization and inferential abilities unlikely to be found at such an early order of neuronal organization. Rather, I will argue that the value of the selectively tuned, single neuron mirroring response to human cognition in general is the provision of a *neuronal iconic grounding* that is both organizationally prior to — and *mutual* to — the subsequent system representema of the fully semiosic "self" and "others."

In Figure 5, schematic (A) depicts the reasoning common to the *convergence theories* regarding the role of the mirror response in enabling intersubjectivity. Here, the physical similarity of neuronal response allows a comparative "matching" to take place whereby agents compare their own inner experiences of witnessing and of performing certain actions, and realize that these two inner experiences are similar. A preliminary computation (not shown) sets up the premises from which a subtractive deduction (in brackets) of phenomenological differences essentializes the relata into a comparison of the actions (A) of self (S) and other (O). This comparison is then syllogistically analyzed (for no other analysis would result in the desired outcome) and as a result of the analysis, the certain degree of similarity between self and other is experienced.

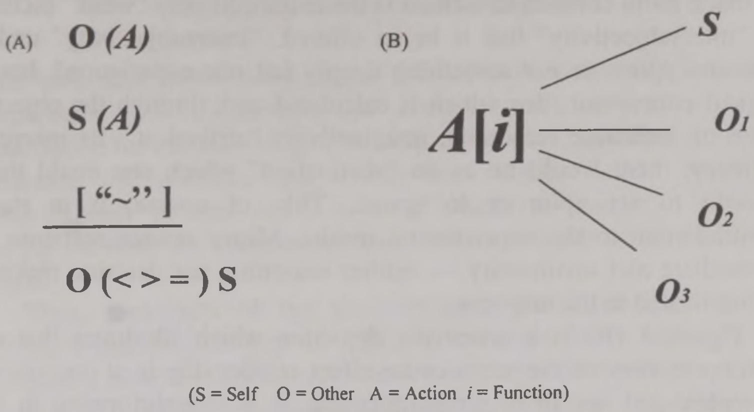

Figure 5. Convergent versus emergent theories regarding the role of mirror neuron response in enabling intersubjectivity.

The odd combination of computationalism and hidden anthropomorphism apparent in the above description is something that is not at all uncommon in contemporary neuroscientific conjectures regarding the manner in which mental events come to be experienced.[7] What is

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[7] Thus, while present considerations of space and scope force me to limit the discussion of the rest of this paper to a consideration of how the iconic function of the mirror neuron tuned response to specific interaction *per se* (that is, without consideration as to the identity of the agent of such interaction) may underlie our most symbolic concepts of "self" "empathy" "intersubjectivity" and "other minds", correspondingly 'intractable' problems regarding secondness and thirdness that plague traditional discussions in the literature of cognitive neuroscience will obviously benefit by the application of a Peircean neurosemiotic, as well.

Secondness and relations of indexicality appear to underlie the so-called 'binding problem' (the question, briefly, of why the red is never dissociable from the apple on which it appears), while it is precisely the thirdness of symbols which accounts for the so-called 'hard problem' of consciousness, which is no more than the 'problem' of how a world of iconic and indexical relations ('neuronal activity' in the degenerate information processing sense) could ever result in a world of rich, phenomenological, subjective experience.

Needless to say, I will be addressing these very two complex and demanding issues explicitly in the future. For the purposes of this article, however, it suffices for me to draw the distinction between iconic, self-exhaustive relationships that I believe characterize selectively tuned neuronal response (such as found in mirror neurons) and the kind of "yet computational" view of neuronal activity whereby the activity *itself* is of much more concern to us here is the extraordinarily "weak" picture of "intersubjectivity" that is being offered. "Intersubjectivity" under this conception is *not* something deeply felt nor experienced, but a logical *concept* or *idea* which is calculated and, through the objectivism of deductive reasoning, imaginatively "arrived at." Its inherent efficacy, then, would be as an "abstraction" which one could then choose to act upon or to ignore. This, of course, is in stark contradiction to the experimental results. Mirror neuron response is immediate and involuntary — neither reasoning nor decision making is implicated in the response.

Figure 5 (B) is a schematic depiction which illustrates that an *emergent* view of the same cause-effect relationship is at once more complex and yet more straightforward. It is straightforward in its insistence that the iconic recognition of "Action A" (or, indeed, of any selective and exclusively "tuned" response) is stable, immediate and primary and does *not* need to be calculated through a logic of deductive reasoning to be "arrived at" — rather, in its function *as* an icon, it is the very *ground* upon which calculations and logical reasoning are enabled to take place, via its provision of a consistently bounded *relatum.* It is more complex in its insistence of multiply additional layers of sedimentary semiosis before the subsequently emergent relata of "self" and "other" are robust enough to be so distinguished (i.e. — to function in further instances of semiosis as icons of their own).

Following these distinctions to their logical conclusions throws into sharp relief the differences between a neuroscience that is semiotically conceived and one that is not. Let us expand upon these last two points, then, by way of our conclusion, in order to more explicitly illustrate how a *neurosemiotic* conception of "self and other" "iconicity" and "intersubjectivity" may fundamentally transform our present understanding of phenomena such as mirror neuron activity as well as to open up future neuroscientific research agendas in directions yet precluded by an intransigently asemiotic conception of the relationship between neuronal sign-exchange and the activity of an embodied yet symbolic mind.

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not seen as an organic, living system but as lifeless engineering-variety "information" which a larger living system *uses* to, paradoxically, "know" itself and its world.

Iconicity in the tuned response

We have seen how on the neural level, iconicity is "built" through experience both evolutionary and ontogenetically and provides the foundation for the massively re-entrant cascades of still further iconic, indexical and symbolic sign activity that virtually define "mind" in both its most "private" and in its most "distributed" sense — which is to say, in both the subpersonal and in the extra-personal ecology of signs.

Thus, regardless of the surrounding ("upstream" and "downstream") neuronal activity of which it is necessarily a part, we can justifiably establish selectively tuned single neuron response — such as evident in face recognition and in the mirror neuron response — as a ground for *iconic* activity in the Peircean sense of firstness, that *one place predicate* or 'raw qualitative experience' which delineates its object *as* that object (and no other) and which, upon being brought into relation with any other than itself, provides the polarity and brute relata whereby indexical relations (and, ultimately, symbolic relations of thirdness) can then take place.[8]

"Anything whatever", Peirce reminds us, " be it quality, existent, individual or law, is an Icon of anything, in so far as it is like that thing and used as a sign of it" (CP 2.247).

For *iconicity,* "is not based on some prior ground of physical similarity [i.e. — it is not a *matching* relation], but in that aspect of the interpretation process that does not differ from some other interpretive process…it is the base on which all other forms of representation are built [and] the bottom of the interpretive hierarchy" (Deacon 1997: 76).

Taborsky (2001) refines this subtle distinction even further when she writes: "This first state of being is not non-relational, but is rather,

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[8] Note that in our discussion of iconicity, we are not positing the *primal* experiential iconic relationships of the neuronal system, which must have certainly happened at — and indeed, what must have engendered — the earliest points of its own prehistorically semiotic development, but icons (and indices and symbols) that are functioning *as such* in the particular instances of semiosis under investigation. Thus, the fact that the iconic response selective to "x and only x" at the site of the "tuned" single neuron may itself be the result of local iconic, indexical and even symbolic relational activity "upstream" (as, in fact, is both concluded by the neurobiological research *and* predicted by the semiotic of Peirce) in no way changes nor diminishes its function as an icon upon which further semiosis may then legitimately take place.

the state of being-in-a-relation without the capacity to refer to that relation. It is completely internal and is "present, being such as it is, while utterly ignoring everything else, is positively such as it is (CP 5.44)" (Taborsky 2001: 5). It is precisely this iconic firstness of selectively tuned, mirror neuron response that provides the ground for the subsequent *hypostatic abstraction* (of "self" and "other" upon the ground of mutually selfless and otherless action *qua* action iconicity) to take place.

Because mirror neurons distinguish action succinctly but agency not at all, the neurally primitive experience instantiated by either the execution of an action by oneself or the observation of that same action by another *functions iconically* within the context of the neuronal semiosphere, and is represented congruently in the mirror neuron system as simply the presence of a specific action, A. Iconically, A thus *equals* A [*i*] (that is: A *is* A for all and any agents) *prior* to the later integration of *indexical somatic representations* into the still larger *symbolic* organization of "consciousness" and "self".

Construed thusly, *being* — that A *is* and therefore cannot not be — is mutual across agency *before* the ontogenesis of a linguistic and biologically higher-order "self". Differentiation between $A_{[s]}$ and $A_{[o]}$ comes both logically and organizationally later under this hypothesis, for as is almost certainly the case in the many hard-wired reflexes in humans and in other animals — evolution builds in a good many automatic response systems to ensure that a necessary-for-survival strategy is faithfully and unerringly passed on.

Mirror neuron research, rightly construed, demonstrates that not only language, but also *actions themselves* constitute a "public" domain upon which and out of which the "subject self" is at least partially constructed. Thus, there is no fully cognized "*self*" to speak of that does not take the actions of others as the fabric from which itself is weaved. Indeed, Pierce reminds us that to maintain that "I am altogether myself and not at all you" constitutes a "metaphysics of wickedness" (CP 7.570). "Others" are in a sense *in* us and in our actions from the start.

The neurosemiotic emergence of self *from* other

For the majority of theorists working in the field traditionally conceived cognitive neuroscience, however, the notion that the human "subject" is *not* coterminous with biological individuality and that "neither selves nor neighborselves [are] anything more than mere vicinities"(CP 4.69) may be seen as heresy at best and utter lunacy at worst. Yet from a neurosemiotic standpoint, this assertion is unsensational.

"Immediate feeling is the consciousness of the first; the polar sense is the consciousness of the second; and synthetical consciousness is the consciousness of a third or medium," writes Peirce (CP 1.382). But it is important to distinguish here between the polar *sense* — "something that cannot properly be conceived…for conceive it is to generalize [and therefore] is to miss altogether the hereness and nowness which is its essence" (CP 8.267) — and the fully semiosic relata of the symbolic "self" and "other".

The dialogic and triadic nature of our upwardly organizing self, we have seen, allows our organism to literally construct (realize) a "self" that is made at least partly out of the internalized actions of others — actions which are internalized on the neuronal level via mirror system interactions, the nature of which are *intersubjective* by definition, as part of what mirror neuron pioneer Vittorio Gallese (2001) calls our "subpersonal architecture".

"Self" and "other", in the final analysis, are sign relations that *actively* construe *each other*. And thus the argument is made from a neurosemiotic standpoint that the most significant contribution of the mirror neuron system to human cognition is *not* the "reasoning," dualistic conceptual orientation that representation is mutual *between* agents — "my representation of x and your representation of x occur similarly in both of us, therefore you and I are similar" — but, rather, the inherently neurosemiotic orientation that intersubjectivity — *mutuality* itself — is an *iconic,* and therefore in some sense *a-priori* property of representational experience *within* agents — whereby "my existential and iconic experience of *x* is mutual to both my symbolically integrated experience of myself and to my symbolically integrated of you".

The *sameness* of "self" and "other" here is quantitative (the same one) rather than just qualitative (the same as). Empathy and self-preservation are thus deeply, inextricably, biologically bound. And in this we might reflect at last that in our capacity as sign-using creatures, we don't primarily reason *to* "intersubjectivity" — but rather (as the history of our species all too often attests) — "reason" may be one of the strategies by which we move *away* from it. For at the mirror neuron level of organization, the distinction between seer and doer, action and reaction, identity and alterity is — like the "reflection" one finds oneself presented with in front of a full length mirror — a distinction which is impossible to maintain. Witnessing and performing, "self" and "other", are thus not higher-order behaviors which *converge upon* the organizationally primitive and biosemiotically prior mirror system — rather, they are but two of the results, products and "proper significate effects" which ultimately *emerge from* it.

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По ту сторону своего и чужого: нейросемиотическое проявление интерсубъективности

Хотя нейробиология, когнитивные науки и “исследования разума” в течении последних двух десятилетий бурно развивались, до сих пор это не сопровождалось таким же развитием в области семиотического понимания исследуемых явлений. До сих пор неизвестно, каким образом

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[10] Available: http://www.library.utoronto.ca/see/SEED/Vol1-1/Taborsky-Journal1.html.

знаковые связи на уровне нейронов воздействуют в более широкой сети психологически более доступных знаковых связей. Данная статья пытается очертить возможности подобного подхода именно к нейросемиотике. В качестве пробного материала и точки отправления используются последние открытия в нейробиологии: визульно-моторные переходы и ответные реакции отдельных селективно настроенных нейронов. С этой позиции по поводу “интерсубъективности” утверждается, что *ens rationis* проявляется как функция нейро-семиосферы, которая может абстрагироваться, конструироваться и взаимно делиться между агентами.

Teispool oma ja võõrast: intersubjektiivsuse neurosemiootiline ilmumine

Nagu üldteada, pole närviteaduse, kognitiivse teaduse ja “teadvusuuringute” plahvatusliku arenguga kahe viimase kümnendi jooksul siiski tänini kaasnenud samasugust arengut nende valdkondade poolt uuritavate nähtuste semiootilisel mõistmisel. Senini pole teada, kuidas märgiseosed neuronite tasandil saavad toimida psühholoogiliselt ligipääsetavate märgiseoste laiemas võrgustikus. Käesolev artikkel püüab olla esialgseks lähenemiseks just säärasele *neurosemiootikale*. Oma proovimaterjali ja lähtepunktina kasutame viimaseid avastusi neurobioloogiliste uuringute vallas: visuaal-motoorseid üleminekuid ja üksikneuronite valikuliselt häälestatud vastusreaktsioone, mis on laialtlevinud kortikaalseks nähtuseks. Sellelt lähtekohalt väidetakse “intersubjektiivsuse” kohta, et *ens rationis* ilmub kui neuraalse semiosfääri funktsioon, mis saab abstraheeruda, konstrueeruda ja toimurite vahel vastastikku jaotuda.

Sign Systems Studies 30.1, 2002

On the epigenesis of meaning in robots and organisms: Could a humanoid robot develop a human(oid) Umwelt?

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Abstract. This paper discusses recent research on humanoid robots and thought experiments addressing the question to what degree such robots could be expected to develop human-like cognition, if rather than being pre-programmed they were made to learn from the interaction with their physical and social environment like human infants. A question of particular interest, from both a semiotic and a cognitive scientific perspective, is whether or not such robots could develop an experiential Umwelt, i.e. could the sign processes they are involved in become intrinsically meaningful to themselves? Arguments for and against the possibility of phenomenal artificial minds of different forms are discussed, and it is concluded that humanoid robotics still has to be considered "weak" rather than "strong AI", i.e. it deals with models of mind rather than actual minds.

Even readers with no interest whatsoever in the scientific and philosophical study of artificial intelligence (AI) might have noticed the following: Back in 1968, in Stanley Kubrick's movie *2001 — A space odyssey*, it was the spaceship's board *computer* HAL whose intelligence exceeded by far that of his human collaborators. Now that we have actually reached the year 2001 the appearance of AI in popular culture has taken a significantly different shape. In Steven Spielberg's recent movie *A. I.* (based on a treatment of Stanley Kubrick, who died before he could produce the movie himself), it is the humanoid *robot* David, looking very much like any ordinary little boy, who exhibits not only human-level intelligence, but also develops human feelings (or at least convincingly appears to do so).

Obviously there is a huge gap here between the science fiction and the actual science facts. Neither computers like HAL nor robots like David have been built or could be built within the foreseeable future. Nevertheless it might be worth pointing out a couple of parallels to actual AI research. From its inception in the mid-1950s AI, as well as the rest of the cognitive sciences, was dominated by the so-called *computer metaphor for mind*, which stated that cognition is computation and the relation between mind and brain/body the same as between computer software and hardware. Accordingly, an understanding of mind was sought not at the level of the body, which was considered just an implementation — which happens to be carbon-based in the case of humans, but could as well be silicon-based in the case of computers — but at the level of implementation-independent representations and algorithms. That means, given the right program, i.e. the program used by the human mind, a computer like HAL could indeed have a human mind.

This view has been strongly contradicted by, among others, Searle (1980) who in his famous *Chinese Room Argument* compared a computer's processing of internal symbols/representations to a non-Chinese-speaking man's processing of Chinese symbols according to formal rules without grasping any of the semantics. In both cases, Searle argued, the symbol processing might very well be meaningful to observers, but it cannot possibly be or become intrinsically meaningful to the processor itself. Hence, computers might very well be powerful tools in the study of cognition, a position Searle referred to as *weak AI*, but they could not be actual minds themselves, a position he referred to as *strong AI*. Searle (1980) did, however, not conclude that strong AI in general, i.e. the building of artificial minds, was impossible, but only that computer programs are the wrong approach due the fact that they lack a number of "causal powers", including *perception*, *action* and *learning*.

Since the late 1980s increasingly many cognitive scientists, to some degree following Searle's ideas, have emphasized the importance of "embodiment" and "situatedness", i.e. interaction of cognitive agents with their environments (e.g. Varela *et al.* 1991; Clark 1997;

Clancey 1997; Pfeifer, Scheier 1999). AI has been one of the driving forces in this development, shifting much interest from computers to robots or so-called *autonomous agents*, and from the study of internal knowledge representation to sensorimotor processes and the way they shape cognition. One of the insights gained (or regained) was that the mind is in fact not largely independent of the body, but in fact strongly determined by it. Not surprisingly, Uexküll's concepts of *Umwelt* and *Merkwelt* have been adopted by a number of AI researchers and cognitive scientists (e.g., Brooks 1986, 1991; Prem 1996, 1997, 1998; Clark 1997; Sharkey, Ziemke 1998; Ziemke, Sharkey 2001; Ziemke 2001). Brooks (1991), for example, writes: "as von Uexküll and others have pointed out, each animal species, and clearly each robot species with its own distinctly nonhuman sensor suites, will have its own different Merkwelt". For AI research striving to model human intelligence this has radical consequences: Clearly, if cognition is dependent on body and sensorimotor capacities, then the only way to achieve or study human-level or human-like intelligence in artefacts is to equip them with human-like bodies and sensorimotor capacities, i.e. to build *humanoid robots*.

There are by now a number of projects which have taken this approach, such as Brooks' well-known *Cog* project (Brooks *et al.* 1998) or Kozima's *Infanoid* project (e.g. Kozima, Yano 2001). Both Cog and the Infanoid are upper-torso humanoids, i.e. roughly human-size robotic torsos equipped with stereo-vision heads, arms and hands with degrees of freedom roughly similar to those of human bodies. However, obviously this only solves part of the problem. Even if a (human-like) body nowadays by many is considered a *necessary* condition for a (human-like) mind, it could hardly be a *sufficient* one. The remaining question is, roughly speaking, how to get a mind "into" the body. Both of the above projects aim to let their robots undergo some kind of *artificial ontogenesis* in physical and social interaction with their environment. Both also particularly emphasize the interaction with human caregivers, based on theories of social learning in infants (e.g., Vygotsky 1978; Tomasello 1999). That means, Cog and Infanoid are supposed to acquire or develop sensorimotor and cognitive capacities, and ultimately a mind, in some kind of long-term interaction similar to the ontogenesis of human children (note, however, that it is only the software, not the hardware/body, which develops). Taking this approach to the extreme, one might argue like

Zlatev (2001: 155) that such "robotogenesis could possibly recapitulate [human] ontogenesis, leading to the emergence of intentionality, consciousness and meaning" in robots.

The question whether or not a (humanoid) robot could indeed develop/have a (human-like) mind, including a (human-like) phenomenal Umwelt, has recently occupied a number of researchers in cognitive science and semiotics (e.g., Emmeche 2001; Nöth 2001; Sharkey, Ziemke 1998; Ziemke, Sharkey 2001; Ziemke 2001; Zlatev 2001). The question what exactly the semiotic status of such a robot would be apparently has no simple answer. Traditionally, semiosis has often been considered to necessarily involve living organisms. Morris (1946), for example, defined semiosis as "a sign-process, that is, a process in which something is a sign to some organism". Similarly, Jakob von Uexküll considered signs to be "of prime importance in all aspects of life processes" (T. von Uexküll 1992), and made a clear distinction between organisms, which as *autonomous subjects* respond to signs according to their own *specific energy*, and inorganic mechanisms which are *heteronomous* (cf. Nöth 2001; Ziemke, Sharkey 2001).

Nowadays, the distinction between organisms and mechanisms seems less clear. Computers are commonly considered to be at least involved in semiotic processes. Sebeok, for example, writes (in personal communication cited by T. von Uexküll 1982) that "the criterial feature of living entities, and of machines programmed by humans, is semiosis". Andersen *et al.* (1997) have argued in detail that computers/programs, when it comes to semiosis, fall somewhere in between humans and conventional mechanisms, but that they ultimately derive their semiotic "capacities" from the interpretation of their designers and users. The major difference, they argued, was that living systems are autopoietic, i.e. self-creating and -maintaining, whereas machines are not (cf. Nöth 2001; Ziemke, Sharkey 2001). Hence, their "tentative conclusion" was that "the difference between human and machine semiosis may not reside in the particular nature of any of them. Rather, it may consist in the condition that *machine semiosis presupposes human semiosis and the genesis of the former can be explained by the latter*" (Andersen *et al.* 1997: 569, emphasis added). Similarly, Nöth concluded his discussion of whether or not robots have an *Umwelt* as follows:

> Needless to say, a machine, in spite of a certain autonomy in its agency, can never be said to have its ultimate goal within itself. The objectives of a machine have always been established from outside, namely by the engineer who designed it and the user who switches it on and off. Thus, the robot's ultimate framework of reference, its final causality, is elsewhere, and thus the resulting semiotic process is alloreferential. (Nöth 2001: 696–697)

However, many would argue that in the case of robots which self-organize and develop in long-term interaction with their environment, independent of their human designers, it is simply not the case that the genesis of robosemiosis can be (fully) explained with reference to human semiosis. The "problem" that makes it difficult, at least at a first glance, to make a sharp distinction between living organisms and today's adaptive robots (also commonly referred to as *artificial life*), is that the latter nowadays have a number of the qualities/properties of the former. Ziemke and Sharkey (2001), for example, discussed in detail that three properties which Jakob von Uexküll (1928, 1982) considered unique for organisms (adaptation/growth, use of signs, centrifugal construction) can to some degree also be found in today's robots. Similarly, Nöth (2001: 695–696) identified "four reasons why robots interact in the same way with their environment as organisms do" which "support the argument that not only organisms, but also robots have an Umwelt in [von] Uexküll's sense": (a) both robots and organisms have an Umwelt (or in fact Merkwelt) in the sense that, limited by available senses/sensors, they can only sense part of their physical environment; (b) both process environmental stimuli selectively; (c) both can have "internal representations of their Umwelt"; (d) both are equipped with perceptual organs/modules and effector organs/modules.

Given these similarities between robots and organisms, arguments for the possibility of robot minds cannot easily be dismissed. Zlatev, for example, sees "no good reason to assume that intentionality is an exclusively biological property [...] and thus a robot with bodily structures, interaction patterns and development similar to those of human beings would constitute a system possibly capable of meaning" (Zlatev 2001: 155). In more detail, Zlatev's elaborate proposal for the development of a robot mind[1] is based on the following cornerstones:

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[1] It should be noted that this proposal is fairly similar to the ideas underlying both Infanoid and Cog project.

> (*) sociocultural situatedness: the ability to engage in acts of communication and participate in social practices and 'language games' within a community;
> (*) naturalistic embodiment: the possession of bodily structures giving adequate causal support for the above, e.g. organs of perception and motor activity, systems of motivation, memory and learning; [...]
> (*) epigenetic development: the development of physical, social, linguistic skills along a progression of levels so that level n+1 competence results from level n competence coupled with the physical and social environment. (Zlatev 2001: 161)

In the case of a robot that actually fulfilled all of the above criteria it might indeed be difficult to justify why exactly it should not be considered to have a human-like mind and Umwelt. It might very well pass what Harnad (1989, 1990) called the *Total Turing Test*, i.e. its behavior, including both symbolic capacities (as tested in the original, purely language-based Turing test) as well robotic, i.e. sensorimotor, capacities, might become indistinguishable from that of a human. Nevertheless, according to Nöth (2001), it is just a man-made machine, lacking own goals and thus only capable of "alloreferential" semiotic processes (cf. above quote). Nöth's argument, as well as our own arguments coming to similar conclusions (Sharkey, Ziemke 1998; Ziemke, Sharkey 2001; Ziemke 2001), might seem counterintuitive, as can be demonstrated with the following thought experiment (in fact an extension of Zlatev's (2001) thought experiment). Let us assume you buy some future version of Cog or Infanoid, now equipped with legs, etc., so it does actually look like a child (perhaps even as much as Spielberg's fictitious humanoid David). Let us further assume that the robot learns, e.g., through language games (cf. Zlatev 2001) to refer to your family, your dog and objects in your house by their proper names. Could we really say, as Nöth (cf. above quote) seems to argue, that its language use and all other semiotic processes are *alloreferential*, i.e. the words have no intrinsic meaning to the robot itself, but they are only meaningful to you and your family? What if the robot, unknown to you, played with the neighbor's children and learned new words and phrases from them, or possibly even went to school? Finally, what if eventually it could pass the Total Turing Test? Is there really any good reason to assume that such a robot should not be able to develop own intentionality and intrinsic meaning?

Well, there are in fact a couple of good reasons, and here are some of them. Firstly, although the above robot seems to possess at least some form of the "causal powers" that Searle (1980) pointed out as missing in computer programs (cf. above), i.e. perception, action and learning, the Chinese Room Argument (CRA) still applies to it. As Cog and Infanoid (cf. above), the robot consists of hardware and software. It has a physical body and a computer program, or perhaps a number of programs, controlling it. Each of these programs is of exactly the type Searle (1980) argued to be incapable of intentionality due to their computational nature,[2] and their embedding in a robot (the so-called *robot reply*) is exactly what he rejected as making no difference whatsoever. It should, however, be pointed out that, of course, not everybody agrees with Searle in this point (see, e.g., Harnad 1990; Zlatev 2001).

Secondly, despite a certain convergence of science fiction and philosophical thought experiments, it should be pointed out that the above is indeed just a thought experiment. Its technical feasibility does in fact seem more than questionable. The idea that a humanoid robot could develop a human mind and Umwelt, just because its body is to *some* degree human-like and thus might be able to, e.g., receive similar visual input and have similar possibilities of, e.g., manually grasping objects, seems to reduce the body to some kind of input-output interface to the world. Robot bodies are, however, in many ways extremely different from living bodies, in particular human bodies, and thus unlikely candidates for supporting the same kind of phenomenal mind/Umwelt. In particular, robot bodies (hardware) and control systems (software) are not at all integrated the way living bodies are. Robot bodies do, for example, not grow. Furthermore, Ziemke and Sharkey (2001) argued in detail that robots lack *endosemiosis* and therefore also lack what T. von Uexküll *et al.* (1993) referred to as the *neural counterbody*, formed and updated in our brain as a result of the continual information flow of proprioceptive signs from the muscles, joints and other parts of our limbs, and thus giving rise to the experience of the living body as the center of our subjective reality. That means, even if you believe that such a humanoid was capable of exhibiting human-like behavior and having *a* phenomenal

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[2] As pointed out by Searle (1990), this includes connectionist/neural networks.

Umwelt, exactly what reasons are there to believe that the Umwelt *would* be human-like?[3]

Does this mean that artificial minds (in the strong sense) are impossible? Of course it does not. Our conclusion from the first above argument is just like that of Searle (1980), that AI might very well be possible, but not with central cognitive processes implemented as computer programs, i.e. purely formally defined systems. The conclusion from the second above argument is that, taking embodiment seriously, and taking the bodily differences seriously, (a) humanoids are due to the lack of integration between body and software unlikely to be able to exhibit human-like behavior, and (b) even if they could, they would still be unlikely to do so with a human-like mind.

As discussed in detail elsewhere (Sharkey, Ziemke 1998, 2001; Ziemke, Sharkey 2001; Ziemke 1999, 2001), we believe that the key to understanding mind is to understand the *autonomous* and *autopoietic*, i.e. self-creating and -maintaining, nature of living systems (Maturana, Varela 1980). Autopoietic systems have a natural (rather than a metaphysical) kind of intentionality or aboutness in the sense that they are autonomous unities concerned with assimilation/dissimilation of material from/into their environment for the purpose of self-maintenance and survival. Living systems are also far more integrated than the above humanoids in the sense that their ontogenesis does in fact start from a single cell from which they grow in a centrifugal fashion (Uexküll 1982; cf. Ziemke, Sharkey 2001; Ziemke 2001). Hence, a more natural route towards artificial minds would be the attempt to create artificial autopoietic systems (cf. also Boden 1999). This would be very unlikely to result in systems even remotely similar to humans, but it would avoid the somewhat dualist/functionalist approach of building a hardware body and then trying to make it develop a software mind.

In sum, it has been argued here that robots, as long as they are allopoietic machines consisting of “dead” hardware bodies and computational control programs, will not be able to develop intrinsic meaning or autonomy by means of some kind of artificial ontogenesis as envisioned by Zlatev (2001). The sign processes embedding living systems into their environment, on the other hand, as well as their

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[3] Elsewhere we have discussed in detail the relation to the case of Clever Hans (Sharkey, Ziemke 2001).

ontogenetic development, are intrinsically meaningful to themselves due to their autopoietic, self-creating and -maintaining nature.[4]

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О эпигенезе у роботов и организмов: может ли у человекоподобного робота развиться человекоподобный Umwelt?

Статья рассматривает новейшие исследования, связанные с человекоподобными роботами, и мыслительные эксперименты, занимающиеся вопросом, до какой степени у подобных роботов может развиться человекопободное сознание, если вместо запрограммированности начинать их обучать как детей, посредством общения со своей физической и социальной средой. Особенно интересен вопрос (как в семиотической так и когнитивно-научной перспективе), может ли таким образом у роботов выработаться основанный на опыте Umwelt, т.е. могут ли знаковые процессы, в которых они участвуют, стать внутренне значимыми для них самих? Рассматриваются аргументы как за, так и против возможности разных форм искусственного интеллекта и делается вывод, что область человекоподобных роботов нужно считать скорее “слабым” чем “сильным искусственным интеллектом”.

Tähenduse epigeneesist robotitel ja organismidel: kas inimsarnasel robotil võiks areneda inim(sarnane)-omailm?

Käesolev artikkel käsitleb uuemaid uurimusi inimsarnaste robotite vallas ning mõtte-eksperimente, mis tegelevad küsimusega, mil määral seesugustel roboteil võiks eeldatavasti areneda inimsarnane teadvus, kui ette programmeerituse asemel panna nad õppima — suhtlemise kaudu oma füüsilise ja sotsiaalse keskkonnaga, nagu inimlapsed. Iseäranis huvipakkuv küsimus (nii semiootilisest kui ka kognitiivteaduslikust perspektiivist) on, kas seesugustel roboteil võiks areneda kogemuslik omailm, s.t kas märgiprotsessid, milles nad osalevad, võiksid saada neile enestele sisemiselt tähenduslikuks? Käsitletakse nii poolt- kui vastuargumente tehisvaimu erinevate vormide võimalikkuse suhtes ning järeldatakse, et inimsarnaste robotite valdkonda tuleks pigem pidada “nõrgaks” kui “tugevaks tehisintellektiks”.

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Intrasemiotics and cybersemiotics

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Abstract. The concept of intrasemiotics designates the semiosis of the interpenetration between the biological and psychological autopoietic systems as Luhmann defines them in his theory. Combining a Peircian concept of semiosis with Luhmann's theory in the framework of biosemiotics makes it possible for us to view the interplay of mind and body as a sign play. The recently suggested term 'sign play' pertains to ecosemiotics processes between animals of the same species stretching Wittgenstein's language concept into the animal world of signs. With intrasemiotics there is an inner interplay. Lorenz in ethology has used the concept of motivation, and Uexküll the concept of tone, mostly describing the outgoing effect on perception and the reactions on perception. One could view intrasemiotics as the interplay between Lorenz' biologically defined motivations and Freud's Id, understood as the psychological aspect of many of the natural drives. In the last years of development of his theory Lorenz studied how emotional feedback can introduce just a little learning through pleasurable feelings also into the instinctive systems because, as he reasoned, there must be some kind of reward going through instinctive movements, thus making the appetitive searching behaviour for sign stimuli possible. But he never found an acceptable way of modelling motivation in biological science. A cybersemiotic model may combine these approaches, defining various concepts of thoughtsemiotics, phenosemiotic and intrasemiotics, combining them with the already known concepts of exosemiotics, ecosemiotics, endosemiotics to an approach which studies the self-organising semiotic processes in living systems.

Introduction[1]

Peircian semiotics is specific from other semiotic paradigms in that it not only deals with intentional signs of communication but also encompasses non-intentional signs such as symptoms of the body and patterns of in-animate nature. Peircian semiotics breaks with the traditional dualistic epistemological problem of first order science by framing its basic concept of cognition, s*ignification,* on a triadic semiotic philosophy. The triadic semiotics is integrated with a theory of continuity between mind and matter (*synechism*) where the basic three categories (*Firstness, Secondness,* and *Thirdness*) are not only inside the perceivers mind, but also in the nature perceived. This is connected to the second important ontological belief in Peirce's philosophy, namely *tychism* that sees chance or chaos as a basic characteristic of Firstness. This is finally combined with an evolutionary theory of mind (*agapism*) where mind has a tendency to take habits in nature. Chaos or chance is seen as a First, which is not to be explained further (for instance by regularities). It is the basis of habit taking and evolution. The chaos of Firstness is not seen as the lack of law as in mechanicism and rationalism, but as something full of potential qualities to be manifested individually in Secondness and as general habits and knowledge in the dynamic objects and semiosis in Thirdness (Peirce 1992). This is the deep foundation of Peirce's pragmatism. As a result of the initiative of Thomas Sebeok in biosemiotics, Peirce's semiotics is now interpreted as covering all living signifying systems. Cybersemiotics is seen as a generalisation of biosemiotics using, among others, Niklas Luhmann's work for further development.

Luhmann's triadic autopoietic systems

Luhmann has generalised the autopoietic concept of Maturana and Varela (1980) to also comprise psychological thinking systems and socio-communicative systems. He views psyche as a silent inner

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[1] The present article sums up and develops the ideas published in recent works (Brier 2001b, 2001c), and combines these with a motivational theory of Brier (2000). Further, a visual model of the theory, inspired by Hermann Hesse's *The Glass Bead Game*, is developed, combining writing and symbolic visualisation to create a condensed expression of the theory.

system, a closed system of perception, emotions and volitions. A special linguistic system has to be created for communication to happen. Communication is again an organisationally closed system: only communication communicates. Social systems are communicative systems with human bodies and minds as surroundings.

To Luhmann (1995), communication is a sequence of selections, namely of (1) information, (2) utterance, and (3) meaning. The two first have to be made by what we traditionally call 'the sender', the last one by the receiver. The receiver chooses the understanding of the signs produced, and then one could say that a message is produced when the receiver says something that the sender chooses to understand as a confirmation of understanding of the intention of the sender's first message. Finally, in a fourth selection the message is connected to present practice.

Although his view of information is partly based on Shannon's concept, it differs from it in that Luhmann does not believe in its use outside human social communication. The information concept functions as a quantitative aspect within a meaningful human context. Further he combines the information with the aspect of utterance and meaning. Luhmann stresses that both the sender and the receiver have to make their choices to produce a meaningful message. Information is choices related to subject matter, utterance is choices pertaining to the way to say something, and meaning is the choices of interpretation of the listener of the human context. It is especially in the social communicative construction of meaning that Luhmann's theory connects to semiotics. In the following I will reformulate it from a cybersemiotic viewpoint.

The cybersemiotic view

One way to understand our inner mental world is to see it as a way of representing our bodily interactions with the environment through the constructions of a felt signification sphere. In this way, an individual "point of view" as a center of cognition, interest, and interpretation is created. What Spinoza calls conatus, self-value and self-interest in preserving the individual's and species' self-organizing structure, is basic to living systems' ability to signify. But this individual signification sphere is again perturbed by the species specific social interactions starting with mating, rearing of the young, competition for hunting territory, hierarchy in the group, co-operation in food gathering and hunting. These social interactive activities first generate sign games and, later in evolution, in humans, language games.

The construction or development of meaningful and informative messages has as a prerequisite autopoiesis, signification and conatus/motivation/intentionality. It is only within this triad that the selections of information, utterance, and meaning are possible. I think that Luhmann's theory has problems producing a concept of meaning that relates deeply to the flesh, blood, and life (conditions) of biological systems and to the existential conditions of human consciousness. Here, pragmatic language philosophy, like Wittgenstein's language game theory and Lakoff and Johnson's embodied cognitive semantics as combined with ethology, all seen within Peirce's semantic framework (Brier 2000), tell us that signs as concepts and classifications arise in our embodied biological and social "life forms". From our inner world we express our bodily experiences in social relations.

Viewed in this way, Luhmann's (1990) three autopoietic systems are all needed to create meaning of a message and one needs the sign concept to understand their interaction. One way of getting out of the impasse of Luhmann's functionalism, where the role of body and mind in the production and meaning of social communication has not been adequately grasped by theory, is to view the interpenetration between the three organizationally closed systems semiotically. Signs acquire meaning where the systems interpenetrate. Interpenetration is Luhmann's term for the interplay between the biological autopoiesis, the psychic closure and the socio-communicative system with its own closure at the social level. We can conclude that *sign and language games arise on the basis of the interpenetration of the autopoietic systems.*

Meaning is then seen as generated by the interpenetration of the systems. For example, language is a part of the socio-communicative system, but it does not really get a meaning before it interpenetrates with psychic system and gets to indicate differences of emotions, volitions and perceptions 'putting words' on our silent inner being. But our cognitive, emotional and volitional qualities would only have a weak connection to reality if they were not connected to the survival of the living systems' organisation as a body in its interacting with the environment's differences in the development of a signification sphere in the evolution of the species.

Biosemiotics and metaphor theory have argued extensively for the importance of embodiment in semiosis (Brier 2001a). I have tried to show the connection between the biosemiotic (ethologically based) concept of motivation and the motivational concept of embodied cognitive semantics (Brier 2000). With the help of Figure 1, I showed that ethology and embodied metaphor theory both have discovered that the conception of a sign as standing for something for somebody in a particular way is controlled by some releasing mechanism that connects motivation, perception and behavior/action into one systemic process as already Jakob von Uexküll (1957) described in his *Funktionskreis* and, which Heinz von Foerster refers to as perceptual *eigenvalues*. Instinctually, the actual IRM (Innate Release Mechanism) is chosen through the urge coming from a specific motivation. This is again based on biological expectancies and vital needs, like for food and mating. I argue that the linguistic motivation that Lakoff and Johnson claim to control the ICM (Idealised Conceptual Models) have connection to the biological motivations in many instances. This is obvious in a much-used example where a woman classifies a man as a bachelor, and therefore as a potential mating partner. It is our biopsychological embodiment that ties these relations together.

The analysis of Lorenz work showed that a phenomenological-emotional concept was necessary to understand the production of meaning. I want here to point out that this is consistent with Peirce's placing of feeling as an attribute of Firstness.

Knowledge systems thus unfold from our bio-psycho-socio-linguistic conscious being. Their function is to help us to orient (ourselves) in the world and act together in a fruitful way, but they do not explain us to ourselves. I here see Peirce's view, that we cannot split the concepts of mind and matter from the beginning, as a very sound and a profound basis for further analysis. I do not see any good reason why the inner world of cognition, emotions and volition should not be accepted as just as real as the physical world as well as our cultural world of signs and meaning. Finally to both the spiritualist and the materialistic, embodied life, even with only one cell as the body, has to be a basic part of, or a component of constructing a reality. We are thinking *in,* or maybe even *with* the body. The psyche and its inner world arise within and between biological systems or bodies. With Peirce one may say that there will always be some kind of psyche in any kind of biological autopoietic and code dual system.

Still, a partly autonomous inner world of emotions, perceptions and volitions, only seems to arise in multi-cellular chordates with a central nervous system. Lorenz (1973) argues that such a system with emotions and experiences of pleasure is necessary for animals to have appetitive behavior, searching for the objects or situations that can elicit their instinctual behavior and release the motivational urge built up behind it. This is qualitatively different from how reflexes function on a signal, which is a proto-semiotic informational level. The sign function of instincts is on a genuine semiotic level.

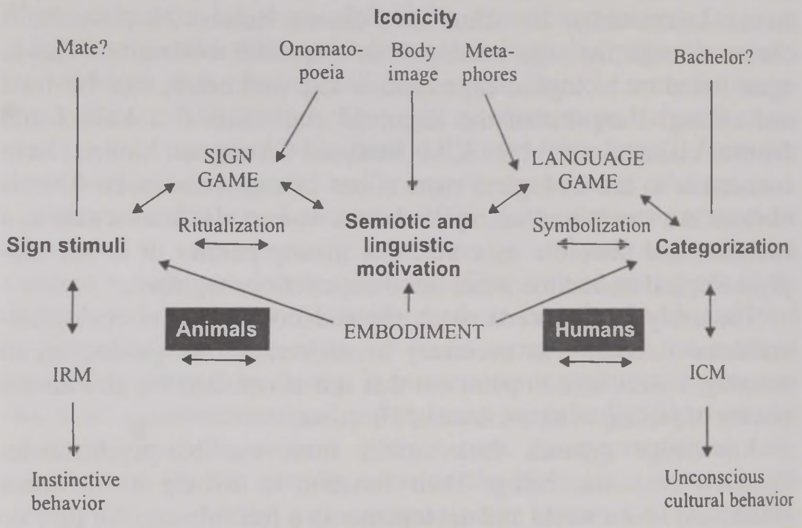

Figure 1. Shows the relation between linguistic motivation and instinctive motivation in animal behavior by relating animal and human signification through a biosemiotic framework combining knowledge from ethology and embodied cognitive semantics. It is suggested that although animals do not have language games, they have sign games. Semiosis is thus going on in two different levels in animals and humans. But in both cases it is embodied and basic biological motivation has a role to play although other forces (cultural) are additional influential on the linguistic level. The figure points to the similarity between the ethological concept of IRM (innate release response) and the cognitive semantic concept of ICM (idealized cognitive model) as postulated structures guiding motivational attention and ideas of iconicity. The figure is quoted from (Brier 2000) where further explanation is to be found.

I consider the contribution of cybersemiotics as mainly being the clearing up of the metaphysical background of both cybernetics and semiotics to make it possible to place cybernetics and semiotics in relation to each other, especially in their modern versions of second order cybernetics and autopoiesis theory on one hand, and as biosemiotics on the other. Cybersemiotic has further accepted the concept of motivation and embodiment as an important part of the biosemiotic communication concept. As argued above, embodiment and motivation are seen as important common aspects between the sign games of animals and the language games of humans, thus integrating biosemiotics with the cognitive-semantic embodied metaphor theory of Lakoff and Johnson, and with the elder Wittgenstein's language philosophy.

Luhmann's theory of the human socio-communicative being consisting of three levels of autopoiesis can be used in cybersemiotics to distinguish between (1) the languaging (Maturana) of the biological systems, which is the coordination of coordination of behaviors between individuals of a species on the reflexive signal level, (2) the motivation driven sign games of the bio-psychological systems and, finally, (3) the well driven language games level of the self-conscious linguistic human in generalized media of the socio-communicative systems. A semiotic understanding has thus been added to Luhmann's conception, and his theory is placed in the Peircian triadic metaphysics. This leads to formulation of a number of new distinctions and concepts.

Intrasemiotics

It is obvious that what we call language games arise in social contexts where we use our mind to coordinate our willful actions and urges with fellow members of the culture. Some of these language games are then about our conceptions of nature, filtered through our common culture and language. But underneath that, we also have emotional and instinctual *bio-psychological sign games* (Brier 1995). These function for humans as unconscious paralinguistic signs such as facial mimics, hand movement gestures and body positions with an origin in the evolution of species-specific signification processes in living systems.

Simultaneously, we have also an internal communication going on between our mind and body. In Luhmann's version it is something different from what Kull (1998) calls *psychosomatics*, as it is not a direct interaction with culture but only with the psyche. On the other hand it is not only *endosemiosis*. The terms endosemiosis and exosemiosis were probably both coined by Sebeok (1976: 3), endosemiosis denoting the semiosis, which takes place inside the organisms, and *exosemiosis being the sign process that occurs between organisms*. Endosemiosis became a common term in semiotic discourse (see Uexküll *et al.* 1993), meaning a semiotic interaction at a purely biological level between cells, tissues and organs. Nöth and Kull (2000) introduced the term *ecosemiotics,* specifically for the signification process of non-intentional signs from the environment or other living beings that takes a meaning for another organism that is, for instance, hunting. Thus a sign signifying an organism as a suitable prey is not intentionally emitted by the organism preyed on, and is therefore rather endosemiotic than ecosemiotic. What can we then call the internal semiotic interaction between the biological and the psychological systems?

The interaction between the psyche and the linguistic system I call *thought semiotics*. This is where our culture through concepts offers us possible classifications of our inner state of feelings, perceptions and volitions. These, in their non-conceptual or pre-linguistic states is not recognized by conceptual consciousness, I call *phenosemiotic processes*. For short I just call them *phenosemiosis*.

As the interactions between the psyche and the body are internal bodily, but not pure biological as in endosemiotics, I call the semiotic aspect of this interpenetration between the biological and the psychological autopoiesis *intrasemiotics.* These different names are coined to remind us that we deal with different kinds of semiotics. In the future, we have to study more specifically the way semiosis is created in each instance.

Today we know that there are semiotic interactions between the hormone systems, the transmitters in the brain and the immune system and that their interactions are very important for the establishment of the autopoietic system of second order, which a multicellular organism constructs. Its parts are cells that themselves are autopoietic systems and these are again on a new level organized to an autopoietic system. But we do not know very well what the relations are from our lived inner world of feelings, volitions and intensions to this system. It seems that certain kinds of attention on bodily functions, such as imaging, can create physiological effects in this combined system. As mentioned above, this is partly carried by different substances that have a sign effect on organs and specific cell types in the body (endosemiotics). We also know that our hormonal level influences our sexual and maternal responses. Fear turns on a series of chemicals that change the state and reaction time of several body functions, and so on. This is a very significant part of the embodiment of our mind, but intrasemiosis seem to function as a meta-pattern of endosemiotic processes. For example, our state of mind determines our body posture through the tightness of our muscles. There is a subtle interplay between our perceptions, thoughts, feelings, and bodily state, working among other things through the reticular activation system. There is still a lot we do not know about the interaction between these systems.

The nervous system, the hormonal system and the immune system seem to be incorporated into one big self-organized sign web. Now, the autopoietic description of living cybernetic systems with closure does not really open for sign production *per se*, and semiotics in itself does not reflect very much about the role of embodiment in creating signification. Thus, the cybersemiotic suggestion to solve this problem is that signs are produced when the systems interpenetrate in different ways. The three closed systems produce different kinds of semiosis and signification through different types of interpenetration, plus a level of structural couplings and cybernetic 'languaging', as Maturana and Varela (1980) call it.

The autopoiesis theory underlines that two interpenetrating systems are closed black boxes to each other. But Maturana points out that interpenetration develops over time to a coordination of co-ordination of behavior that he calls languaging. By then reciprocal structural coupling has formed between the two systems where signs can be produced and exchanged. Maturana's concept of *languaging* seems to be the bio-psychological connection between two individuals in a social species. But it is not the sign and/or language game as such; it is the cognitive coupling that is the coordination necessary for communication to develop as a signification system with its own organizational closure. I would, therefore, suggest that we distinguish between *languaging* and *sign games* at the level between reflexes and instinctual movements. The perception eliciting reflexes is independent of motivation, whereas the perception of sign stimuli is motivation-dependent, which leads into the instinctual sign games.

Ethologists would here point to how certain instinctual movements become ritualized and get a release value for instinctive behavior as 'sign-stimuli'. As Lorenz (1973), in his last period, realized that emotions had to be connected to the performances of instinctual movements to create the motivational urge of appetitive behavior, we here have criteria to distinguish between the two levels. We here see how the connection between signs and internal or phenomenological understanding is constructed. Lakoff (1987), and Lakoff and Johnson (1998) have shown how this basic mechanism of bodily meaning can be extended by the workings of metaphorical processes to encompass socially and culturally produced signs.

Based on ethology and biosemiotics it appears that our cognition manifests itself as embodied semiosis, motivated in our biological social interest that is a powerful creator of structure and meaning in our signification sphere. Most animal behavior is — like much of our linguistic categorizations and use of metaphors — considered to be unconscious. Still ethologists had to realize that motivation is not a physiological concept (Brier 1992, 1998), emotional experiences are connected to the perception and behaviors with an instinctive basis.

Sign games are developed into language games through evolution and in the life of the infant human. As we are born and grow into human social communication the psyche is perfused with signs. Our mind is infected with language and we become semiotic cyborgs or what we call humans. We are in this view born as animals with a capacity to construct this interpenetration between the psychic and socio-communicative systems, creating internal interpretants that are meaningful to us because of the mutual structural couplings of languaging established in evolution.

Meaning is seen in biosemiotics, cognitive semantics, autopoiesis theory and ethology as embodied. But with the new cybernetics and Uexküll, I suggest that embodiment is thought of as much broader than only the structure of the nervous system, or even the integration of the neurotransmitter, the hormone and the immune systems through reaction to common sign substances that they secrete. As Fogh Kirkeby (1997) suggests, we should look at the body-mind or the body-thought as a complex phenomenological dynamical system, including the construction of the environment and the other (body-mind) systems that make it possible for signification to appear.

Realising that a signification sphere not only pertains to the environment, but also to the perception of other members of the species in cultural and proto-cultural behaviour as well as to perceptions of own mind and body hood, I use a little 'eco' as a prefix to the signification sphere, when it is the aspect of it pertaining especially to non-intentional nature and culture outside the species in question. Both in in-animate nature, in other species and in cultural processes, we can observe differences that signify meaning to us, although never intended by the object where we will sum up the concepts developed so far).

A cybersemiotic model for biosemiotics

I conclude the article by putting the mentioned and new developed concepts together in a rather complicated model. By symbolically placing the concepts on, between and outside the various parts of the human body I am visualizing the difference for instance between levels of semiosis and signalling, exosemiotic and internal semiotic processes. The meaning is to provide a visual overview for those that like this. Those that only see simplifications and limitations in models like this can just skip it.

See Figure 2 for an overview of the cybersemiotic concepts built up so far. On the left side we see only the cybernetic-autopoietic-functionalistic described processes. In the middle we see the communicative aspects or the exosemiotics between two organisms. On the right we then look at the internal-semiotics of the organism. Finally to the far right we look at the organism's perceptual connections to the environment, creating its signification sphere. With Nöth and Kull (2000) we call this signification aspect ecosemiotics.

Ecosemiotics focuses on the part of our language that is about how all living systems represent nature in signification spheres, ending with language games in culture. Cybersemiotics points out that the basis of these eco-language games is the eco-sign games of animals, combined with a signification sphere (originally called 'Umwelt' by Uexküll), created through evolution. Further, these are based on an intricate interplay between the living system and its environment, establishing what Maturana and Varela call structural couplings. The signification sphere is a workable model of nature for this living system that as a species has existed and evolved through millions of years. This is also true for the human species, indicating that our language has a deep inner connection to the ecology of our culture. Any existing culture is a collective way of making a social system survive ecologically. As such, the cybersemiotic theory of mind, perception and cognition is a realistic one, but not a materialistic or mechanistic one. It builds on an inner semiotic connection between living beings, nature, culture and consciousness carried by the three Peircian categories in a synechistic and tychastic ontology in an agapastic theory of evolution delivering a philosophy going beyond the dualistic oppositions between idealism (for instance in the form of spiritualism) and materialism (for instance in the form of mechanism).

Based on the concept relations in figure 2 we can go back to figure 1 and now see that the linguistic motivation must be placed in the area of thought-semiotics where our internal non-linguistic phenosemiotic processes of mind meet with the concepts of language and imbue them with inner meaning. Whereas the animal motivation stems from the intrasemiotic area where the endosemiotic processes of the body cells meet with the phenosemiotic processes of mind and awareness. The cybersemiotic model thus provides a conceptual framework, in which these different levels of motivation can be represented and distinguished (in a way that was seemingly not possible in the earlier three different frameworks of biology, psychology and socio-culture). Thus by viewing meaning in an evolutionary light as always embodied, and seeing the body as semiotically organized in Peirce's triadic worldview, where mind as pure feeling is Firstness, a transdisciplinary framework can be constructed that supersedes some of the limitations of the earlier divisions of subject areas. This was my goal, when I started these quests in the early eighties, when the depth of the problem of motivation in ethology dawned upon me. This gives us hope that the cybersemiotic development of biosemiotics can contribute to an inter- and transdisciplinary semiotic theory of information, cognition, communication and consciousness.

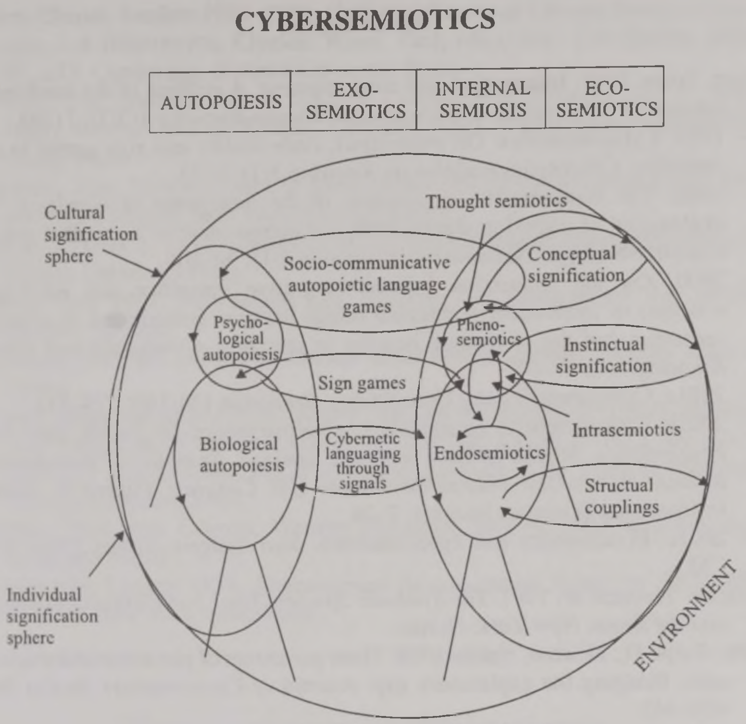

Figure 2. The cybersemiotic model classifying different types of semiosis and proto-semiotic processes. The semiotic language here is symbolic not iconic. Thus localization of the processes has nothing to do with the actual bodily locations as the head, for instance, is also a part of the biological autopoiesis, and has endo-semiotic processes. To limit the complexity, I have placed most of the cybernetic-autopoietic concepts on the left person and all the semiotic ones at the person to the right. But all concepts concern both persons. Each person is placed in a signification sphere. When these are combined through socio-communicative autopoietic language games a common signification sphere of culture is created. The vertical gradient is symbolically referring to basic biological processes as lower or more basic than linguistic conscious processes. Underneath language games is the biological level of instinctually based sign games, and under that, the cybernetic languaging game of the coordination of coordination of behavior. The higher levels are seen as depending on the function of the lower. The autopoietic view is seen as describing functionality and the semiotic meaning producing and exchanging processes. To get the concepts explained you will have to refer to the articles text. If, from this model, we go back to Figure 1, we can now place the linguistic motivations in the area of thought semiotics and the animal motivation in the intra-semiotic area.

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Интрасемиотика и киберсемиотика

Концепция интрасемиотики указывает на семиозис при взаимопроникновении биологических и психологических автопойэтических систем, как это определяется в теории Луманна. Комбинирование в рамках биосемиотики пирсовской концепции семиозиса с теорией Луманна делает возможным рассмотрение игры разума и тела как игры знаков. Недавно предложенный термин "игра знаков" указывает на экосемиотические процессы между особами одного вида, распространяя таким образом витгенштейновскую концепцию языка на знаковый мир животных. В этологии Лоренц использовал понятие мотивации, а Юкскюлль понятие тона, описывая выделяющееся влияние перцепции и связанные с перцепцией реакции. Интрасемиотику можно рассматривать и как связь между биологически определяемой мотивацией у Лоренца и понятием Id Фрейда, понимая это как психологический аспект многих естественных стремлений. В последние годы своей жизни Лоренц изучал, каким образом эмоциональная обратная связь может посредством приятных ощущений в определенной степени вызывать переход выученного в систему инстинктов. Он утверждал, что инстинктивные движения должны сопровождаться каким-либо поощрением, что привело бы к возникновению прочной связи между поведением, связанным с поисками пищи и определенными знаковыми стимулами. Но он так и не нашел подходящий модус для описания мотивации в биологических науках. Киберсемиотика может объединить эти подходы, дефинируя разные концепции семиотики мышления, фено- и интрасемиотики и комбинируя их с уже известными концепциями экзо-, эко- и эндосемиотики для подхода, изучающего самоорганизирующие процессы в живых системах.

Intrasemiootika ja kübersemiootika

Intrasemiootika kontseptsioon osutab semioosile bioloogiliste ja psühholoogiliste autopoeetiliste süsteemide põimumisel, nii nagu seda määratleb Luhmann oma teoorias. Kombineerides biosemiootika raames Peirce'i semioosi kontseptsiooni Luhmanni teooriaga, saab võimalikuks keha ja vaimu vastasmängu vaatlemine märgimänguna. Hiljuti väljapakutud termin 'märgimäng' viitab sama liigi isendite vahel toimuvatele ökosemiootilistele protsessidele, laiendades nii Wittgensteini keelekontseptsiooni loomade märgimaailmale. Etoloogias on Lorenz kasutanud motivatsiooni mõistet ja Uexküll tooni mõistet, kirjeldades pertseptsiooni väljaulatuvat mõju ja pertseptsioonile osakssaavaid reaktsioone. Intrasemiootikat võib vaadelda ka seosena Lorenzi bioloogiliselt defineeritud motivatsiooni ja Freudi *Id*-i vahel, käsitledes seda kui mitmete looduslike ajede psühholoogilist aspekti. Oma teooria viimastel arendamisaastatel uuris Lorenz, kuidas emotsionaalne tagasiside võib meeldivate tundmuste kaudu teataval määral põhjustada õpitu kinnitumist instinktide süsteemi. Ta väitis, et instinktiivsete liigutustega peab kaasnema mingit tüüpi hüvitis, mis võimaldaks toiduotsimisega seonduva käitumise kinnistumist teatavatele märgilistele stiimulitele. Kuid ta ei leidnudki vastuvõetavat teed kirjeldamaks motivatsiooni bioloogiateadustes. Kübersemiootika võib need lähenemised ühendada, defineerides mõttesemiootika, fenosemiootika ja intrasemiootika erinevaid kontseptsioone ning kombineerides neid juba teadaolevate eksosemiootika, ökosemiootika ja endosemiootika kontseptsioonidega lähenemiseks, mis uurib iseorganiseeruvaid protsesse elussüsteemides.

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Back to the science of life

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Abstract: We give a survey of epistemological and ontological approaches that have left traces in the 20th-century biology. A common motive of most of them is the effort to incorporate biology into the realm of physical sciences. However, such attempts failed, and must fail in the future, unless the criterion for *what science is* becomes biologically oriented. This means broadening the realm of classical natural sciences, incorporating at least part of the thesaurus of the "humanities". We suggest three mutually complementary candidates for further development in this direction: modular biology, the hermeneutics of the living, and the semiotic disciplines.

> *In the bitterness of their victory over their clerical opponents, [the biologists] have made the meaninglessness of the universe into a new dogma.*
> Dyson (1979: 249–250)

Recently, we have witnessed a number of strange terminological shifts, where the subject of particular science becomes confounded with the science itself. Thus *psychology* means both mental phenomena and the science studying them, a piece of fine *organic chemistry* was needed when life originated on the planet, and the same holds for, say, physiology, ecology, botany, or even biology as such. But observing that a plant is growing is not biology yet, nor speaking about one's feelings and thoughts is psychology. The scope of a special science is *always* more limited than its subject. Life is not *only* biology, mind is not the same as psychology.

This does not mean that special sciences deal simply with a mere subset of traits characteristic for their subject. An established science, if *creative*, will also *create* new phenomena appropriate for the current set of paradigms held at the time. Monoclonal antibodies, inbred clones of mice, or a single species of protein in a test tube are *constructs* of a special science — biology. Such constructs, and models based thereon, may provide extremely efficient tools, models and maps, enabling description and understanding of certain aspects of reality. However, any model — scientific or otherwise — is no more and no less than a caricature of the real world, and we should remain aware of the limits of its validity. Paradoxes and inconsistencies between a model and observation may indicate either a principal fault, or a mere transgression of the limits of model applicability. As Sidney Brenner (1997: 36) noted, Occam's razor should always be accompanied by Occam's broom — to sweep the cut bits under the carpet. A substantial part of model formulation concerns defining the borders of the carpet — i.e. the part of world where our models make sense.

Within the realm of natural sciences, biology has always held a strange position. Not all features of the living could be forced to meet the stringent measures of "hard" science, as exemplified by classical physics. It is not because spontaneity, evolution of complex systems, historicity, or even meaning were absent from the non-living realm. It is because during the last three centuries, modern science had chosen to ignore such appearances as mere epiphenomena of "real", objective, fully knowable causal laws acting in the background. For biology, however, the task to meet such criteria was even harder than for other experimental sciences: evolution and ontogeny always tended to escape any general rules. Here we shall try to show how various schools of biological thought try to negotiate the paradox.

Besides such "physicalist" attempts, there always existed a respectable tradition of philosophical thinking that pinned down those properties of the lived world (*Lebenswelt*) which resist "collapsing" into the schemes of physical sciences and "biology" derived thereof.

In this article we shall treat briefly some of the numerous 20th-century attempts to found biology in a way which would respect specificity of the living realm, yet take advantage of the methodological armoury of "hard" sciences. All such attempts represent different ways of projecting the teeming realm of the living onto a kind of *map*, or better grid or matrix, containing limited number of dimensions and therefore methodically manageable. The examples chosen are mostly balancing on the edge between turning life into physics, or jumping out of the physical world altogether. This "living on the edge" is, of course, inherent to the very realm of life (Kauffman 1993). However, depending on the factors taken into account, it can project into substantially different conceptions of the "science of life". All of them necessarily carry a burden of some sort of bias. Depending on what axes were selected for the projection, we obtain different models of life, often incompatible, at least to some respects, with other models.

As an alternative, we give in the second part a short survey of biosemiotics, as we understand it. In the third part we attempt to formulate outlines of another two "grids" which we consider to be best fitted, at present, for understanding the realm of the living, namely modular biology and hermeneutics of the living (undoubtedly charged with their own biases).

1. Physicalism

We use this somewhat ugly term to encompass all the worldviews based on the conviction that *all* natural phenomena are subject to eternal, immutable laws. In biology, there have existed several great schools of physicalism, differing in how they were able to treat the historical dimension of life. We will proceed from mechanicism and its branch through biological structuralism, vitalism and organicism, to biology as understood by two contemporary authors: Mae-Wan Ho and Stuart A. Kauffman. We will discuss the extent to which the explanatory scheme of these branches relies to objective existence of immutable, once-for-all given laws (objective in the sense "existing out there", not merely "agreed by peers"), compared to free exploration and invention within the space of meanings.

Mechanicism

A mechanism is a projection of the world into the geometrical space. Making use of a device — mechanical or not — means understanding causal interdependencies of its parts, i.e. being *in principle* able to characterize them by a set of (simple) mathematical equations. It should be stressed that mechanical functioning could never be reconciled with historicity, introduced by evolution. The clockwork functioning of the world was the leading idea in natural sciences up to the end of the 19th century. This ethos began to crumble with the onset of modern physics and mathematics. Moreover, hand by hand with mechanism *always* goes the question after its creator.

Owing to trifles of history, the mainstream biology has remained the stronghold of mechanicism long into the 20th century. This, surprisingly, persists despite the fact that biologists fully acknowledge evolution as the principal formative force shaping the realm of the living. The uneasy compromise was helped by extreme reductionism ending in atomism, both chemical (molecular behaviour) and conceptual (contemporary evolutionary genetics). It is true, the argument goes, that at the macroscopic level we observe intentionality, free will, historicity and the like, but all these are *nothing but* epiphenomena safely grounded in the mechanical behaviour of molecules — i.e. something fully predictable from the initial and boundary conditions. Yet chance may enter at this level, be it genuine chance, measure of our ignorance, or some tricks implemented from the quantum world. If we, however, succeed to set such appearances, which are felt as *disturbances*, aside, or if we succeed to suppress them experimentally, we should end up essentially with predictable, truly objectively accessible world. All phenomena at the macroscopic scale of both space and time can be explained as causal consequences of either elementary mechanical movements, or genetic instructions read and executed blindly by mechanical protein contraptions.

Contemporary mechanistic thought in biology is characterised by two pillars: (1) molecular biology as taught by Jacques Monod (1979), and (2) sociobiology epitomized by the name of Edward O. Wilson (1998). Yet even in such strongholds of mechanicist thinking we can follow a strange — albeit rarely reflected — shift away from hard science and towards semiotics. Monod introduced the concept of *gratuity,* which, by all measures, cannot be acknowledged as belonging to chemistry. It is rather a description how *molecules become symbols*. The nature of molecules as *chemical* entities suddenly plays only a marginal role: they serve as a mere medium to store or deliver *meaning*. Sociobiology, in turn, gave birth to *memetics*, which parts even with the last bonds of the causal molecular world and becomes a free game of symbols (Dawkins 1989; Blackmoore 2000). By these and similar moves even the mainstream of biology may have transgressed its own horizon long ago.

Biological structuralism

Structures, the central concept of (biological) structuralism, can again be viewed as a kind of reduction — projection — collapse of the multi-dimensional space onto a *construct*. This time it is not the 3D Cartesian space of the mechanicists. Instead of invariant molecules and kinetic laws, invariance is supplied by implementations of *structures* into the lived world (see, e.g., Webster, Goodwin 1996). Evolution and morphogenesis is viewed as a result of lawful (i.e. in principle, as in the previous case, fully knowable) transformations of ever-existing and unchangeable *structure*. The structure is a system of relationships that always has existed, and its transformation proceeds according to fixed rules (although this does not mean that transformations themselves are given in advance — only the *rules* are conservative, not the *outcomes*). Knowledge of rules of (trans)formation allows one to analyse the order of formations of things, and the principal task is to find these rules.

Structuralism also stresses the relationship between the whole and its parts: a thing is to be understood not as a single fact or term, but as a totality, and only as such it has any meaning. Its parts gain their meaning only from their position in the whole structure. If we succeed in deciphering the nature of the relationships between the parts and the whole, we get a model of a given structure. Such a model will become a formal analogue of all models organized by that structure; thus it makes it possible to unify even domains which, at first sight, have nothing in common (for example various mathematical theories). In science, the structuralist approach is an attempt to overcome — or better, complement or correct — explanations based on the reduction to the molecular level. Each level of description becomes the basic level with its own structural laws.

It is important to realize that the system of transformations — in the structuralists' interpretation, is *closed*; it develops and becomes enriched because of inherent rules that are independent of outside influences. At the same time it does not allow the structure to transgress the limits pre-set by rules. Novelties may appear only if they have always been *virtually present* as potentials of the structure. Historical events, i.e. trajectories of the system in time, cannot change the rules — otherwise no structured space would exist, but only a kind of eternal flow akin to the Heracleitan River. From a postulate of the self-sufficiency of a structure it follows that a structure can be totally known in itself, without any need to refer to elements outside the structure.

In a closer view, the very notion of virtual presence brings about problems. "Virtual presence" is not objective: the structure is a mere point in the space of possibilities. This space is teeming with possibilities, also mutually exclusive ones, in a kind of superposition. Structuralists tend to stress that any decision, selection or interpretation results in a collapse from this space into a single solution, thus revealing a preexisting attractor. But we might ask whether the system of transformations could not be open, endlessly creating new possibilities — and new *structures*.

Structuralism, as physics and as molecular biology, is seeking what is timeless, fixed, and constant: the grammar and the vocabulary of a given language or of a given phenotype. Evolution and morphogenesis become a system of fixed and lawful (i.e. objectively decipherable) transformations where no contingency is allowed. We end with a kind of rational morphology supported by mathematics.

The aim is thus similar to that of physicalism. However, in contrast to mechanicism, structuralism has no ambition to reduce biology to physics. Biological phenomena stay in their own "causal domain" (Havel 1996), without reference to other domains of description. Physics is attractive because it supplies examples (analogies) how to build a rational taxonomy without any need for history. To disclose such an order for the realm of living beings should be — according to structuralism — the principal goal of all biologists. Hence, biology should break away from the flaws of historicity and finally transform itself into a true science worth of physicalists' criteria.

Vitalism and organicism

The vitalists' endeavour (here we present mainly views held by one of its main protagonists among the biologists, Hans Driesch (1905, 1914, 1929)) was also to encompass the phenomenon of life into the body of physical science. Vitalism is a conviction that life processes are autonomous, i.e. understandable only in the context of the living, not from some "simpler" levels, such as that of chemistry. But these autonomous processes, themselves, are also governed by a fully describable principle(s). Life, as a property of a living body, is in no way the result of physico-chemical events, but rather a ruler of those. This, however, does not mean that spontaneity or even free will should be allowed for.

The vitalists therefore felt a need to find and define principles controlling vital processes; they always stressed that such principles should be expressed as measurable variables, being in simple mathematical relations to magnitudes already known. Thus, the priority was, again, to discover simple laws that govern life, i.e. to broaden the realm of physics to be able to embed life more completely into it. This quest can best be demonstrated by their rejection of Darwinian theory: they held that introducing historical contingencies into pure science was unacceptable!

Driesch, as one of the pioneers of experimental embryology and discoverer of regulatory processes in early embryos, centres his efforts on the explanation of regeneration. To understand such phenomena, one has to presume the existence of harmony (causal, structural or functional) and purposiveness in organisms. His aim was to prove this assumption.

When in the 1920s it became obvious that vitalism had become depleted of explanatory potential and dogmatic, i.e. of no practical use in experimental *science*, the term *organicism* was coined instead in the 1930s (Bertalanffy 1960). Its aim, again, was to explain the obvious fact of emergent properties of complex systems, encountered on the way from a "lower" level of description to a "higher" one. This tamed form of vitalism survived in developmental biology for the rest of the century and, according to Gilbert and Sarkar (2000) will also have much to say in the century coming.

Perhaps it will, but we do not see much difference between the organicist statement "Different laws are appropriate for each level of description", and the vitalist "There are life-specific laws". In our opinion, the controversy — often very heated — between mechanicism, vitalism and organicism could perhaps have been resolved on a purely terminological ground. Not much will change if we, instead of proposing "autonomous laws of the living realm", speak of expanding physics and chemistry in order to accommodate life, pointing to generally accepted instances of such previous expansions, such as the whole area of organic chemistry. Moreover organicist statements can also easily be applied to any complex dissipative system, which means that they do not provide the answer to the basic question: "What is the difference between the living and the nonliving?" Is our understanding sharper if we speak of *information*, *complexity*, or *structure* without having clear idea of the meaning of such words?

The anxiety *not* to leave the Cartesian world "where the laws of chemistry and (Newtonian) physics rule" is, in our opinion, condemned to failure. If biology, psychology and similar areas of human knowledge are to become *sciences* with a status similar to physics, they ought to abandon their vain attempt to confine biology into the Cartesian space and do what physics did several decades ago: transcend it.

"Enlightened physicalism" of M.-W. Ho: Introducing the concepts of quantum physics

One possibility how to do this may be encompassing, at last, the 20th century developments in physics. Quantum physics has turned the traditional question after material structures upside down and started to ask after the structure of matter, opening thereby perspectives unavailable to classical physics. Surprisingly, few biologists took this challenge seriously. Mae-Wan Ho in her earlier works (see, for example 1993, 1994) makes a serious attempt to describe living beings in terms of self-structuring fields. Inspired by the Fröhlich theory of resonance (see, for example, Pokorný 1995), she sees living beings as coherent systems synchronized through many levels of organization.

According to Ho, organisms can be characterised by high-efficiency energy transfers with minimum losses. She interprets this fact as evidence that energy transformations in living beings are of a different order from those described by standard chemical kinetics. The latter are defined for reactions in homogenous space involving very high numbers of molecules, and characterized by quantities based on the averaging of states of large numbers of particles (temperature, concentration, free energy, entropy, etc.). Such quantities, however, cannot be defined for the interior of living cells — they have no meaning there, because the space within the cell is highly structured. Evidence for the presence of elaborate — almost crystal-like — order within living things is seen in the observation that live cells, unlike dead ones, exhibit optical polarization. This means that cells do not contain anything like homogeneous solutions (see also Hess, Mikhailov 1995, 1996, or any current textbook, for support of this notion; compare also the concept of evolution based on non-ergodicity in Kauffman 2000).

In such a highly ordered space, huge numbers of molecules (of the order of 10^{20}) interact in a coherent (i.e. coordinated, nonlocal) manner, ensuring extreme efficiency of energy transfers. Ho assumes that the coherence present in organisms is quantum in nature, and interprets living beings as highly coherent systems, interconnected through many spatial (10^{-10}–10^{1} m) and temporal (10^{-14}–10^{7} s) orders. Although she is far from providing conclusive evidence for the involvement of quantum phenomena, we believe that her introduction of quantum physics concepts into biology represents a hopeful way of transcending the mechanistic worldview.

"Enlightened physicalism" of S. Kauffman: Introducing history

Stuart A. Kauffman (1993, 2000), in contrast to concepts discussed above, fully recognizes the creativity and historicity of the physical realm. He started with modelling the dynamics of very complex systems, and showed that such systems have an inherent property of becoming self-organized and evolving. He therefore maintains that, in evolution, order (structure) will establish itself "for free", *in spite of* natural selection. From the mathematical world of models Kauffman made a decisive step to the physical world and attempted to find laws that would govern the evolution of a non-ergodic world. Kauffman's key concept is the *autonomous agent*, defined as an entity able of self-reproduction and of performing work cycles — i.e. canalising the flow of energy. An autonomous agent, in addition, can act *on its own behalf* in the sense that it evolves towards maximizing the efficiency of both these essential functions. Obviously, any living being belongs to the category of autonomous agents. What, however, should the properties of a physical system be for it to be able to act on its own behalf, i.e. to become an autonomous agent? Such a system must be able to increase its own organization.

But this is not the end of the story: autonomous agents are busy manipulating the surrounding world in order to maximize its diversity, co-constructing thereby a *biosphere*: "Biospheres persistently increase the diversity of what can happen next" (Kauffman 2000: 4). The configuration space of a biosphere cannot be defined in advance.

It does not, however, mean that biospheres are heading towards chaotic and unlimited diversity. *Reaching out and making a living* means making sensible choices from the space of possibilities created. We stress the word *choices* as an opposite to necessity imposed by natural selection: informed choice is unthinkable without the historical, experiential, hermeneutical dimension.

Kauffman tried to decipher lawful properties behind co-constructing biospheres, and he suggests the tentative 4th law" of thermodynamics. "As an average trend, biospheres and the universe create novelty and diversity as fast as they can manage to do so without destroying the accumulated propagating organization which is the basis and nexus from which further novelty is discovered and incorporated into propagating organization" (Kauffman 2000: 85).

Is this vitalism? If we take Driesch as a reference, the answer is *no*. There is, in Kauffman, no sign of the stiff physicalism so typical of Driesch. Quite the opposite is true: Kauffman focuses on *creativity*, *spontaneity* of the living. But how to name this quality "scientifically", formulate a concise theory, develop testable hypotheses and appropriate methods for their testing? In other words, how to define laws for non-ergodic evolving physical systems? In this sense Kauffman's views may be very close to those of the American semiotician C. S. Peirce, who hundred years before Kauffman stated that "natural laws are acquired habits".

2. Biosemiotics

Biosemioticians maintain that, in contrast to inanimate matter which can be characterized by causal processes (action and reaction), the essence of the living is in *semiosis*, manipulation with symbols. Whereas "natural laws" represent generalizations about natural processes, helping to arrange the original heterogeneity under a small number of simple and homogeneous rules, the process of semiosis leads towards greater heterogeneity, elaboration, i.e. evolution (compare with the evolution of Kauffmanian *biospheres* above). Biosemiotics is an abstraction from the (causal) physical world, and focuses itself to a universe perfused with signs, where organic wholes participate in a never-ending interpretative process. The principal terms of biosemiotics are *meaning* and understanding, and the processes that create them. We consider crucial the following thesis, with all its reminiscences of vitalism or organicism:

> The world is material, but all matter is organized into forms and these again can be further organized. There are qualitative differences between these organized forms. What exists are not just fundamental particles, energetic fields, and their organization: Reality has during its evolution become organized into characteristic primary levels (the physical, biological, psychical and social). Entities at higher levels possess emergent properties, some of which are ontologically irreducible to lower level properties. (Also called material pluralism or irreductive physicalism). Semiotic phenomena may be characteristic of some, but not necessarily all levels. (Emmeche 1997: 96)

We come to the view of an unfolding *semiosphere* (Hoffmeyer 1998) not incompatible with the visions of Kauffman or even those of Teilhard de Chardin (1956). All living beings participate, as *experienced* entities, in this process:

> [...] we can say that when life, and thus natural selection, emerged inside the Earth system we had already passed beyond the secure sphere of physics into the sphere of communication and interpretation. In this sphere the dynamics of history (evolution) changed and began to become individualised, so that each little section of history became unique and henceforward no big formulas could be erected covering the whole process. *Organic evolution is narrative rather than lawlike* [...], and if quantification is wanted, it should be searched not at the level of genetics, but at the level of the constrained thermodynamic system framing organic evolution. (Hoffmeyer 1997: 365; our emphasis, A. M. and F. C.)

Semetic, instead of genetic, processes and interactions are considered the driving force of evolution. Emmeche (1997) even hopes that the biosemiotic effort will lead towards the integration of semiotics, biology and physics, and thus to the comprehension of emergence of new orders of complexity.

3. Perspectives

Examples above illustrated what were the problems biology has been struggling with for the past century. Biological field theory, structuralism, epigenetics, general systems theory, organicism and many other theories attempting the holistic or top-down approach in science, all remain somehow suspicious from the point of view of "true", prosperous, reductionist science. Biosemiotics, on the other hand, has completely left the realm of natural sciences.

The objective for the 21st century is clear: either to conclude that *some* aspects of life's appearance simply cannot be subdued to the scrutiny of objectivist biology as we know it today, or to create a concise holistic theory of life, broadening thus the realm of biological science.

In the following part of our essay we shall attempt to outline two methodological (or epistemological) approaches that, to our opinion, may show some promise in relation to the second option mentioned: modular biology and hermeneutics.

Modular biology: resurrecting classical genetics

The term module can refer to a very heterogeneous set of entities. It can be applied to functional units in genomes — e.g. exons that can shuffle between the genes, thus increasing functional variability of encoded proteins (Patthy 1995). It can also represent autonomously developing units in ontogeny (Gilbert *et al.* 1996). However, here we shall focus mostly on the concept of *modules* as structural, regulatory, or functional units within cells (Hartwell *et al.* 1999), although some of the conclusions may apply also to the developmental, and even genomic, understanding of modules. What is common to all three conceptions mentioned is that modules serve as a kind of archetypal "scaffolding" for explication, i.e. forming some phenotypical trait. The scaffolding is relatively stable as to its internal relations. Its existence is a *necessary* condition for building the trait in question, but the trait itself cannot be *derived* from the existence of the scaffolding. What, then, comprises a module? Some of the Hartwellian modules are identical to previously recognized multiprotein complexes, such as the ribosome. Such entities could be, at least in principle, isolated *in vitro* and subjected to detailed chemical and physical analysis that would optimally lead to a 3-dimensional model of the corresponding molecular machinery. Others correspond to known regulatory or signal transduction pathways, such as protein kinase cascades and transcription regulation circuits involved in cell cycle regulation, hormone response and other cellular processes. In a general case, it is not *spatial localization* but *functional relations* what decides whether a particular molecule belongs to a particular module. In extreme cases, molecules belonging to the same module might never co-exist in the same cell! As a rule, modules are more likely to be discovered by the "old-fashioned" methodical apparatus of classical genetics than by high-tech 21st century biochemistry alone, although they can, of course, be studied *also* by biochemical and molecular methods.

However, results of such studies, interesting as they undoubtedly are, do not contribute much to the understanding of relations between modules themselves. When studying these relations, we treat modules as black boxes, characterized only by their inputs and outputs. (For an alternative approach to the analysis of intracellular processes in terms of a network of relations — not between modules, but between molecules, see also Kanehisa 2000).

Indeed, if we aim towards understanding the basis of the extraordinary diversity and plasticity of life, we may that find the structure of the network of inter-modular relations matters more than the intra-modular processes. Modules themselves appear to be surprisingly conserved, comprising a kind of "basic toolbox" or a set of standardized blocks from which diverse bodies are built. What we observe as differences between modules in different lineages are more like dialects than different languages. Modules can become interconnected with other modules in a variety of ways, thus enabling new combinations of intracellular regulations or ontogenetic pathways.

The conservative character of modules could be due to the necessity for *horizontal communication* between distant genealogical lines. This supposition is fully relevant at the level of the genetic code (note that the whole transcriptional and translational mechanism is a module par excellence) — especially in bacteria and archaea. Frequent and extensive genetic exchange across the bacterial world calls for a universal and conservative genetic language. To explain the conservation of modules by the necessity of horizontal transfer would, however, be quite challenging. The lineages represented by recent eukaryotic species tend to be well, if not hermetically, isolated. Horizontal exchange might have some importance immediately after speciation in so-called hybridization chains where great chunks of genetic material can move from species to species by interspecific hybridisation.

Another possible justification for a language of modules may be symbiosis: its existence will allow the partners to "understand" (or manipulate?) each other to differing extents. It is not that important whether the partners exchange their genetic material (mitochondria, chloroplasts) or not (lichens, ciliates, parasites). Such higher-order phenotypes require intimate interconnections between the regulatory systems of the constituting species. The establishment of multifarious symbiotic associations is typical in the biosphere, and the existence of a universal modular language undoubtedly makes it easier. It may even appear that symbioses (even in spite of the risk of parasitism) are advantageous in evolutionary terms, to the extent that there is a pressure to maintain the universal language *in spite* of genetic isolation.

Perhaps the most popular (and best known) example of a module, both in the Hartwellian and in the developmental sense, is the system of *Hox* genes. Chromosomal location of these genes is collinear with the body axis and their function corresponds to morphological modules which can be recognized on the body, such as segments (for a review see e.g. Davidson 2001). The products of homeotic genes, conserved throughout the metazoan kingdom, thus assign an "address" to the body structures. Incorrect addressing caused by incorrect functioning of the homeotic coding leads to so-called homeotic mutations, when structures appropriate to one type of segment appear at incorrect, ectopic sites. Many other regulatory modules are of such archetypal nature, for example systems specifying the dorsoventral axis in animals, the proximal-distal axis of appendages, the establishment of boundaries between body compartments, neurocranium, or left-right asymmetry. Similar archetypal regulations can be found also in plants.

Also another aspect of the project of modular biology, formulated by Hartwell *et al.* (1999), deserves attention in our context. The authors explicitly point to an obvious analogy between the processing and integration of multiple environmental and external signals by a (modular) cell on one hand — and analogous tasks performed by the metazoan nervous system on the other. As a result, they arrive to a rather shocking question: are there any modules that would correspond to a cellular equivalent of our nervous system?

If we accept this analogy and all conclusions it could lead to, we cannot but accept that, one day, cell biology may have to embrace the whole arsenal of methods, approaches and theories worked out in the long centuries of the study of diverse aspects of human nervous system. And there is no reason to stop at methods developed in the realm of neurobiology and related "nearly exact" sciences: biology has to be open to input from the humanities as well.

On the first glance, such an idea may appear preposterous, unacceptable and absurd. However, from a closer perspective the same objections could be raised against the previously sketched mechanistic models underlying most of traditional biology, as they are based on the rather immodest assumption that man-made devices are adequate models for understanding the world around and within ourselves.

Hermeneutics of the living (or better by the living): Interpretation everywhere

Taking the data of "standard" biology and re-interpreting them in the light of hermeneutics may be a good example of such an approach (Markoš 2002). In other words, we can view a living body as if it were a reader of texts, endowed with internal history (that of an individual and/or of a lineage). It masters a natural language, with understanding the meaning through word-by-word instructions as well as through cues, contexts, game of words, memory, communication with others, etc. In short, the hermeneutic approach considers *any* living being as if endowed with abilities analogous to human consciousness.

As an example, take the gene — protein level of description. Here, genes play the role of dictionary entries, whereas proteins represent words that could appear in various grammatical forms, and, together with other proteins, constitute a plethora of predicates. The cell uses all this to weave a texture of temporal and spatial expressions, which reflect its context in the world.

A multicellular body can also be taken as an expression, where differentiated cells (including the extracellular matrix) are elements of syntactic and semantic relations. The dictionary would not be genes but whole modules (for example signalling cascades). In this metaphor, ontogeny is a species- (or genus-, phylum-, etc.) specific *explication* of a very old and conservative text shared by the greater part of, or even all, living beings. Like any explication, this too is subject to "cultural", historical shifts in course of evolution. A species-specific understanding of the genetic script is then an analogy to culture — specific understanding of, say, holy writ or the law codex. In this species-as-culture analogy, all the appearances of members of a species (morphology, behaviour, etc.) are results of habits acquired in course of historical contingencies. It follows that the causal bond "genetic inscription → body appearance" is far from being strict.

The deciphering of a code in DNA is often taken as a historical milestone: the existence of a digital code was, and is, felt as a warranty that all what is really important can, and indeed is, unequivocally written down in a string of symbols — bases. But there are two facets of the problem. First, it is true that digital information *can* be unequivocally copied *within the realm* of the digital. But it is often forgotten that it *cannot* be simply copied when transferred into a realm of the analogue, i.e. into the realm of bodily structures. This transition *always* requires interpretation (Gadamer 1989). The interpretation act is never a simple decoding as in case of transcription, translation, or transforming digital magnetic track into a text page on the screen (or a printer). Interpretation is always based in previous experience of the individual, species, lineage, an experience that goes back to the very beginning of life. Any interpretation is a historical singularity that will change the run of the world. To adapt the terminology of S. Kauffman, autonomous agents, by performing interpretation acts, bring the world into the adjacent possible.

In this respect, we are already entering the realm of ontology, the ontology of hermeneutic circle as laid out by M. Heidegger — or as outlined by modern physics in a somewhat different flavour (although non-physicists rarely appreciate this). However, even the physicists' world does not encompass the semiotic dimension yet. Adoption of the hermeneutic and semiotic methods by natural science would, hence, mean a decisive step towards *biologisation of physics*, centring sciences in biology — a bold parallel to the already accomplished biologisation of chemistry by development of organic chemistry and biochemistry.

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Назад к науке о жизни

Статья предлагает обзор эпистемологических и онтологических подходов, оставивших свой след в биологии XX века. Общее для всех них стремление — соединить биологию и точные науки. Попытки эти не удались и им суждено провалиться и в будущем, пока критерии, на основании которых определяется статус науки, не станут биологически ориентированными. Это означало бы расширение классической сферы наук о природе, путем присоединяя к ним хотя бы части понятийного аппарата "гуманитарных наук". Предлагаем три взаимодополняющих друг друга возможных кандидата для дальнейшего развития в этом направлении: модулярная биология, герменевтика живого и семиотические дисциплины.

Tagasi eluteaduse juurde

Artikkel annab ülevaate epistemoloogilistest ja ontoloogilistest lähenemisviisidest, mis on jätnud jälje 20. sajandi bioloogiasse. Ühine motiiv enamikule neist on püüe liita bioloogia ühte täppisteadustega. Seesugused katsed on siiski ebaõnnestunud, ja ebaõnnestuvad ka tulevikus, kuni kriteeriume, mille alusel määratletakse, *mis on teadus*, ei ole muudetud bioloogiakeskseks. See tähendab klassikaliste loodusteaduste sfääri laiendamist, ühendades nendega vähemalt osa "humanitaarteaduste" mõistestikust. Esitame kolm vastastikku üksteist täiendavat kandidaati selle suuna edasiseks arendamiseks: modulaarne bioloogia, elusa hermeneutika ja semiootilised distsipliinid.

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Three types of semiotic indeterminacy in Monod's philosophy of modern biology

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Abstract. Synthesizing important research traditions in information theory, structuralist semiotics, and generative linguistics, at least three main types of semiotic indeterminacy must be distinguished: Kolmogorov's notion of *randomness* defined as sequential incompressibility, de Saussure's principle of *contingency* of sign which ensures the possibility of translation between different sign systems, and Chomsky's idea of *indefiniteness* in generative mechanisms as a requirement for the explanation of semiotic creativity. These types of semiotic indeterminacy form an abstract system useful for the description of concrete sign processes in their syntactic, semantic, and pragmatic dimension. In his philosophical reflections on modern biology, Jacques Monod used the conceptual opposition *chance versus necessity* to analyse several phenomena of indeterminacy (especially in molecular biology). The biosemiotic approach to life permits to apply the suggested system of semiotic indeterminacy on these phenomena.

Larvatus prodeo

The semantic field of indeterminacy is of great importance for modern science. Without notions like randomness, contingency, indefiniteness, probability, and undecidability, it would be impossible to formulate central findings of logic, information theory, semiotics, quantum physics, biology, sociology, etc. So this semantic field extends across the borders between natural, structural, and cultural sciences.

Biosemiotics can profit from an intense reception of the multifarious explorations of indeterminacy in modern science. Systematically, it is necessary to build up an abstract system of different types of semiotic indeterminacy that can be applied to the analysis of concrete sign processes. Historically, the philosophical reflections on modern biology that were made in the so called "French school of molecular biology" (Fantini 1988: 14) are rich in interesting ideas for the biosemiotic exploration of indeterminacy.

A close reading of Jacques Monod's *Le hasard et la nécessité* (Monod 1970) shows that Monod reflects on three different kinds of *hasard* which can be co-ordinated within the semiotic dimensions of syntax, semantics, and pragmatics (1). These types of indeterminacy should be defined with the help of information theory, structuralist semiotics, and generative grammar, respectively (2). I have to concentrate on the first two types, randomness and contingency (2.1 and 2.2), and can only hint at some aspects of the third type, indefiniteness (3).

1

At its first publication in 1970, Monod's *Le hasard et la nécessité* has stirred up a heated debate about the philosophical premises and consequences of molecular biology. In the centre stood Monod's thesis that life results from a very improbable event (Monod 1970: 62). I do not want to reanimate the great hubbub that arose around this special kind of tychism and its existentialistic looks. Instead, I propose to analyse the use of the expression *hasard* in Monod's natural philosophy because here, semiotics can show its relevance to theoretic biology.

The conceptual structure underlying the use of the expression *hasard* in Monod's natural philosophy consists of three main elements.

Monod encounters the first type of indeterminacy in the primary structure of proteins. This structure is built up as a sequence of amino acids the order of which is *au hasard* (Monod 1970: 127): if the linear succession of 199 amino acids in a chain of 200 is well known, no rule exists to predict the last one. This kind of unpredictable structure I will call *random*.

The second type of indeterminacy shows up in Monod's discussion of the genetic code. He comes to the following conclusion: it seems to be very probable that this code is *chimiquement arbitraire* (Monod 1970: 182), because no stereochemical reason can be given for the selection of a certain codon in the DNA to codify a certain amino acid in the primary structure of a protein. This kind of missing motivation I will call *contingent*.

Naturally, Monod does not intend to say that the biosynthesis of a protein is an *ad hoc* process when he underlines the importance of randomness and contingency. On the contrary! According to Monod, the highly invariable primary structure of a protein results, directly or indirectly, from the whole history of the biosphere. But exactly because of this thoroughly historical causality, it is impossible to decipher the biochemical function of a protein from its primary structure (Monod 1970: 128f). We can state the same in respect to the contingency of the relation between an amino acid and its encoding in the DNA: in a diachronic perspective, the concrete sign functions result from historical processes which cannot be fully specified only with the knowledge of their end-products. Analogously it must be said that even in a synchronic perspective, the knowledge of the chemical structure of the codons on the one hand and of the amino acids on the other hand is not enough to deduce the whole mechanism that connects these two sides. This third kind of *a posteriori* I will call *indefinite*.

For Monod, these three types of indeterminacy are primarily no reflections of the limits of biological knowledge but inhere in the ontological structure of life itself (Monod 1970: 148ff). The sequence of amino acids in a protein *is* random, the codon for an amino acid *is* contingent, and the functionality of a protein *is* indefinite. In the light of Monod's natural philosophy, a possible semiotic exploration of these phenomena of indeterminacy would by no means be an analysis of biological discourse but a research directed towards the objects of biology.

The next step in such a semiotic exploration must define the notions of randomness, contingency, and indefiniteness in more formal terms. The distinction between syntax, semantics, and pragmatics provides us with a useful framework hereto.[1] For the purpose of

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[1] Cf. Cariani (1998) on the distinction between syntax, semantics, and pragmatics as a general framework for biosemiotics.

analysing Monod, I propose the following definitions of these semiotic dimensions that differ from the classical ones of Charles Morris (1938), insofar as their conceptual base is the Hjelmslevian notion of the sign function as a relation between different semiotic planes (Hjelmslev 1993).[2]

A sequence of semiotic objects is investigated *syntactically* when neither the possible inner sign functionality of the elements of the sequence nor possible sign functions between this sequence and other ones are considered. The main abstract syntactic characteristic of semiotic objects is the order in which their elements follow one after the other. Information theory is mostly interested in this one-sided linearity.

Semantically, the connections between different semiotic planes are decisive. These relations can be registered in the single elements of one sequence as sign functions between a form of expression and a form of content. But sign functions can also be described between different sequences, whether they are internally sign-functional or not. The main abstract semantic characteristic of semiotic objects is their functionality. Structural semiotics has focused on these biplanar phenomena.

When the generation of semiotic objects is scrutinized, their *pragmatic* dimension comes into play. Such an exploration should be directed towards the interplay of syntax and semantics. The main abstract pragmatic characteristic of semiotic objects is their processual quality. Generative grammar is an important example of this kind of research although the name of this theory seems to designate only syntactic studies. But generative grammar describes one special semiotic competence as a capability to build up syntactically ordered sign functions so that this process works like an interface between expression plane and content plane (Chomsky 1988).

The three notions of indeterminacy found in Monod's natural philosophy can be mapped onto the semiotic dimensions of syntax, semantics, and pragmatics.

The *randomness* of the primary structure of proteins is of syntactic form: only the linear order of the chain of amino acids is involved in the statement that the question after the 200th element in the primary

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[2] Cf. Chebanov (1999) for another biosemiotic use of glossematics.

structure of a protein cannot be answered only with the knowledge of the previous 199 elements.

Contingency is a semantic phenomenon: the chemical structure of a DNA codon cannot be inferred from the chemical structure of the encoded amino acid and vice versa. So there are two different planes (a plane of expression manifested by the DNA sequence and a plane of content manifested by the primary structure of the protein[3]), and no motivation for the specific connections between their elements in terms of one plane or the other can be found.

Indefiniteness is pragmatic indeterminacy. The knowledge of the two planes of the sign function between the primary structure of a protein and the encoding in the DNA is not enough for specifying either all the processes that build up the linearity of the protein and of the encoding, or all the processes that lead to the biplanarity of the sign function, both in a diachronic or in a synchronic perspective. And exactly this is meant by indefiniteness.

2

It is necessary to fix the still loose coupling between Monod's types of indeterminacy and the three semiotic dimensions. In the following, this will be done for randomness and contingency. Andrei N. Kolmogorov's information-theoretic concept of randomness cannot only sharpen Monod's description of syntactic indeterminacy but will also help to indicate the limits of information-theoretic models for biological phenomena (2.1). Thereafter, the structuralist concept of the sign is applied to analyse Monod's semantic indeterminacy. In the semiotic tradition, Ferdinand de Saussure's principle of arbitrariness of sign and Roman Jakobson's postulate of universal translatability are the main references hereto (2.2).

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[3] In Hjelmslevian semiotics, the expressions *expression* and *content* are "arbitrære" (Hjelmslev 1993: 55). They are used only to distinguish terminologically between the two planes contracting a sign function. Therefore, it would be equally possible to write: a plane of expression manifested by the primary structure of the protein and a plane of content manifested by the DNA sequence.

2.1

The decisive idea for defining indeterminacy on one semiotic plane comes from the information-theoretic work of Kolmogorov that meanwhile developed into the theory of algorithmic information.

To define the randomness of a sequence of semiotic objects, first of all it is necessary to introduce the notion of the complexity of such a sequence. The Kolmogorov complexity of a semiotic sequence is the length of the shortest program that could produce the sequence in question as an output of an abstract automaton (like a universal Turing machine). The sequence is *random* when its complexity is approximately equal to its length. In the view of Kolmogorov, randomness means that we practically cannot compress a sequence by its algorithmic representation because a random sequence shows no or only negligible inner regularities. In comparison with the bit-length of such regularities, the program generating them would be describable with decisively fewer bits (Kolmogorov 1969).

Monod's example of syntactic indeterminacy is a paradigm of randomness in the sense of Kolmogorov complexity. That the 200th amino acid in the primary structure of a protein cannot be predicted even when the first 199 amino acids are well known, is only a more concrete way of saying that there are no algorithmically compressible regularities in the primary structure.

But Kolmogorov complexity not only permits a formalization of syntactic indeterminacy. In a meta-theoretic perspective, this concept can also be used to disprove Monod's assumption that he has shown the impossibility of finding some regularities in the primary structure of a protein (Monod 1970: 127). Here, we have to employ an incompleteness theorem of the computer scientist Gregory J. Chaitin who has developed the theory of algorithmic complexity into a prosperous meta-mathematical discipline.

Chaitin's incompleteness theorem indicates the following limit of information-theoretic reasoning: the proposition that a sequence has a Kolmogorov complexity greater than a certain fixed value cannot be proved in a formal axiomatic system with a Kolmogorov complexity smaller than this value (Chaitin 1974).[4]

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[4] More precisely: a formal axiomatic system with Kolmogorov complexity greater than K plus a constant (dependent on the automaton that implements the system) is needed to generate the set of all theorems stating that a sequence has Kolmogorov

The drastic consequence of this theorem for Monod's philosophy was drawn by Bernd-Olaf Küppers. The assumed impossibility of disproving the randomness of the primary structure of a protein is itself unprovable in the framework of a formal system that has a Kolmogorov complexity smaller than the one of the primary structure. Küppers argues that to find by chance in the set of more than 2^K possible sequences the right one that proves as a codification of a formal system the randomness of another sequence with Kolmogorov complexity *K*, is very improbable (Küppers 1990: 100ff). A second way to formulate this improbability goes as follows. The chances to find an algorithm as a formal model for the evolution of a primary structure are very small because the sequence in question may be supposed as of tremendous complexity when described on the level of specification necessary to include algorithmically every kind of known natural law that could generate regularities in the sequence. It follows again that for all practical purposes, the construction of a formal system with the necessary complexity for a proof of randomness of primary structure is not feasible.

2.2

Küpper's meta-theoretic critique of Monod is not the consequence of an information-theoretic *a priori* but of a natural *a posteriori*: when the complexity of a system has grown in its history, it is conceivable that the randomness of its initial state could be deduced from its description at a later time. The more it is amazing that one important application of Kolmogorov complexity on the object level of biology follows an information-theoretic *a priori* reasoning.

Chaitin's struggle for an algorithmic theory of evolution based on Kolmogorov complexity shows the impossibility of reducing the evolutionary process to syntactic processes. Even in a very simple model of evolution proposed by Chaitin, he must introduce a semantic criterion through the backdoor: syntax is not enough.

Chaitin describes a computable sequence of rational numbers leading in the infinite limit to an uncomputable infinitely complex number called Omega as an "abstract example of evolution" (Chaitin

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complexity *N* (for all *N* smaller than or equal to *K*) and of all theorems stating that a sequence has a Kolmogorov complexity greater than *K* (Chaitin 1974: theorem 4.3).

1988: 317). Chaitin's Omega number is the famous halting probability of a universal Turing machine. Alan Turing has proven in 1936 that this halting probability is not computable (Turing 1936): it is a random real number with infinite Kolmogorov complexity. So Omega can be seen as the limit of a computable sequence of rational numbers that converges to Omega uncomputably slowly.

It is not surprising at all that the rational numbers in this sequence will have an ever increasing Kolmogorov complexity. What Chaitin, however, is interested in, is the complexity of the first K bits of each of the rational numbers because at some time the Kolmogorov complexity of these first K bits will not fall under the threshold value of K bits.

How is the sequence of rational numbers converging to Omega built up? Chaitin constructs the Nth approximation of Omega as follows: "One merely considers all programs up to N bits in size and runs each member of this finite set of programs for N seconds on the standard universal Turing machine. Each program K bits long that halts before its time runs out contributes measure 2^{-K} to the halting probability Omega" (Chaitin 1988: 317). A non-syntactic criterion is present here at a very important position: every program N bits in size has the chance to run N seconds on the universal Turing machine. This cannot be justified in pure syntax; the time limit is of pragmatic nature: we cannot wait till infinity for the halting of a program.

For biosemiotics, there is more to get out of Chaitin's algorithmic model of evolution. In its finite version, a computable infinite sequence of strings with a fixed length of N bits is determined as an approximation to Omega. Then, there exists a time t after which the strings will not alter any more. These strings have a Kolmogorov complexity not less than N bits because they cannot be computed by any program shorter than N bits in less than t seconds. Chaitin remarks that in some respect the N bits of information of the strings generated at time t and later "are coming from t itself" (Chaitin 1988: 318). These N bits are simulating the first N bits of the halting probability Omega, and the time t encodes the information about how long we have to wait till seemingly knowing them.

Information-theoretically, such a source of normally not accessible information is called an oracle (Chaitin 1977). This diviner has a genuinely semantic function. It connects a syntactic sequence (like a string of N bits in Chaitin's finite model for evolution) to another one (like the first N bits of the halting probability) that cannot be computed anyhow from the first sequence. But this first sequence can act as an expression of the second one so that the second sequence is the content of the first one. In Chaitin's evolutionary model, this sign functionality really strikes the eye: the first sequence is computable, the second one is uncomputable, so the second sequence cannot be deduced from the first one, but the first sequence can stand for the second one when we have established the time t as a non-syntactic criterion.[5]

Ferdinand de Saussure has recognized the absent mutual deducibility of two nevertheless connected planes as the essence of the sign. Although the exact meaning of de Saussure's first sign-theoretic principle, *l'arbitraire du signe* (Saussure 1967: 100), has been and still is the object of an intense debate in semiotics, I think that the Danish glossematician Niels Ege has correctly analysed de Saussure's notion of *contingency*.[6] He distinguishes two perspectives on the sign. Seen from the outside, a sign is presupposing a whole system of signs and vice versa, so in this respect a sign, as an element of a semiotic system, is not contingent. But seen from the inside, the relation between a given expression and a given content is not motivated by either plane and, therefore, is contingent in the sense of de Saussure (Ege 1970: 26).

From this double perspective, it is possible to recognize another version of de Saussure's insight into semantic indeterminacy. In his essay *On linguistic aspects of translation*, Roman Jakobson (1971) formulates a principle of universal translatability. Understanding a sign, means to be able to translate it into another sign not necessarily of the same semiotic system but also of other such systems. Therefrom does not follow that there normally exists a one-to-one correspondence between both signs. But when we permit, for example, different lengths of the involved sequences, we can say that what is semiotic, is translatable.

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[5] Here, Küpper's conjecture: semantic structures are syntactically random (Küppers 1996: 213f), is within reach. In a semiotic way, it should be formulated as follows: syntactic sequences entering a sign function are Kolmogorov random with respect to each other.

[6] I use the term *contingency* rather than *arbitrariness* because of Lacan's right criticism of the second expression (Lacan 1975: 23, 32, 41).

In respect to the sign function, de Saussure's principle of contingency designates the same semiotic fact as Jakobson's principle of translatability: a sign is translatable because its inner relation between an expression and a content is contingent in spite of the determination of the sign by its semiotic system; and the relation between an expression and a content establishing a sign is contingent because the resultant sign is translatable from one semiotic system into another.

3

By showing itself as translatability, contingency is the main semantic premise for the growth of semiotic freedom (Hoffmeyer 1996). To discuss this evolutionary process in-depth, it seems necessary to look upon its pragmatic dimension. What biosemiotic insights can we await here that go beyond those in the syntactic and in the semantic dimension?

Our description of pragmatic indeterminacy in Monod's natural philosophy has shown that we have to search for an answer by scrutinizing the processual indefiniteness in the generation of syntactic and semantic structures. For biosemiotics, the main theoretic reference for this kind of research is evolutionary theory. In a Darwinian framework, we should await important hints especially from the subtheory of natural selection because there, the very historicalness of evolution must be explained (Maynard Smith 1993: 42).

Abner Shimony has underlined that the theory of natural selection has no general principles of its own which could not be derived from propositions of the evolutionary subtheories of variation and heredity (Shimony 1989). Stripped bare to their respective formal structure, variation means the exchange of an element at one position in a sequence that does not necessarily imply any functional relation to another sequence, whereas inheritance *per se* designates a functional relation between different sequences. Now Shimony writes,

> I construe the neo-Darwinians as trying to say meta-theoretically that the evolution of the biosphere, subsequent to the establishment of the genetic code, is governed by the principles of heredity and variation and the laws of physics, and is constrained by biological and environmental boundary and initial conditions, but *not constrained otherwise*: within these constraints *let happen what happens*. (Shimony 1989: 229; emphasis by Shimony)

If we accept this description, then for biosemiotics the neo-Darwinian research program is a conceptual experiment upon the radicalization of pragmatic indeterminacy. Why radicalization?

Pragmatic indeterminacy was defined as the unsurmountable indefiniteness of forms possibly occurring in the generation of syntactic and semantic structures. And the background of definiteness with which this indefiniteness contrasts, consists of the syntactic and the semantic dimension, their indeterminacies included. If selection, as a pragmatic phenomenon, is the process of establishing syntactic and semantic structures, and if Shimony is right to see selection as a result of variation, inheritance, and some boundary conditions, then pragmatics is nothing else than the interplay of syntax and semantics in certain contexts. With respect to the three types of indeterminacy, this means that pragmatic indefiniteness occurs when syntactic randomness and semantic contingency meet under certain conditions. No further pragmatic constraints on such events should be awaited; or, as Monod has put it, pragmatic indeterminacy is *essentiel* (Monod 1970: 149).

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Три типа семиотической неопределенности в философии современной биологии Моно

Синтезируя важнейшие исследовательские традиции в теории информации, структуралистской семиотике и генеративной лигвистике, нужно различать по крайней мере три главных типа семиотической неопределенности: понятие слуайности у Колмогорова, дефинированное через несократимость последовательностей; принцип арбитрарности знака у Соссюра, делающий возможным переводимость между разными знаковыми системами и принцип индефиниции генеративных механизмов Хомского, что является предпосылкой семиотической креативности. Эти типы семиотической неопределенности составляют абстрактную систему, которую можно использовать при описании конкретных знаковых процессов в синтаксическом, семантическом и прагматическом измерениях соответственно. Анализируя в своих философских работах разные феномены непоределенности (особенно в молекулярной биологии), Жак Моно пользовался концептуальным противопоставлением между случайностью и необходимостью. Биосемиотический подход к жизни позволяет при изучении этих феноменов использовать предлагаемую систему семиотической неопределенности.

Semiootilise määramatuse kolm tüüpi Monod' kaasaegse bioloogia filosoofias

Sünteesides olulisi uurimistraditsioone informatsiooniteoorias, strukturalistlikus semiootikas ja generatiivses lingvistikas, tuleb eristada vähemalt kolme peamist tüüpi semiootilist määramatust: Kolmogorovi *juhuslikkuse* mõistet, mis on defineeritud järgnevusliku koondamatuse kaudu, de Saussure'i märgi *suvalisuse* põhimõtet, mis võimaldab tõlgitavust erinevate märgisüsteemide vahel, ja Chomsky generatiivsete mehhanismide *indefiniitsuse* ideed, mis on semiootilise loovuse seletamise tingimuseks. Need semiootilise määramatuse tüübid moodustavad abstraktse süsteemi, mida on võimalik kasutada konkreetsete märgiprotsesside kirjeldamiseks vastavalt süntaktilistes, semantilistes ja pragmaatilistes mõõdetes. Oma kaasaegse bioloogia ainelistes filosoofilistes käsitlustes on Jacques Monod kasutanud kontseptuaalset vastandust *juhuslikkuse* ja *paratamatuse* vahel, analüüsimaks mitmeid määramatuse fenomene (iseäranis molekulaarbioloogias). Elu biosemiootiline käsitlusviis lubab nende fenomenide puhul rakendada väljapakutud semiootilise määramatuse süsteemi.

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Where bonds become binds: The necessity for Bateson's interactive perspective in biosemiotics

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Abstract. The paper examines important discrepancies between major figures influencing the intellectual development of biosemiotics. It takes its perspective from the work of Gregory Bateson. Unlike C. S. Peirce and J. von Uexküll, Bateson begins with a strong notion of interaction. His early writings were about reciprocity and social exchange, a common topic among anthropologists of the time, but Bateson's approach was unique. He developed the notion of meta-patterns of exchange, and of the "abduction" of these meta-patterns to a variety of other phenomena, in both biology and in game theory. Later, Bateson's concept of *ecology of mind*, the product of interactive phenomena, was modified by a non-purposive cybernetics. Biosemiotics has yet to adopt Bateson's interactive stance, which is absent from Peirce's approach to communication, of Uexküll's *functional cycles*, and of Hoffmeyer's discussion of the relation between *culture* and *environment*. Rather than pursuing notions of appropriate "subjectivity" through changed ethical response to ecological conditions (Hoffmeyer's discussion of empathy), the paper discusses the advantages of an approach that continues to focus on conditions of paradox and pathology. Specifically, Bateson's *resolution* of the relation between culture and environment arises from situations of blocked communication where ecological bonds become binds.

Introduction

The central importance of Gregory Bateson's ideas to the new biosemiotics, specifically to the writings of Claus Emmeche and Jesper Hoffmeyer cannot be disputed. The following concepts in the writing of Emmeche and Hoffmeyer are references directly drawn from Bateson: the conceptualization of difference as a "difference that makes a difference"; the refutation of mind and body as Cartesian duals in which "mind" lies in a hierarchical and therefore superior position to "body"; code duality, a distinction between analogue and digital coding in which analogue coding cannot be reduced to digital coding and vice versa; the importance of this for a better understanding of adaptation, as currently — orthodox neo-Darwinian molecular biology — conflates the two and attributes them holus-bolus to the activity of "the gene"; the notion of consciousness as a switch; the importance of disentangling notions of consciousness and human intentionality from a framework of control, specifically control over the environment; the notion of "the pattern which connects" as a methodological and epistemological project which overcomes the gap between culture and environment; the role that inter-subjective play among animals, and hence prototypical instances of "deceit" and "trust", has for our understanding of the origins of the linguistic distinction "not" (rather than the conventional notion that bodily gestures generated this communicative distinction). Emmeche has remarked that Bateson emerges as a "full-blown semiotician" (Emmeche 1999: 291n).

As a source of inspiration for the new biosemiotics and ecosemiotics, Bateson takes his place alongside C. S. Peirce and J. von Uexküll. Unlike the latter, Bateson begins his analysis from a different starting point, that of interaction rather than "subjectivity". As this paper will explain, Bateson's starting point is crucial if and when biosemiotics (and/or ecosemiotics) begins to include aspects of social relationship within the "life of signs" and must do so when it engages the issues of culture and environment. Culture embodies not only signs but signifiers and interpreters in relation to each other. So far discussion of this aspect of culture in biosemiotics has been minimal.

Communication: Inter-subjectivity and monologue

Neither Peirce nor Uexküll rejected an inter-subjective perspective. Indeed, the later writing of C. S. Peirce took up inter-subjective themes and as Oehler remarks Peirce's tendency to conceive "subjectivity" inter-subjectively gets stronger towards the end of his life (Oehler 1987: 11). Nevertheless, Peirce reached his concept of signification initially as a result of a phenomenological analysis of the dialogue situation. Thus the communicative process and distribution of relations between speaker and hearer were marked as if signification in communicative activity followed from conversational dialogue with oneself. While Peirce is able to transform Kant's "transcendental subjectivity" to intentions of a speaker in actual communicative situations, he did not analyze communicative situation itself in terms of social variance of speakers. Peirce' theories of reality assumed ideal communicative groups. As a result the translation of Peirce from philosophical discourse to social discourse is difficult and requires commentators bold enough to re-align Peirce's vocabulary in order to bring it into sufficient correspondence with more sociological thinkers. One interesting attempt is made by Wiley who, in conjoining Peirce with his contemporary, George Herbert Mead, expands upon an implicit notion of "I" in Peirce's writing and translates it as the subjective "self" in order to place it in relation to G. H. Mead's thoroughly social conception of "me" as the self-in-society (Wiley 1994).

J. von Uexküll's writing is further removed from social processes. In fact he confines his writing to cellular and inter-cellular sign systems, on the one hand, and sign systems in which animals in their environment appear as "meaning-utilizers of meaning carriers in their environment" (T. von Uexküll 1987: 175). He thought of biological sign systems as "natural codes" which, unlike culture specific codes, were "innate". If culture specific situations were dialogical, biological sign processes were based on "monologue". Uexküll's discussion of functional cycles demonstrates what he means by 'monologue' for — using sender-receiver terminology — the receiving function and the function of transmitting came together in such a way in a "functional cycle" that the biophysical receptors of an organism are "receivers", while the operative biophysical effector following such "reception" are "transmitters". There is, therefore no dialogue between senders and receivers in "functional cycles", and no self-reflexiveness during sending and reception. As T. von Uexküll states, the system or class of signs which a human observes and talks about is therefore very different to, perhaps in opposition to, the class of signs of the organism under observation.

As with many biologists, J. von Uexküll believed that the prototype of sociality among human groups was language. And while the use of language is clearly inter-subjective, nevertheless "the schemata (private character of signs) which we have formed during our life are inter-subjectively identical only in the most general outlines" (T. von Uexküll 1987: 161). Hence J. von Uexküll proceeds to investigate private character of "the exchange of signs", schema in "a subjective universe" both among humans and more particularly between humans and animals. Biosemiotics is urged to continue to examine the "subjectivity" of organisms in relation to environment. Thus:

> In order to make the concept of semiotics valuable for both biology and medicine we must examine what it means [to undertake an examination of how] all signs that can be exchanged between living systems as well as between these and their surroundings... the signs that an observer of life systems registers are in the first place signs with which he interprets the events he himself has observed. However since the living systems he has observed are themselves interpreting their own surrounding, he must interpret their interpretations whereby these systems decipher their environment [...] We must , as meta-interpreters, try to reconstruct the interpretation that points the way for the paramecium in its surroundings. (T. von Uexküll 1999: 650–651)

Nevertheless, meta-interpreters of living systems derive a large proportion of their perceptions and cognition from the social world of which they are a part. Biological scientists today, even of paramecium in their surroundings have a hard task convincing their public that their observations are entirely "value free".

Bateson's interactive stance

While some sociologists, especially in the period 1920–1940 looked for the prototype of human sociality in language, the tradition of sociology, certainly of anthropology, is heavily weighted towards the proposition that the roots of human sociality are to be found in social acts rather than languaging. The social enactment of signification, rather than the mere ability to signify provides the rudiments of "bonding" in social exchange. Bateson follows this trend though much of his later writing about human sociality provides a study of the adverse effects of "bonding", the "double bind" that can lie within social bonds, and binds in ecological interactions as well. The differences between Bateson and Uexküll on the issue of the "subjectivity" of the organism, and of the position of observers reporting upon "subjectivity" and "feedback" are therefore important.

As an interactionist Bateson argued that "Mind", subject, self, as with the many forms of subjectivity and individuality so pervasive in western scientific thinking, was not "in" the head, but always derived from the interactions of self with other and self with system. And this understanding must be fundamental to participatory observation, whether of humans or of animals or of the human-animal world. With regard to any issue of intelligence and observation, Bateson, consistently wrote against the idea of a single located space of explanation. He thought that such a framework of explanation always to led to error. In the realm of human beings, many of the problems in approaching mind and self in sociology, anthropology and linguistics arose from the way each discipline presumed that the internal mind of individual selves was a starting and ending point for their investigation. The same was true of animal intelligence. Uexküll is evidently no exception to discussing animal intelligence, perception and communication from the vantage point of the individual organism. Perhaps this is why Bateson does not refer to him in his own writing, though he must have known of Uexküll's opposition to Darwinian interpretations of evolution. Bateson's own method was of double description and never that of single description, that Newtonian dimension which always located "self" or "mind" in a single space. For Bateson mind is "no-thing". It is empty. It exists only in its ideas and these again are no-things. And an idea is what mind makes of it, in its communicative interactions, namely an example of something or other (Bateson 1978: 9).

Bateson always started analyses with interaction between individuals, and never with the single individual. The unit of analysis, reciprocal communicative interaction, belonged to neither individuals *per se* but rather reflecting rules of relationship between the communicating partners. Senders and receivers were, of course, connected in some physical manner to each other, for all communication requires a material carrier, but the communicative content drawn from physical connection was at another, less important level of meaning than that drawn from the rules of the relationship existing between the communicators.[1] Among humans, any messages must be interpreted primarily from the rules of the relationship existing between individuals; in the animal world this included such phenomenon as predator and prey, a "dog chasing a hare".

There are, perhaps, three periods of his investigation of intersubjective interactions. In each period Bateson tended to look not only at single interactions but at patterns of interactions and meta-patterns of those interactions in a dynamic context. In other words from the beginning of his career in the 1920s Bateson developed a meta-level focus in his discussion of social interactions. This was most unusual in social psychology and of anthropology both of which continued from the 1920s to the 1970s to derive explanation from empirical data of observed interactions, mostly through small group research or ethnographic study of small communities. Kurt Lewin's field theory of social psychology, to which Bateson was attached during the 1940s and 1950s, was an exception. In their studies of community, social anthropologists re-constructed empirical observations of ritual acts involving, for example, sacrifice of animals and plants. It was within this re-written "structure" of social relations, the anthropologists depiction of ordered relations that individual observations of ritual acts took on an overall coherence as a belief system.

In Bateson's Australasian period of fieldwork, that is to say his research prior to World War II, Bateson looked at aspects of reciprocity or gift exchange in the middle part of the Sepik River of New Guinea. He argued that patterns in gift giving ought not originate from direct observation of individual gift giving *per se*, but from a more dynamic aspect in which variance in the cycles of cumulative interactions the main focus. He argued that observed reactions of

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[1] Bateson even believed that symbolic interactionists like George Herbert Mead who investigated the meaning of symbols told only half a story of the relation between social action and communicative reflexivity. G. H. Mead's concept of roles and role-taking did indeed describe a social "reaction of reaction", but Mead never considered a meta-patterning of the dynamics of exchange in role-taking, which would have resulted in the investigation of "I know that you in your role are taking account of me in my role" allied to analysis of the rules of the relationship i.e. "what are the social conditions of role-taking in the first place?" Bateson and his colleagues at Palo Alto undertook such analyses.

villagers to a receipt of a gift, yielded information about "the reaction of reactions" to gift giving. Rather than reporting a simple empirical outcome of how individuals engaged in acts of exchange vis-à-vis one another, an anthropologist should concentrate on how these "reactions to reactions" generate exchange cycles. In turn, this leads to a consideration of the changes which cumulative interaction brings about within exchange cycles.

Thus, long before postmodernism, Bateson was arguing that the dynamics of such exchange cycles would only become apparent through a "reflexive take" on empirical fieldwork data. As the observer's reflexive take shifts to the dynamics of interaction and its characteristic cycles, the patterns of interactive dynamics in the cycle of exchange would reveal evidence that empirical treatment of data would ignore, possible runaway effects of cumulative interactions, for example. Bateson termed this study of meta-patterns of exchange "schismogenesis", for, at the point that runaway occurs, initial patterns of reciprocity become transformed into vicious circles and are broken-up. He argued there were cultural preferences for particular interaction sequences, hence cultural preference enters into particular forms of runaway, unless that culture enacts procedural rules to prevent the occurrence of vicious circles (Rogers 1981: 235ff). In addition, he argued that there was cultural preference for particular forms of interactive sequences between individuals and/or groups which prevented runaway effects and that this pattern of cultural preference was a striking outcome of the embeddedness of interaction sequences in cultural relationships. He presented a comparative case study based on his research in New Guinea and in Bali.

His meta-pattern perspective permitted Bateson to pursue the notion of the "universality" of reciprocity or exchange in a very different manner from other anthropologists. Instead of writing about the universality of reciprocity and the way a common underlying structure of reciprocal exchange enters into all types of human social relations, he began to "abduct" his investigation of cumulative interactions of "reciprocity" in a variety of contexts, such as comparing gift-giving with the diplomacy of armaments races. Later these included studies of cumulative interactions in game theory, the prisoner's dilemma for example, and in families who have one member diagnosed as schizophrenic.

During his years elaborating cybernetic thinking, 1945–68, Bateson discussed interaction in cybernetic control systems, where oscillations produced not only runaway but also an alternative phase, that of the dampening down of feedback cycles. The pattern of binds in reciprocal exchange that needed to be studied Bateson noted, emerged from an understanding of the sort of oscillation that meta-patterns of interactivity displayed. He also enlarged upon his key concept that phenomena which people believe occurs inside the head, are part of a broader pattern of communicative interactions that includes social relations between people. Important meanings arose recursively, in feedback between individuals and those with whom they had intimate social relationships. Always a description of the "reflexive take" of people in interaction was required, before meaning could be interpreted in any communicative setting. The other important feature was that such descriptions of "reflexive take" should occur at various levels of interaction, one mapping upon another, so, for example, evidence about the injunctive or normative aspects of social relationships between people which gave overall context to their communication should be placed against evidence about the content of signification: metaphor, imagination etc.[2]

In the last ten years of his life Bateson carried these ideas forward into his "ecology of mind", his most lasting contribution. An ecology of mind requires that we must come to an understanding of living systems as part of own life-process, while at the same time recognizing that our own self-hood is part of that larger whole. Clearly this cannot be accomplished through so simple a method of description as describing as series of "needs" in a located space. Indeed, Bateson's initial objections to the methodology of one of the founding fathers of anthropology, Bronislaw Malinowski, was that Malinowski, in arguing about human social exchange, reduced "the social" in social activity to the biology of "needs", and Malinowski's depiction of "functional cycles" elaborated upon this reductionism.[3] I do not know

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[2] Much of the way in which Bateson revised cybernetics cognitive modeling of "control" as an aspect of located information is covered in my own book *A Recursive Vision: Ecological Understanding and Gregory Bateson* (Harries-Jones 1995) and in the book by Steve Heims, *The Cybernetics Group* (Heims 1991). Hoffmeyer also refers to Bateson's objections to control assumptions.

[3] Objections among anthropologists to Malinowski's "functionalism" a theory which proposed, inter alia, that all significant phases of cultural activity could be seen as an expansion of the biology of needs was widespread even before World War II.

of any Bateson reference to the "functional cycles" of J. von Uexküll, but it is reasonable to assume that his same objections would hold.

Ecology of mind

Because of the inherently social nature of communication, it is possible to step outside of the content of inter-subjective communicative interactions and adopt a mode of interpretation that is logically above, or "meta" to the events initiating the communication. In other words, it is possible to discuss human communication at the level of the rules about responses to messages, and even discuss meta- patterns of messages among communicants. This may be difficult, but family therapists following in the footsteps of Gregory Bateson accomplish this all the time, clarifying how inappropriate pattern and rules of communication create disturbance in meaning among the communicators. The problems of interpreting meta-communicative patterns in ecological situations are far more difficult. The rules of human-environment exchange are very uncertain, so strictly speaking there can be no "meta" "meta" perspective, in the sense of a perspective derived from "above" immanent conditions of exchange in human-environment relations. This, perhaps is a reason for so many cultures adopting a transcendental spiritual rather than immanent ecological perspective of their relations to their environmental surround.

Comprehending the ecology of living systems, requires, even more definitively than the study of communicative interaction among human beings, a concerted focus on both the difficulties and the possibilities of reflexive interaction with "nature". In one of Bateson's most amenable articles, "The pattern which connects", his sophisticated approach invokes all manner of interpretative forms at various

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Subsequently the criticism entered into introductory texts in anthropology. Bateson was always careful to be as positive as he could about Malinowski's achievements in published articles. In his private correspondence Bateson was scathing. An interesting exchange about Malinowski is contained in the correspondence he had with Meyer Fortes, and Bronislaw Malinowski himself, in and around November, 1935 [SPEA-Margaret Mead Collection, Library of Congress, Bateson Correspondence Box 01]. It is also of interest that Bateson's primary objection to Karl Marx was that Marxian political theory built itself upon a premise of human needs. The concept of "needs" as an explanatory premise, Bateson would argue later, introduced a confusion in logical types i.e. it was an abstract generality which required contextual unravelling.

levels of perception that might aid us to develop meta-perspectives: logical distinctions, aesthetic appreciation and their embodiments — shapes, forms and relations in their symmetries and in their modulation. There are always empirically observed connections in the morphology of a living creature, he reminds us, always patterns of bilateral symmetry and serial homology within a growing organism which can be readily observed The pattern which connects the crab to the lobster, the orchid to the primrose, me to you, are less obvious, for the pattern which connects these embodiments to each other are meta-order connections, based on similar relations between parts and their interaction within some ecosystemic whole. Finally there is a third level, meta-meta-connection (not to be confused with Peirce's notion of Thirdness) which is even more difficult to grasp. Here a comparison between the interaction of crabs and lobster must be compared with the comparison between men and horses, and all of us to the amoeba. It is these sorts of third level patterns of connection that we must try to grasp in the understanding of how humanity fits its own idea of self-hood into a larger whole of interactive interconnection of living systems. The question is not simply one of meta-interpretation of homologies in organisms but a comparison of patterns of patterns of interactive similarities and differences. "The *pattern which connects* is a meta-pattern. It is a pattern of patterns. It is that meta-pattern which defined the vast generalization that indeed *it is patterns which connect*" (Bateson 1978: 9).

In his final years of writing Bateson addressed himself to the topic of how we should develop a recursive epistemology able to think about such interconnections. In one of very his last papers Bateson pursues this point with regard to the differences between the logic in syllogism, that is the logic of empirical science, and tautology in nature. The latter he terms the logic of Barbara, and invokes the phrase "men are grass" in order to explore the tautology, i.e., tautology in the sense of mutual connectedness. He explores the metaphorical sense, juxtaposition of signs in the Barbara tautology, but behind the metaphor "men are grass" Bateson invites us to look at ecological circumstance. Humanity adapts to, and alters grass, through human agricultural practices. In fact the most cursory research reveals that the "men-grass" bond has been fundamental in the evolution of human beings and history of cultures. A broad ecological view of this pattern is that grasses have domesticated our species. As a consequence of species domestication the grasses are among the most successful organisms on Earth. The most productive plants for human beings have been those with edible seeds — grasses such as corn, wheat, rice and barley. Today cereal grains provide some two third's of humanity's intake, directly and through grain fed livestock, and occupy about half of the world's arable land. Yet modern crops are utterly dependent on a human agricultural infrastructure that feeds and waters them, protects them from pests and looks after their germ plasm (Bright 1998: 35–36). Successful bonds yield enormous mutual benefit, yet as Bateson points out, these very same bonds can also lead to relational dilemmas, both in human beings and in the natural world. Misunderstanding the significance of reciprocities in exchange and their mutual causality can threaten survival.

Culture and environment: The Hoffmeyer triangle

In his organizing diagram in *Signs of Meaning* Hoffmeyer seeks to untie western dualistic approaches to three fields of inquiry (Figure 1). The first approach is that of psycho-somatic dualism — duals raised in cognitive science and elsewhere that separate mind and body, mental activity from bodily activity. The second field of inquiry he unties is that of biology and semiotics, the dualism arising because biology predicates its analyses on the overwhelming determinism of inner nature, while one aspect of inner nature, the capacity to communicate, has come to be analysed in another discipline through "external" investigation of "languaging" and/or signification. Hence a prevailing dualism between inner nature and outer nature. The third field of inquiry he discusses is the dualism between culture and environment. Here Hoffmeyer argues that ecologists keep on splitting the world up into two distinct sectors, the natural and the cultural, thereby upholding several illusions that alienate human beings from nature (Hoffmeyer 1996: 43). He seeks to repair this dualism through an analogical extension of "subjectivity" in so far as the capacity for "subjectivity" in human culture can lead both to "empathy" for animals and other living organisms, and that empathy is in turn linked to the "ethical status" of animals and other living forms. The ethical debate within human culture is essential, Hoffmeyer states, in order to keep reviving "our existential need to empathize with other *umwelt* builders in this weird and wonderful world" (Hoffmeyer 1996: 141).

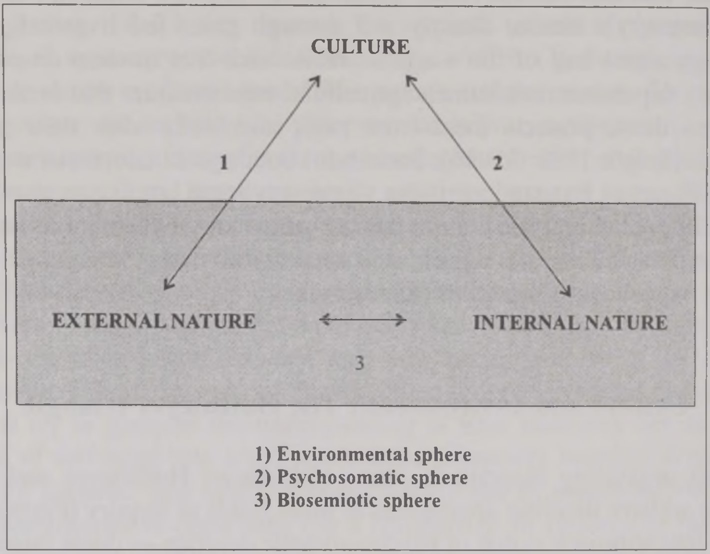

Figure 1. Hoffmeyer's "Lost Connection", or how biosemiotics mediates between humanity's outer and inner nature and between culture and nature (from Hoffmeyer 1996: 96).

The dualism Hoffmeyer seeks to overcome lacks the congruence of his other two cases. There are both differences in respective time periods of cultural formation and of formation of environmental conditions, and in their respective oscillation and rates of change. Hoffmeyer acknowledges that the operational aspects of memory, learning and forgetting are far more plastic in the realm of culture — as a result of language — than they are in the biophysical environmental realm of evolution, and that the patterning of code-duality in the two instances is therefore, not the same. There is a difference, yet the difference between the two does not yield a dualism.[4] The crux of

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[4] As I report in my own book, Bateson noted there were differences between culture and its evolutionary environment in that the level of genetic constraint in evolution had no parallel in culture. While genetic adaptations can affect levels of

Hoffmeyer's argument is that though our individual life stories become divorced from our genetic history, *"Not one but two stories are being enacted in the human body and consciousness"* at the same time (Hoffmeyer 1996: 133; italics in original).

To support his argument, Hoffmeyer discusses how evolutionary growth of language and self-consciousness in *Homo sapiens* has enabled human beings to break out of their own subjectivity and enabled them to share one large common Umwelt. He observes in the passage cited above how the common bond of speech increased the capacity of humans to empathize with animals and other living species and prepare humanity for the current "ethical drama of the human race". He calls for a profusion of semiotic niches in which humans relate to the "subjectivity" of other living creatures. In an earlier passage he states that "The spoken word has endowed the semiosphere with its very own self-referential vertical semiotic system [to complement horizontal semiosis of interconnections]. A new code duality has emerged and with it the dynamic basis for a totally different kind of evolution: cultural history" (Hoffmeyer 1996: 112). The problem is that Hoffmeyer talks here and elsewhere of "culture" and cultural history in a universal sense, though concepts examined are really a presentation of European cultural premises, specifically the premises of western science. Evolutionary appraisal of his key notions, "subjectivity" and "human empathy" is especially prominent, following a tactic frequently used by western science (until recently by western anthropology as well) in order to depict the existence of cultural predisposition. There is no need to evoke evolutionary sequences to investigate inter-subjectivity towards nature. There are many cultural examples open for inspection and which give detailed evidence as to how humans develop empathy towards nature. The conundrum is that such cultural examples are supported by traditional ecological knowledge and not supported by western scientific knowledge.

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levels of constraint among populations, culture "has no level of control between individual learning and the level of population". Culture cannot alter the homoeostatic bias of individual learning in the manner that genetic control at population level can alter the homeostat of the phenotype (Harries-Jones: 1995: 258). Among other things, lack of such constraints feeds potential for runaway in learned ideas. Perhaps we could add to this distinction by noting that while genetic constraints operate through the process of division and replication of an unbound state, the expansion and contraction of ideas evoked in a reflexive process is somewhat different from genetic conservation or mutation.

A good place to start is with the Australian Aborigines. Here there are a profusion of semiotic niches in which humans relate to the "subjectivity" of other living creatures all the way from interpretations of the Dreaming to anecdotal stories drawn from the lives of individuals (Rose 2000). Among the Yarralin, a band of Australian Aborigines, human beings are indeed regarded as being close to other placental mammals. It is dingo, the Australian wild dog, that is taken to be the true marker of the boundary between humans and other living creatures, or "what humanity would be if humans were not what we are". The reason given for their cultural preference for dingo is that humans are like no other animals in so far as the shape of their genitals is concerned. Clearly humans are not like Australian marsupials. Male kangaroos have their testicles and penis back to front from a humans perspective. Female kangaroos also have a pouch, human females do not.

Rose brilliant and sensitive account of the Yarralin centres around how Yarralin form their knowledge of boundaries between humanity and other living systems. Yarralin feel that they interpret very differently from the way that white Australians interpret the same evidence. And indeed they do. In the case of Yarralin, knowledge is indeterminate, it is not immediately gained through experimentation, and always subject to contextual revision in discussion among members of a social unit. The process of determining meaning is one of testing many meanings in a seeming free-for-all until some form of consensus is reached in the social unit and then "it is finished". There is redundancy to account for and there are countless reciprocities to pay attention to and interpret. Moreover "just as other beings' actions elicit response from human beings, so also human actions elicit responses from other beings [...][Yarralin believe] other species are watching us, reacting and responding" (Rose, 2000: 228)[5].

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[5] Rose's evidence is a clear break with Hoffmeyer's arguments about human Umwelt exhibiting graded "subjectivity". Hoffmeyer's thesis is that "The more anthropoid its [the character of the animal's] *umwelt*, the greater our empathy with it" (Hoffmeyer 1996: 140). Animal characteristics, behaviour and anatomy are rarely graded outside European cultures the way they are within it. Ours tend to follow the Linnaean categorization. As the Yarralin show, other cultures give animals and the living world very different symbolic qualities and shapes than those which European cultures perceive. Before we became human, the Yarralin say, we had genitals like dogs: "Women had a vulva stuck out the back and men had a penis that was attached up the belly, and when they mated they became stuck together the way that dogs do

Rose's evidence for Yarralin belief and the dynamics of their knowledge system is strongly related to Yarralin social interaction. She argues that in a total cultural system, its "totality" created by the social boundaries between white Australians and black Aborigines. Testing the veracity of events occurs and fades away within the dynamic interplay of communication and interpretation among Yarralin themselves. In this respect, nothing external is drawn into to the local culture or its knowledge system, though as a result of this social rejection of the external Aboriginal knowledge survives.

The knowledge system of western ecologists is also characterized by an inward looking social circle. As Bateson argued, any change in cultural ideas requires breaking, or reform of, social bonds in addition to a shift in levels of semiotic interpretation. Social bonds, not primary biological dispositions such as the capacity for sympathy and language, are the primary injunctive for human beings and social bonding cannot be abstracted from belief preference and appraisal of knowledge. The dominant idea discussed in Bateson's "The cybernetics of self" (Bateson 2000: 309–337) is that the "self" must be conjoined within a different social grouping in order to achieve a different epistemology. Bateson pointed out that the paradoxes of life from which extrication is so difficult always lead back to binds of relationships.

In his discussion of ecosystems, he suggests how modern day science alters the reciprocal bonds between humanity and nature in such a way that science drives nature mad. His example was the "death" of Lake Eire and the case of the St.Clair River next to Detroit spontaneously bursting into flames in the 1960s. Rather than consider how "empathy" for environment might relate in such a case to an individual's stance on his or her ethical responsibilities for environment, Bateson's resolution was to foster understanding of recursive epistemology, and of the dynamic interaction where *bonds* become *binds* . His premise was that faulty human thinking about nature will always return to stab humanity in the back. Therefore our primary methodology should be that of the uncovering of non-awareness of recursion in human-nature bonds and a further understanding of how

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[...] people used to get stuck together for days, even weeks. The dingo called in 'doctors' to fix us up. The bat cut a new vulva, and put a mussel there to keep it from closing up again. Bower bird (*Chlamydera nuchalis*) was the doctor for the men. He put the penis at the proper place and positioned the testicles correctly" (Rose 2000: 48).

this state of affairs locks — in cumulative errors of interpretation. A grappling with paradoxes, as they emerge, should be a primary means through which we investigate this problem. Since Bateson's death the paradox of "sustainable development" has provided an empirical example.

Conclusion

This paper has considered various aspects of Bateson's work and shown how they are predicated upon interaction rather than "subjectivity". In his early work, his examination of patterns in gift giving in human exchange lead him to an understanding of cumulative interactions within exchange cycles, which in turn revealed the presence of vicious circles and the presence or absence of feedback. Though Bateson borrowed from C. S. Peirce, particularly Peirce's methodology of abduction, he did not endorse Peirce's pragmatics, almost certainly because of the phenomenological framework of Peirce's methodology. In addition, while Bateson clearly supported Peirce's triadic logic, Peirce's discussion of the dialogical in communicative situations was, to a large extent, monological. Without understanding feedback properties at different levels, the one "meta-" to the other, Bateson believed one could not explain social dilemmas that arise in learning and other aspects of communication.

The type of feedback prevalent in J. von Uexküll's discussion of "functional cycles" is also monological rather than interactive. Uexküll's concept of Umwelt has been open to different sorts of interpretation. One argument is that "no animal ever takes up the role of an observer" (T. von Uexküll 1987: 162). Objects in the animal world are "only objects on which they are dependent as a result of biological needs (e.g. hunger) and which disappear from their surrounding world as soon as the need has passed". If so, then the operation of functional cycles must also be of a categorically different type of feedback than those predicated on the information principles of cybernetics. Another argument supporting J. von Uexküll is that animals are indeed "cognitive observers". One interpreter suggests J. von Uexküll's depiction of the relation of organism (as subject) to environment is in the form of a hermeneutic circle. A relationship of complementarity is struck between the Umwelt and the inner world of the organism through the organism's ability to form a "cognitive model" of its Umwelt, or, to use Uexküll's expression, there is a counter-structure between the organism and its environment as carrier and receiver of meaning (Nöth 1999). Bateson would not support either justification, the one because functional cycles are not cybernetic, the other because his own interactionist perspective categorically rejected hermeneutic interpretation.

In Bateson' terms, a bond is something beyond straightforward investigation of semiotic ties of a paramecium in its surroundings, or even of bonds identified through investigation of signs exchanged between organisms in living systems. Bateson emphasizes instances in which bonds have become binds, and these always involve mistakes in interaction. As Bateson argued, non-resolution of binds always threaten survival. For this reason I suggest that the link between culture and environment depicted in the third leg of Hoffmeyer's triangle of biosemiotic enquiry is best represented in the form of a Möbius strip. That is to say, there is a "twist" in the join between the two terms culture and environment and that this "twist" designates a series of paradoxes in cultural and environmental interaction, each of which sensitizes us to the cumulative non-resolution of mutual causal reciprocities. Finally, closing the dualism between culture and environment requires careful use of the concept of culture, and the use of empirical evidence drawn from "cultures" in the plural rather than a supposed universal "culture", since theories of knowledge are themselves culturally specific.

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Когда связи становятся связующими: о важности интерактивного взгляда Бейтсона для биосемиотики

В статье подвергаются анализу различия в подходах разных авторитетов, чья интеллектуальная деятельность повлияла на развитие биосемиотики. При выборе точки зрения автор исходит из работ Грегори Бейтсона. В отличие от Пирса и Юксюлля Бейтсон начинает с понятия интеракции. Его ранние работы касались взаиозависимости и коммуникации — центральных тем в работах тогдашних антропологов. Но подход Бейтсона все же выделялся своей уникальностью. Он создал теорию о метамоделях социальной коммуникации и об их “абдукции” в разные феномены как в биологии, так и в теории игр. Позже Бейтсон на базе концепции *экологии духа* (которая является выражением феномена интерактивности) разрабатывал нецелевую кибернетику. Биосемиотика еще не приняла интеракционный подход Бейтсона — он отсутствует в коммуникационных исследованиях Пирса, в функциональном круге Юксюлля и в рассуждениях Хоффмейера об отношениях между *культурой* и *природой*. Вместо того, чтобы исходить из понятия “субъективности”, которая якобы возникает при изменении этического отношения в соответствии с экологической обстановкой (рассуждение Хоффмейера о эмпатии), статья выделяет подход, который сосредотачивается на состояниях пародокса и патологии. Точнее, точкой отталкивания при анализе отношений между культурой и природой у Бейтсона является состояние блокированной коммуникации, где экологические отношения становятся связующими.

Kui seosed muutuvad siduvateks: Batesoni interaktiivse vaate olulisusest biosemiootikale

Artikkel analüüsib olulisi erinevusi nende autoriteetide seisukohtade vahel, kelle intellektuaalne tegevus on mõjutanud biosemiootika arengut. Vaatenurga valikul lähtutakse Gregory Batesoni töödest. Erinevalt C. S. Peirce'ist ja J. von Uexküllist, alustab Bateson interaktsiooni mõistest. Ta varajased kirjutised puudutasid vastassõltuvust ja sotsiaalset kommunikatsiooni — keskseid teemasid tolleaegsete antropoloogide hulgas — kuid Batesoni lähenemine oli siiski unikaalne. Ta lõi teooria sotsiaalse kommunikatsiooni metamustritest ja nende "abduktsioonist" mitmesugusteks teisteks fenomenideks nii bioloogias kui mänguteoorias. Hiljem arendas Batesoni kontseptsiooni *vaimu ökoloogiast* (mis on interaktiivsuse fenomeni väljenduseks) edasi teist järku küberneetika. Biosemiootika pole veel Batesoni interaktsioonilist lähtekohta omaks võtnud — see puudub nii Peirce kommunikatsioonikäsitluses, Uexkülli funktsiooniringis, kui ka Hoffmeyeri arutluses *kultuuri* ja *looduse* suhete üle. Selle asemel, et lähtuda kohase "subjektiivsuse" mõistest, mis tekkivat eetilise suhtumise muutumisel vastavaks ökoloogilisele olukorrale (Hoffmeyeri arutlus empaatiast), tõstab siinne artikkel esile lähenemist, mis jätkuvalt keskendub paradoksi ja patoloogia seisunditele. Täpsemalt, Batesoni lähtekohaks kultuuri ja looduse suhete analüüsimisel on blokeeritud kommunikatsiooni seisund, kus ökoloogilised seosed muutuvad siduvateks.

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Feeling the signs: The origins of meaning in the biological philosophy of Susanne K. Langer and Hans Jonas

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Abstract. This paper describes the semiotic approach to organism in two proto-biosemiotic thinkers, Susanne K. Langer and Hans Jonas. Both authors develop ideas that have become central terms of biosemiotics: the organism as subject, the realisation of the living as a closed circular self, the value concept, and, in the case of Langer, the concept of symbol. Langer tries to develop a theory of cultural symbolism based on a theory of organism as a self-realising entity creating meaning and value. This paper deals mainly with what both authors independently call "feeling". Both authors describe "feeling" as a value-based perspective, established as a result of the active self interest manifested by an organic system. The findings of Jonas and Langer show the generation of a subject pole, or biosemiotic agent, under a more precise accent, as e.g. Uexküll does. Their ideas can also be affiliated to the interpretation of autopoiesis given by the late Francisco Varela (embodied cognition or "enactivism"). A synthesis of these positions might lead to insights how symbolic expression arises from biological conditions of living.

> *Art is the surest affidavit that feeling, despite its absolute privacy, repeats itself in each individual life. It is not surprising that this is so, for the organic events which culminate in being felt are largely the same in all of us, at least in their biologically known aspects.*
>
> Susanne K. Langer (1967: 64)

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1. Introduction

Ideas for a biosemiotic approach to organism, as they have been elaborated in the last ten years or so (Emmeche, Hoffmeyer 1991, Hoffmeyer 1997, Kull 1999), often show affinities to concepts of earlier thinkers, some of them biological "holists". This has best been shown by Sebeok (1976) for the case of Jakob von Uexküll, who by now has become a classic of biosemiotics. My paper is meant as another attempt to discover "proto-biosemiotic" thinking in the 20th century.

Hans Jonas and Suzanne K. Langer have produced influential biophilosophical theories from the 1950s into the 1980s (Langer) viz. the 1990s, Jonas 1973, 1992, Langer 1953, 1967–1982, 1979). Both have developed a range of ideas in their works which touches the theoretical outset of biosemiotics. They (1) conceive of the living as an embodied, material system, they (2) stress its active self realization, they (3) see the living organism as a subject, they (4) conceive of the encounter of this subject with the world as indirect or mediated, hence creating value (in Jonas 1973: 87) words) or vital import (as Langer 1953: 32 puts it). These ideas culminate in Langer into (5) the insight that expressiveness has to be considered as strongly a basic aspect of a living being as functional adaptation (for a review of the differences between Langer und Jonas cf., e.g., Lachmann 2000: 148n64).[2] The qualities mentioned above for both authors are best characterised by describing the organism as "feeling".[3] This term, which is somewhat mirrored in other concepts which see the living basically as "desire" (Barbaras 1999) or, in a more technical angle, as "need" (Kull 2000), tries to radically view the living being as a subjective agent, creating meaning from its needs to cope with the surrounding world, with the *other*. The concepts of "feeling" as Jonas and Langer have elaborated them thus might offer some insights into the subjective dimension created by organic experience.

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[2] There is a number of authors who independently developed notions of a proto-biosemiotic approach to organism, notably Helmuth Plessner (1928), F. J. Buytendijk (1958), Adolf Portmann (1948, 1960), and Kurt Goldstein (1933, 1934). An oblique affinity also exists with Merleau-Ponty's philosophy. In his *Phenomenology of Perception* Merleau-Ponty has heavily drawn on the works of Goldstein (Lachmann 2000: 157n12).

[3] The term "feeling" goes back to William James (1890).

Related ideas can also be found in the version of autopoiesis theory developed by the late Francisco Varela (not identical with the first account of autopoiesis given by Maturana and Varela, 1980). Indeed, although Varela himself always declared that he was not a semiotician, his work touches some important points of biosemiotics. In his late works Varela tried to overcome the solipsistic dangers of early biological constructivism and developed a view of embodied cognition which he called "enactivism". Varela wanted to understand the genesis of selfhood by interactions between autopoietic entities and the external world. In his treatment of the concepts of subjective agency and of biological relevance, and meaning, he prepares ideas which might help a possible synthesis into a "biosemiotic paradigm" (Varela 1991, Varela *et al.* 1991, Weber, Varela 2002).

2. Jonas: Feeling and the "mother-value" of all values

Hans Jonas stems from a phenomenological background. In his attempts to overcome the subject-object dualism (also called the two cultures) of modern science Jonas started to develop a, as he called it, a "biological philosophy". In the centre of his theory of biology stands metabolism. For Jonas, a living system is nothing more than the identity of the process that arranges material compounds into a form. Hence, metabolism is the crucial point of encounter between matter and order, not just energy production. Form arranged by metabolic processes (which in return *are* the form's structure) is constant, whereas substance, the mere molecules, rather are an accidental agglomeration of matter that may pass through various living forms. For Jonas (1992: 21), an organic

> wholeness is self-integrating in active realization, [its] form is not result but cause of the dynamic arrangements of matter, and hence the process at the same time *is* the form. By this central aspect of its functioning metabolism can very well be considered as defining quality of life: every living being does have it, no entity which is not living does have it. (Jonas 1973: 83)[4]

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[4] All translations of Jonas' texts are by the author, as there is no official English translation. Although the work which was published in Germany 1973 as *Organismus und Freiheit* was a translation from the earlier book "The phenomenon of life" (1966),

In the architecture of the metabolic process, Jonas sees prevailing a certain tendency to complex systems, a kind of "order for free" (Kauffman 1998). Self-ordering brings forth structure, but also a first duality in the living. As a metabolic process, form becomes in a way autonomous from matter,

> [...] the difference between substance and form, which is a pure abstraction when applied to inorganic entities, becomes a real distinction. This implies a complete inversion of the ontological relationship: Form has become an essential quality and substance has become an accidental quality. (Jonas 1973: 125)

Metabolism, and with it the living system as it is, are always open to breakdown. Because the living system is dependent on matter to carry on, its autonomy is restricted to the necessity of incorporating and metabolising pieces of matter. This is what Jonas calls "dependent independence" — a paradox that deeply marks the living, which is on one hand related to itself, on the other to the exterior.

Jonas' description of metabolism reminds of Varela's idea of a circular self-closure. A short look at it may clarify Jonas' position. For autopoiesis theory, the process of the living consists in bringing forth this proper process. Autopoieis, particularly in its reformulation by Varela in the 1990ies, is concerned with the process of creating an autonomous identity (Varela 1991). This identity stands in a dialectical relation to the exterior, or other. The living being is thriving on the other, but also endangered by it. Living is ended not when the compounds are changed, but when the process of automaintenance is disturbed:

> An autopoietic system is organized (defined as unity) as a network of processes of production (synthesis and destruction) of components such that these components: (i) continuously regenerate the network that is producing them, and (ii) constitute the system as a distinguishable unity in the domain in which they exist. (Varela 1997: 75)

From this definition, we can better understand the importance of the metabolic model in Jonas' description of the living. The organism is continuously concerned with itself. It tries to keep up metabolic

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Jonas had revised the translation and partially rewritten it (Jonas 1973: 3f). Translations of other German sources, if not marked otherwise, are also by the author.

coherence in the face of changing matter. From this concern, a certain perspective is arising as an interest of the organic system in itself. This establishment of an identity is a basic process of the living. It happens not by revising physical laws for particle-interactions in applying them in a special way to organism, nor by imposing an extra-mechanical entelechy. The organism creates a subjective pole in its attempt to maintain autonomy over the matter flowing through it. It is structuring matter in the process of self-realization to maintain itself as this very process.

Subjectivity arises as a kind of ontological complement to the material auto-production an organism continuously is concerned with. Subjectivity hence is not just found in human conscious intentionality. It is rather at the ground of any behaviour emerging from the biotic outset. Subjectivity is the expression of the fact that a living system is concerned with itself. *Because* life is continued existence against the weight of matter there is a subjective perspective emerging in a living system. This is the perspective of concern: a living system is trying to keep itself up against influences and disturbances. Already basic forms of life therefore might have a subjective perspective as a result of their existential need:

> The difference between environment and world is the *surplus of signification* which haunts the understanding of living and of cognition, and which is at the root of how the self becomes one... There is no food significance in sucrose except when a bacterium swims upgradient and its metabolism uses the molecule in a way that allows its identity to continue. This surplus is obviously not indifferent to the regularities and texture (i.e. the 'laws') that operate in the environment, that sucrose can create a gradient and traverse a cell membrane, and so on. On the contrary, the system' s world is build *on* these regularities, which is what assures that it can maintain its coupling at all times. (Varela 1991: 86, emphasis by the author)

Life is a fragile, precarious principle. Life is not an unlimited success-story, because it is a processual tendency on substantial matter. This permanent instability is the door where the semiotic germ enters the thinking of Jonas: because negation of the living is always possible, its simple existence must always be self-affirmation. Simple existence must be an approvement, a "Yes to myself" to be able to continue. For Jonas, this reflexive movement is the generator of basic value:

> The fundamental point of departure is that life says ‘Yes!’ to itself. In wishing to continue it declares itself as a value [...] May we thus say that mortality is the narrow door through which *value* — the thing addressed by ‘yes’ entered the otherwise indifferent universe? [...] Feeling is the primary condition for something to be ‘worth the effort’. Something gains reality only as a given for feeling and as the feeling of that given. The mere presence of feeling, whatever may be its kind, is infinitely superior to it total absence. Thus, the ability to feel as it came about in organism, is the mother value of all values. (Jonas 1992: 87–88)

Jonas here particularly stresses the self reflexive tendency of matter. But he also pays attention to the dependency on an “other”, always given and probably as basic and as important, and present in the very core of a biological entity via code-duality of soma and genes, formulated by Hoffmeyer (1997). To understand the organism’s necessity to succeed in a surrounding world, Jonas integrates a deep rooted dialectics in his view of living beings: The self-making self has to survive in a world characterised by an “other”. In the antinomy of form and matter found in the metabolic principle of life itself this other-reference becomes a first order phenomenon. Hence, and this is most important, Jonas goes radically farther than a cybernetic account oriented at the circular model of the feedback loop. Indeed he criticizes heavily the cybernetic model for its reduction of animal nature to a dyadic structure with perception and motility as the two moving factors,

> whereas in reality it is composed of the triad of perception, mobility and feeling. Feeling, more basic than the two other potential, and rather linking them, is the animal translation of the basic tendency, that is at work already from the undifferentiated, pre-animal stage on, in the continuous realization of metabolism. (Jonas 1973: 185–186)

Feeling thus is the *interpretant* necessary to make up a biosemiotic entity. Feeling that rises from the intrinsic teleology of organism which Jonas is calling here “basic tendency” is the *tertium comparationis* that links the *causa*, perception, with its *effect*, mobility. Such a causality is a teleological, not a mechanical one. (As Varela and Weber, 2002, have argued, the process of the living establishes an *intrinsic*, or real teleology as a deep feature of the organism). The causation is guided by a self who follows the “mother-value of all values" as a final *raison d'être*, a self which is longing for existence and for further unfolding.

This is what Jonas calls the subject-pole created by the living organism. Feeling always brings forth an interior dimension, or rather, interior, or self, unfold as feeling. What is felt, is felt by this rudimentary "self". What is felt is felt as self, and Self is only possible via feeling. Feeling is the presence of intrinsic teleology, its manifestation as a motivation of behaviour in its most basic sense.[5]

3. Langer: Feeling and vital import

Susanne Langer started as a philosopher of logics in Whiteheadian style and then turned to a more holistic viewpoint. Langer has mainly been recognized as a philosopher of art. This judgement certainly does not pay enough justice to her work, particularly in the late volumes of *Mind* (1967–1982). Langer has worked on a theory of cultural symbols, but she has derived her semiotics from a theory of organism, or, as she called it, "living form".

Langer has become known for her distinction of discursive — logical — and presentative symbols. For Langer all symbols are mental concepts. A discursive symbol thus is a conceptual expression of an idea. A presentative symbol, though, is a conceptual expression of lived existence. Langer believes that there is a common ground of experience shared by humans and other organic beings. As "symptoms" (Langer 1953: 25), expressive gestures, postures, colourings and other embodied signs, this lived experience is constantly and spontanously expressed by all organisms, humans and animals alike. A presentative symbol wields the spontaneous embodiment of a symptom into a "felt concept". Presentative concepts hence are integrating biological and cultural semiotics. On the forefront of this semiotics Langer deals with a concept of "feeling".

A presentative symbol for Langer signifies a concept of "felt life", or rather, as she would have it, *expresses* "felt life". In her eyes, art

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[5] "Drittens schließt diese Transzendenz *Innerlichkeit* oder *Subjektivität* ein, die alle in ihrem Horizont vorkommenden Begegnungen mit der Qualität gefühlter Selbstheit durchtränkt, wie leise ihre Stimme auch sei. Sie muß da sein, damit Befriedigung oder Vereitelung einen Unterschied macht" (1992:26). Jonas (1953) also uses the term 'Emotion'.

symbols are always presentative symbols, hence are semiotically expressive of feeling. Art reaches farther than the discursive sphere and has its roots in the region of our organic foundations. Art therefore can illustrate organic experience, and vice versa, organic experience can explain certain regularities in art. Both have a common source in a general expressiveness of life. This thesis could not be very popular in the fifties, where Langer was elaborating it in *Feeling and Form* (1953), but it might lead us to certain insights in organic semioses. In her transition from art semiotics to biosemiotics Langer is guided by the question

> what new empirical knowledge of the morphology of feeling can we derive from its image in works of art, and what light can this knowledge throw on the unfelt processes of life and the emergence of feeling, animal mentality, human experience and mind? (Langer 1967: 74).

What does the term "feeling" mean for Langer? In her eyes, all organic beings on the one hand are pure matter, on the other hand lived experience. Biological processes are one aspect of an interwoven identity of physiological and intentional aspects. Life can not be different from matter. Thus, there has to be a kind of "forgotten side" of the material setting: Feeling is the manifestation of the biological theatre in a special perspective. "What is felt is a process, perhaps a large complex of processes, within the organism" (Langer 1967: 21).

But who feels? Langer tries to overcome the problem with the term "phase". "Being felt" is a phase of biological processes. "A phase is a mode of appearances, and not an added factor", she says, not a "product of neural impulses, but [...] an aspect of their occurence" (Langer 1967: 30). Like the red glowing of a heated metal is not external to it, but an inevitable aspect of its energy-rich state, feeling (to the "inside") and expressivity (to the "outside") are new phases of the living. The semiotic aspect is an emergent property of complex autopoietic systems. Being felt is a phase in which only organic systems appear. It is a shift to an emergent property that has not been contained in the sum of the parts — "constituents of one kind, brought together in a special combination, may seem to produce a new ingredient which is, however, a phase of their own occurrence" (Langer 1967: 21).

Unlike Jonas, who is focusing on the structuring function of feeling in perception of the world, Langer concentrates deeper on its particular structure, once it has emerged from the movements of organic acts. Feeling turns those processes into experience which are functioning "inside". Feeling displays the meaning those processes have for the concrete realization of the living. What shape does it have? Langer speaks of

> forms of growth and of attenuation, flowing and stowing, conflict and resolution, speed, arrest, terrific excitement, calm, or subtle activation and dreamy lapses. (Langer 1953: 27)

Feeling thus is mirroring what happens to the organism in its self-realization. Feeling is the meaning which external influences and the biological reactions to them have. "All external stimuli, that have effects on an organism affect the matrix, i.e. the organism as a whole, and through it motivate reactions [...]" (Langer 1982: 90). In this view the living being is seen as a more or less autonomous centre reacting by its own laws. Langer herself expresses an affinity to the concepts of general systems theory (Lachmann 2000: 153). But she is going farther, as Jonas does: The living system — as Langer says: the matrix — becomes an active agent: "Every distinguishable change, therefore, arises out of the matrix, and emerges as an act of an agent, for such a vital matrix is an agent" (Langer 1967: 322).

Consequently, the model of organic causation for Langer is not linear, or mechanical. It is rather parallel to the teleological causality we have in Jonas. Langer prefers to view an external trigger as a "motivation" (Langer 1967: 283) acting on a subject rather than a stimulus inducing causally a response:

> The only way an external influence can produce an act is to alter the organic situation that induces acts; and to do this it must strike in a phase of ongoing activity, in which it is immediately lost, replaced by a change of a phase in the activity. (Langer 1967: 283)

"Motivation" is a term also Buytendijk (1958: 28f) uses for the same reasons as Langer does. Buytendijk thereby comes close to Uexküll's biosemiotic insights. Indeed Langer even refines her view by discussing Uexkülls Umwelt-concept. She does so without touching explicitly semiotic grounds. But we can state that the intrinsic teleology of the self-realising organism we discussed above might be used as a common denominator to describe an organism in semiotic terms. This relation sees also Lachmann (2000: 154n9) who refers to Maturana.

Every organism for Langer is composed of acts: small, circular processes joining to larger tissues of organic events and hence forming the "matrix" of the living as a reflexive system of circular acts (Langer 1982: 90). Langer's theory of organic acts therefore is a process theory of the living, as observes Lachmann (2000: 157). But in Langer's view, rather than being a (metaphysical) character of cosmos, processual reality stems from the way living subjects bring forth their reality. Langer hence offers a biological application of Whitehead. It is the organism who realizes the primacy of form over matter. What Whitehead conceives of as a metaphysics is, seen through Langer, the shape which the world gains by and through our organic makeup.

The act-model allows to make an abstraction from the basic biological level. Langer is speaking of the dynamics of life more in general, probably due to her inspiration by Whitehead. In a way Langer occupies a middle position halfway between process thinking and Jonas' views. Langer explicitly rejects the cosmological optimism stemming from Jonas' belief that feeling accompanies every process in organism. She even criticizes him for designing a "biological cosmos". Her theory is more general but lacks the plausibility of a generic account of the semiotic nucleus from the lack of the living. But also in Langer's work we can find an approach to the phenomenon of meaning which is based on considerations about the genesis of values. Langer holds that organisms perceive the meaning of situations according to their physiological needs:

> […] the primary characteristics which animals see are values, and all the qualities of form, color, shape, sound, warmth, and even smell, by which we would naturally expect them to recognize things, enter into their perceptual acts only as […] values for action. (Langer 1972: 55)

This view reminds of Jonas. But speaking about values, Langer first and foremost analyses Uexküll's *Umweltlehre*. For Langer, all organisms have to cope with the existential values of situations they encounter in their surrounding worlds. The values of those encounters depend on the organism's biological structure. Value is thus shared by all organic beings in a common *conditio vitae* (Weber 2001a). On the other hand, Langer is emphasizing the difference of the ambient worlds of different species. Value differs according to taxonomic and even individual particularities: according to a specific and unique *Bauplan*. Following the "mother-value" of all values, the drive to exist, existential values create a vast range of meaning and significance. Feeling translates the biological meaning of a value which has been encountered into a subjective perspective: The value of a situation becomes manifest as feeling: "More and more, then, behaviour — the acts of an organism as a whole in relation to extraorganic conditions — comes to be guided and developed by feeling" (Langer 1967: 425).

According to each kind of organism, particular classes of values are modified into qualia or even, in humans, into mental concepts. Categories arise from these particular classes of value. But value precedes modal discrimination: value lies before the splitting of our perception into colours, tones, smells or touches. All these senses might have an existential dimension lying deeper than their qualia. This is a view which might help explain synaesthesia: Different sensory modes *mean* the same on a basic level concerning survival. A sharp tone and a sharp knife might have a common effect on organic feeling. As studies show, animals and children categorize apparently far-lying objects according to value. E.g. a baby learning to speak may call the brush, the broom and the dog's fur alike, because it touches them with the same sensation (this is an observation I made with my son). Eleanor Rosch (1978) has done landmark studies on this topic, followed by many others (Varela *et al.* 1991). Natural categorization thus yields a kind of natural, or "primary" metaphor (see Lakoff, Johnson 1999: 56). Symbols act via these basic categorization: symbols enact identical values that have the same "import" as their referents, existing in reality.

Langer beliefs that the values which the human organism experiences viz. brings forth are reflected in art. All great art, as she likes to put it, is an approach to organic feeling. The significance of music, e.g., lies in its "vital import", in its relevance to the dynamism of subjective experience. Art for Langer always rests in contact with the organic base: "Art is the creation of forms symbolic of human feeling" (Langer 1953: 40). As the feeling of organic acts itself does, formal elements in a work of art show features as dynamism, swelling, rest, tension, peace. For Langer, these features have the same existential value as can be encountered in organic experience.

In Langer's eyes, organic feeling becomes somewhat transparent in human expressivity. But the access we have to the biotic layer, to the origin of our values, is never a direct one. We cannot tell by introspection what feeling the signs is like. We have to make the detour via artistic expression and so we must to substitute an embodied experience by another. *Because* of its organic source, there may always be ambiguity in the symbolization of feeling. Because "vital import" is reaching far beyond conscious semioses, it might always contain the ambivalences and even contradictions of pure vital dynamism:

> The same feeling may be an ingredient in sorrow and in the joys of love. A work of art expressing such an ambiguously associated effect will be called 'cheerful' by one interpreter and 'wistful' or even 'sad' by another. But what it conveys is really just one nameless passage of 'felt life', knowable through its incarnation in the art symbol even if the beholder has never felt it in his own flesh [...] Even the artist need not to have experienced in actual life every emotion he can express. It may be through manipulation of his created elements that he discovers new possibilities of feeling, strange moods, perhaps greater concentrations of passion than his own temperament could ever produce, or than his fortunes have yet called forth. (Langer 1953: 374)

Due to its origin in value, and its intermodal nature feeling is projected in art as a quality, and not as a mental concept. Works of art exhibit the morphology of feeling, not by resting on conventional iconography, but by what Langer calls "living" or significant form—a form that does not convey a content but has an *effect* by transporting a certain value:

> There is a kind of quality that different colours, or even a tonal form and a visual one, may have in common; even events may have the same quality, say of mystery, of portentousness, of breeziness; and a word like 'breeziness' bespeaks the qualitative similarity of some moods and some weathers. Homer refers to the 'wine-dark-sea', although Greek wine is red, and the Mediterranean is as blue as any other sea water. But the translucent blue in the curve of a wave and the glowing red in a cup of wine have a common quality [...] This quality is the projected feeling. (Langer 1967: 106)

For Langer significant form is an articulate expression of feeling. By reflecting the "verbally ineffable and therefore unknown forms of sentience" (Langer 1953: 39) the symbolization of feeling is a crucial factor of culture as the self-understanding of man. Via symbols felt organic experience can become accessible for others. Art is a means of intersubjectivity, a genuine path of interbeing. The gesture exists *between* the bodies as a gesture of living form *between, inter* the subjects. This might also contribute to explain furthermore the often stressed similarities between art and child's play. In both there are gestures, expressions of possible existence established in the virtual space beyond limited subjects. A theory of subjectivity would have to draw largely on this field (cf. the now classic critique by Helmut Schelsky 1958 on Uexküll).

These thoughts might help to see why Langer declares that "art is the objectification of feeling, and the subjectification of nature" (Langer 1953: 81). Artistic symbols express feeling in the same way as living form does. Their "felt tensions" can be apprehended only if their whole organic background is implied by their appearance. That is why for Langer every work of art has to seem 'organic' and 'living' to be expressive of feeling. (Langer 1967: 103). More recently, Gernot Böhme (1997) has coined the term *Geste der Natürlichkeit*, "gesture of naturalness".

Artistic form is acting as a sign on the same expressive level as organic form. That is what Langer means when she speaks of "living form". The gesture displayed by a work of art must convey the feeling which is provoked by the work's *signifié* when it is encountered in reality:

> But just because the created appearance is all that has organic structure, a work shows us the *appearance* of life; and the semblance of functional unity is indispensable if the illusory tension pattern is to connote felt tensions, human experience (Langer 1953: 373). In creating an emotive symbol, or work of art, the creator does articulate a vital import which he could not imagine apart from its expression, and consequently cannot know before he expresses it. (Langer 1953: 389)

The relation between biochemical dynamics and organic feeling is of the same type as the relation between form and expression in a work of art. Both are expressive by means of their underlying vital dynamics. Expression hence is a symbol of its vital meaning, be it in a work of art or in a living body. As I have shown elsewhere (Weber 2001b), this relation equals the relation classically applied to the tension between body and soul. It is a symbolical relationship, symbolical in a strong sense: the symbol is not a convention but an expression of an underlying necessity.[6]

4. The "conditio vitae": From vitality to expression

These observations about the biological way of meaning creation might give some interesting hints for a semiotic theory of expressivity. Expressivity, as observed by Langer, the generation of meaning which refers to the inner perspective of an organism, could be an important feature of a theory of organism and of nature. Because expressivity is linked to form, like in works of art, this fact re-introduces an aesthetic aspect in the theory of organism. This formal, morphological or aesthetic aspect has not always been absent from biological thinking. Few examplary thinkers out of many more are Aristotle, Goethe and, more recently, Portmann.

Another most influential philosopher who saw a nexus between aesthetic thinking and the living organism was certainly Kant. In his famous reflections in the *Critique of Judgement* Kant tried to explain why a transcendental subject is capable of certain judgements about empirical objects in the world. Two circumstances were equally enigmatic for Kant: the possibility of *aesthetic* judgements and the possibility of *teleological* judgements — whether an object is alive and which criteria have to be adopted for a definition of the living organism (Lenoir 1982: 29).

Kant never solved the enigma (even if it was him who had contributed to complicate it a lot). Kant finally postulated a "happy chance" to reconcile the (empirical) natural manifoldness and the (ideal) faculty of judgement (Kant, *Critique of Judgement*, p. xxxiv).[7] A biosemiotic approach based on "vital import" might provide some more answers. In the living organism, form is correlated with identity,

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[6] This interpretation bears some similarities with Theodor W. Adorno's theory of art and the relation to an aesthetics of nature he sees (Adorno 1973: 115f). Cf. also Dieter Henrich's (2001) work on "Art and Life", where he explains the import of art in a delicate analogy with the momentum of subjectivity, though in solidly keeping to a rational theory of (human) subjectivity.

[7] This is the point where Goethe disagreed: For him, man could intuitively see, or rather "feel" the underlying laws of vital form in natural things, making them symbolical for our own existence, and even beautiful.

the struggle to keep up identity is mirrored in form *and* manifest in the subjective perspective of feeling. Lived or intrinsic teleology and aesthetics seem to come into a close junction that should merit further attention. Langer observes:

> If it could be shown that the forms of reason, or 'laws of thought', are forms of perception exemplifying larger laws of vital process, the 'happy accident' of 'reasonable' forms in nature, that Kant regarded as the basis of aesthetic pleasure, would not look so arbitrary as it did to him. (Langer in Lachmann 2000: 135n25)

Rather, we can add now, these forms might be expressive of the *conditio vitae* underlying organic existence. Beauty in organism is not arbitrary, nor a mere "happy chance". It is a necessity.

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“Чувствуя” знаки: природа значения в биологической философии Сюзанны К. Лангер и Ганса Йонаса

Статья рассматривает семиотический подход к организму в работах двух протобиосемиотических мыслителей. Оба автора развивают концепции, которые стали центральными в современной биосемиотике: организм как субъект, реализация живого как закрытая циркулярная “самость”, концепция ценности, а у Лангер — и понятие символа. Лангер развивает теорию культурного символизма, исходя из организма как самореализующейся системы, которая создает как значение так и ценность. Данная статья сосредотачивает внимание главным образом на явлении, которое оба автора называли “чувство” (feeling). Они описывают “чувство” как основывающуюся на ценности перспективу, которая создается активным “самоинтересом” в органической системе. Результаты Йонаса и Лангер показывают формирование полюса субъекта или биосемиотического агента точнее, чем, например, у Юкскюлля. Их идеи можно связать и с “автопойезисом” (телесное узнавание или энактивизм) позднего Франциско Варелы. Синтез этих разных позиций может привести к пониманию того, каким образом символические выражения вырастают из биологических условий жизни.

“Tundes” märke: tähenduse päritolu Susanne K. Langeri ja Hans Jonase bioloogilises filosoofias

Käesolev artikkel vaatleb semiootilist organismikäsitlust kahe eel-biosemiootilise mõtleja — Susanne K. Langeri ja Hans Jonase — töödes. Mõlemad autorid arendavad kontseptsioone, mis on praeguses biosemiootikas saanud keskseiks: organism kui subjekt, elusa realisatsioon kui suletud tsirkulaarne “ise”, väärtuskontseptsioon ja Langeri puhul ka sümboli mõiste. Langer arendab kultuurilise sümbolismi teooriat, lähtudes organismist kui ennast realiseerivast süsteemist, mis loob nii tähenduse kui väärtuse. Käesolev artikkel puudutab peamiselt nähtust, mida mõlemad autorid on nimetanud “tundeks”. Nad kirjeldavad “tunnet” kui väärtusest lähtuvat perspektiivi, mille

loob aktiivne enese huvi orgaanilises süsteemis. Jonase ja Langeri tulemused näitavad subjekti pooluse ehk biosemiootilise toimuri kujunemist täpsemini kui näit. J. v. Uexküll seda tegi. Nende ideid võib seostada ka arusaamaga autopoeesisest hilise Francisco Varela mõttes (‘kehastunud äratundmine’ või ‘enaktivism’). Sääraste arusaamade süntees võib viia mõistmiseni, kuidas sümbolilised väljendused pärinevad elu bioloogilistest tingimustest.

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Human/animal communications, language, and evolution

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Abstract. The article compares the research programs of teaching symbolic language to chimpanzees, pointing on the dichotomy between artificial language vs. ASL, and the dichotomy between researchers who decided to establish emotional relationships between themselves and the apes, and those who have seen apes as instrumental devices. It is concluded that the experiments with the most interesting results have been both with artificial language and ASL, but with strong affiliation between researchers and animal involved in the experiments. The experiments on talking apes are not so much experiments in psycholinguistics (how far can animal learn human language) but wonderful experiments in the *communities of communication* between human beings and great apes.

Ever since the sixties, American psychologists have been involved in one of the most interesting scientific adventures of the second part of the 20th century: to teach a symbolic language to chimpanzees in order to make them able to communicate with human beings. (1) In the first part of the article, I give a short synthetic presentation of these research programs through two pillars: the dichotomy between artificial language vs. ASL, and the dichotomy between researchers who decided to establish strong emotional relationships between themselves and the apes, and those who have always seen apes as instrumental devices. I show that the experiments with the most interesting results have been both with artificial language and ASL but with strong affiliation between researchers and animal involved in the experiments. (2) Then, I suggest that unlike what has always been said, these experiments on talking apes are not so much experiments in psycholinguistics (how far can animal learn human language) but wonderful experiments in the *communities of communication* between human beings and great apes. Indeed, for the first time in the history of the world, animals (humans) have tried to build up communities whose *only goal* is to seriously communicate with another species. (3) In the third part of the paper, I analyse this situation in the context of the evolution of communication and I try to think human language not as a property that puts the human being apart from other living creatures, but as a property that makes human beings able to better communicate with non human living creatures. In conclusion, I analyse the reasons for which this situation is of great importance for proper thinking on the evolution of communication and biosemiotics.

1. Some introductory remarks on the evolution of communication

Evolution of communication and language have usually been thought of either from a strict phylogenetic point of view or from a pure cultural point of view. Marc Hauser (1996) wrote a classical work on the topic of the phylogenetic evolution of communication through comparative psychology and ethology of communication, but by the very topic of his book Hauser restricts himself to treat the communicative abilities of a number of species which he sees as significant, particularly among primates and birds. Questions of plasticity of communication are quite neglected as is the possible history of such communicative systems which ornithologists have observed it in the form of so-called dialects among birds. Also interspecific communications are roughly forgotten. Nevertheless, Hauser's approach is a usual one, and I am sure his book is now taken as a classical text-book in the field.

It is much more unusual to mix up both phylogenetic and cultural approaches of communication. To adopt that position means that for other species than humans, communicative competences are seen to have a functional plasticity that allows cultural non-trivial cognitive transformations. I do not wish to discuss the topic of animal culture here, a field of research that have been largely renewed during the last years (Lestel, 2001 for a philosophical discussion), but to focus my argumentation on a neglected part of these researches — namely the situation of animals living among humans, animals well adapted in human cultures. Domesticated animals, commensal animals or pets are quite good examples to discuss in that way, but the best one is still the example of the so-called "talking apes" in the USA. In that situation, apes that do not use a symbolic language are able to use it after humans have taught it to them. For the first time in the history of Nature, living beings are now able to use communicative devices taught by other creatures in order to communicate together. Two questions become crucial: what really happens in that operation and what does it mean from an evolutionary point of view?

2. How apes acquire symbolic languages at the end of the twentieth century

Since the beginning of the sixties, there have been a few research programs aiming at teaching a symbolic language to non-human primates. Roughly, four different orientations have been adopted by scientists[1] working in the field.

(a) The first one has been developed by Alan and Beatrix Gardner, from the University of Nevada at Reno, particularly with chimpanzee Washoe. It emphasized the use of ASL as a symbolic medium, and the necessity to establish close affective contacts between human researchers and chimpanzees. Regular experiments were used to complete informal but rigorous training. Trainers could not speak English when chimpanzees are around for example. Extremely draconian criteria were also used to determine that a sign had been acquired by the chimpanzees.[2] R. Fouts tried to get Washoe to teach ASL to another chimpanzee, namely adopted offspring Loulis, and they exchange signs among themselves without the presence of humans.[3]

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[1] Nearly all of them were or are experimental psychologists. The only assured exception is Lyn Miles, who works with orangutan Chantek, and who is an anthropologist by training.

[2] Gardner *et al.* (1989) summarize 20 years of research on ASL and chimpanzees.

[3] A good overview can be found in Fouts, Fouts 1989.

(b) The second orientation may be featured by David Premack's research program at University of Santa Cruz and later at University of Pennsylvania. Premack emphasized the use of an artificial symbolic language, especially designed for the experiments, and on a strong separation between animals being tested and human experimenters.

(c) The third orientation has been adopted by Columbia psychologist Herbert Terrace who drew a strong separation between humans and ape (Nim Chimsky) and used ASL taught in formal way (eight hours a day in a classroom of Columbia University).

(d) The fourth orientation is Duane Rumbaugh's and Sue Savage-Rumbaugh's who have chosen both an artificial language (the Yerkish, a special language designed by professional linguists[4]). and the convivial and "familial" approach already adopted by the Gardner. Three projects have done. The first one was the Lana Project, the second one the Animal Model project and the third one the project with the bonobos, in particular with Kanzi.

3. Experiments on talking apes as experiments on human/animal hybrid communities of communication

These experiments on talking apes still wait to be interpreted. They are scientific studies whose meaning has to be explored, just as had the meaning of quantum mechanics in twentieth century physics. To describe these experiments only in terms of experiments in psycholinguistics (how far can an ape acquire a human language?) is to greatly impoverish what is at stake. In the coming paragraphs, I wish to indicate some fruitful trails from a biosemiotic point of view.

3.1. In these experiments, each ape has an history. "He" becomes a person. In that way, "he" becomes an "heteronomous strong subject", who communicates to humans his desires, his fears and his joys. In natural settings, as described by field ethologists like Jane Goodall, Christophe Boesch, Tetsuro Matsuzawa and so on, these chimpanzees are "autonomous weak subjects". The notion of heteronomous strong subject sounds like a very curious notion to the ears of western people whose cultural tradition is based upon the association of autonomy

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[4] For a summary of this work, cf. Rumbaugh, Pate 1984.

and identity. Transfers of affects and emotions are very strong. Humans may explore these apes' subjective landscapes — and the reverse is also possible. That knowledge is a sharing one, although not a symmetrical one. These apes become creatures for which humans have hopes, fears, joys, pains, etc. Empathy between humans and these primates allows a semiotic strong interaction. We have not paid enough attention to a growing practice, concerning wild animals as well as animals like talking apes: the possibility to feature some animals through their biography — which means temporal coherences, behavioural idiosyncrasies and "mental states" (preferences, repulsions, ...) that feature a given animal.

3.2. What is striking in these research programs is the fact that animals and human beings live together in strong communities that we can qualify as hybrid human/animal communities of sharing of meaning, interests and affects. These hybrid communities are first of all semiotic communities.

Changes in the conceptualisation of language are important to understand what I mean by semiotic communities, in particular following Bates (1979) who saw language as a tool to change a listener's behaviour. In that way, language is defined more by what it allows one to do than by what it is. Then, S. Savage-Rumbaugh (1990) can explain that language is a communication system based on causes and effects. Subject learns how to use language, but also how the others use it. What is important is no longer the presumed intention of the speaker, but the interplay of actions generated at the interface between locutor and interlocutors. Language becomes not only a systems of signs, but also a process organizing the behaviour of several interacting individuals. What is needed is a definition of the speaker more than a definition of language. In that way, Savage-Rumbaugh no longer asks if chimpanzees can learn a language, but if they can become effective speakers. Language is not so much a tool to tell somebody else something[5] but a semiotic tool to live together, and that is also true with animals living among humans.

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[5] Let us assume that story-tellers and philosophers have a special status in the community.

3.3. It is fruitful to explain an important dimension of these hybrid semiotic communities through a new interpretation of the Turing Test[6]. Alan Turing, the designer of the test was one the brightest British mathematicians of the first part of the twentieth century and a founder of the new academic field of theoretical computer science. He kept in mind a basic question for a long part of his life, namely the question of how to know in which way a machine can be intelligent, and in which ways humans may have the possibility to discover it. To answer that question, Turing designed a test, the famous Turing test, in order to test the machine's intelligence. A human H_1, in a room, has to make a decision to know where is another human H_2 and the machine M. H_2 and the Machine are each located in one of two other rooms. H_1 is linked with the machine and the human only through an abstract channel, for instance a computer keyboard. H_1 has to determine who is in which room through questioning M and H_2. If H_1 confused H_2 and M, through the answers to his questions, M is said to be an intelligent machine. In that way, Turing developed a *cooptative approach of intelligence*: an intelligent creature is a creature that/who has been admitted in the community of the intelligent creature by another intelligent creature. The semiotic community does work in the same way: a creature is seen as a semiotic creature if it is allowed to become a member of the community of the semiotic creatures, i.e., if the creature is able to communicate with already admitted members of the community. It is not a vicious circle, because such admittance means a lot of work by both parts in the process, and some basic transformations and results. The notion of *cross-fostering family*, originally coined by the Gardner[7], is important here. It refers to the situation in which members of a species raise offspring of another species — here humans raising chimpanzee offspring. This means that belonging to a semiotic community requires learning (sometimes a cultural learning) and is not at all a matter of fact.

3.4. These experiments on talking apes lead to the still rather neglected questions concerning the ability of human language to modify an animal semiotic system. If these experiments clearly show that these apes really "talk", they also clearly show that these apes do

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[6] Turing (1959).

[7] But the first attempt has been done by the Kelloggs, in which the subjects are chimpanzees and the foster parents are human beings. Cf. Kellogg (1968).

not talk as humans do. The great missing dimension of the analysis of the talking apes experiments is precisely the silence on the essential role that humans play in the process by which some great apes acquire the use of a symbolic language. That dimension has been raised during the 70s and the 80s, but in a very narrow sense as an objection against these studies: it was the so-called "Clever Hans effect". Shortly, that objection points to the possibility that unconscious signals were communicated by humans to animals that would explain the performance of the animal under observation. It must nevertheless be clear that even if the Clever Hans objection does not work,[8] the role of humans is a basic one in the process through which great apes acquire an access to symbolic language. For instance, if apes are able to communicate with humans or with other apes through symbols, it has been humans that have imposed the *conventions* underlying their very use.

3.5. It must also be said that some transformations in the process of acquiring symbols are not well understood. One example refers to the natural vocalizations by Kanzi quite different from natural ones: Kanzi vocalizes more and he uses new sounds, unheard in zoos or natural settings for that species. Let's keep also attention to the fact that some animals use to communicate together through symbolic devices learned from humans without their presence — as Washoe and Loulis did.

The philosophical value of these experiments have been largely underestimated. Let us take only two questions which relates them to biosemiotics. Firstly, these experiments threw new light on the status of human being in the biosemiotic sphere, where he alone has a status of "universal interlocutor". Secondly, these experiments open new ways to deal with origins of language.

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[8] An elegant refutation have been given by experiments in which humans and chimpanzees were communicating together through computer keyboards which put away the possibility of any physical interactions between humans and animals (they were simply not present in the same room. Cf. Savage-Rumbaugh (1986).

4: Human being as a universal interlocutor

4.1. Language has often been featured by philosophers as "the very proper" of human beings. For them, language allows humans to use self-interpretation and self-transformations that other animals lack and leads to the raising of a radical frontier that divides humans on the one hand and animals on the other.

4.2. It does not mean that animal communications are very primitive ones. Quite a few animals, for instance, have the astonishing ability to manipulate other's semiotic systems and to develop what British primatologists R. Byrne and A. Whiten (1988) have called *Machiavellian intelligence*, which refers to surprisingly diverse behaviours used to manipulate communication.

4.3. These philosophers have nevertheless neglected another vision of language, not as the basic feature that divides humans and animals but as the ability that allows humans and other animals to get closer together. Through language, humans have the possibility to acquire knowledge on animal communications, to raise a cultural expertise on human/animal interactions and to devise strategies in order to communicate with animals. In that way, human symbolic language transforms humans in *universal interlocutors* (Lestel 2002) in the field of living beings. Such a situation is possible because both humans and other animals live in the same world. From an evolutionist point of view, we have met similar constraints, different to be sure, but which were of the same nature concerning subsistence and reproduction. Language enables humans to be highly efficient at capturing animals or also at developing a wealth of relations with them on many levels.

4.4. From the neo-Darwinian point of view of the evolution of intelligence, it is striking to realize that animal species that have highly developed semiotic competences and animal species that have highly developed technical competences are almost never the same. For instance singing birds and birds that build complex nests belong to different species. Only two exceptions break the rule: social insects and humans. Among these latter, what characterized humans is that they do not only build complex devices for communicating together but they also build special devices to communicate — and that they are the only species to do that. If human beings invent techniques to communicate with other humans, they also invent new technics in order to better communicate with non-human animals. This is a crucial point: Although some birds are able to imitate other's semiotic systems — humans are alone in being able *to cleverly use* the semiotic systems of potentially all living animals — and not only to blindly imitate them. Humans are therefore universal talkers.

4.5. Humans have also another unique semiotic ability: They alone are building tools that allow non human creatures using different semiotic systems to communicate together to communicate with them, as we saw in the case of talking apes. Thus, humans have developed an elaborated *technozoosemiotics.*[9] Let us keep in mind the bells of the shepherds, etc. Such a trend is still alive. Brazilian artist Eduardo Kac, to name just one, have recently tried to design new semiotic devices in order to make humans able to communicate with bats.[10]

5. Pleasure and evolution of communication

Whoever observes talking primates as I have done is necessarily struck by the intense pleasure these animals takes in communicating with humans through symbolic devices, which leads one to wonder what role such pleasure may have had in the origins of human language (Lestel 2002). Certain philosophical difficulties are usually underestimated whenever people try to build a theory of the origins of language, and I wish to discuss some of them and to suggest a new approach.

(1) Most theories of the origins of language take for granted that the structural properties that feature human language compared to animal communications are also the causes for the emergence of language. For example, it is because humans can tell stories through languages that language emerged as an evolutionary advantage.

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[9] The term has been coined by French artist Louis Bec who devoted his artistic activity to design material interfaces to make humans and animals able to communicate together.

[10] That performance was called "Darker Than Night" and has been shown in a bat cave at the Blijdorp Zoological Gardens, Rotterdam, as part of the exhibition "Fables of a Technological Era". On that performance, cf. Milevska (2000).

(2) All theories on the origins of language fail to take into account its historical dimension. There are no good reasons given in favour of the hypothesis that languages as we know them are only a result of a phylogenetical evolution — on the contrary.

(3) Adaptative advantages attributed to language consider that language has to be thought of as a break away from animal communication. We must be careful about our reasonings: how do we deal with animal communication? Have we explored possibilities to think animal communication without reducing it to a kind of sub-human communication? Let's take an example. Ethologists usually think of animal communication through the glasses of instrumental rationality: what do animals try to tell others in order to reach which goal? An alternative possibility is largely underdiscussed: animal communication does not convey any information to others, but is only a way by which the animal expresses its own affective situation. Not at all: "Be careful, predators!" but: "I am afraid because of predators". In that way, animals have developed an emotional rationality (not an instrumental one), and the so-called messages by animals are taken as events by others.

(4) This leads more generally to the questions of knowing "who talks"? In particular are "subjects" necessarily talking subjects or might we observe "speechless subjects"?

(5) The broadly accepted assumption that the origin of language must be looked for in the functional utilities it provides have to be discussed. In this paper I wish to suggest another story which insists upon pleasure as obtained by language use rather than on strict functional utility. I shall put forward four arguments for this view. The first one will be behaviours that strike any observer of so-called "talking apes" namely the extreme pleasure taken by the primates under observation in the use of a symbolic language to interact with humans. The second one will be the possibility that emerge, from a neurophysiological point of view, that brain areas of language and pleasure are quite similar: around the Broca area. The third one will be the suggestion of the plausibility of an evolutionary scenario for the origins of language close to the scenario proposed by Darwin and Wallace to take into account the so-called "sexual selection". The fourth one refers to the hypothesis by ethologists that close links exist between play behaviours and evolution of language.

6. Conclusion

If biosemiotics is seen as the field of the emergence of meaning in natural world, we have to re-evaluate two major phenomena: interspecies communications, and in particular the break that occurred with the human being as a creature capable of being a "universal interlocutor" for the first time, and the role of pleasure in the emergence of a complex semiotic natural system as language.[11]

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[11] I wish to thank Jesper Hoffmeyer for fruitful comments on my paper

Общение между человеком и животным, язык и эволюция

В статье сравниваются разные исследовательские программы, занимающиеся обучением шимпанзе символическому языку. Рассматриваются две дихотомии: искусственный язык — язык жестов; исследователи, решившие установить эмоциональную связь между собой и обезьянами, — исследователи, видевшие в обезьянах лишь инструментальные средства. Делается вывод, что весьма интересные результаты были получены при использовании как искусственного языка, так и языка жестов, и особенно в условиях, когда между экспериментаторами и обезьянами существовала тесная связь. Эксперименты с говорящими обезьянами являются не столько психолингвистическими опытами (в какой мере животные могут научиться человеческому языку), сколько великолепными примерами *коммуникационного сообщества* между людьми и большими обезьянами.

Inimese ja looma vaheline suhtlemine, keel, evolutsioon

Artiklis võrreldakse erinevaid uurimisprogramme, mis tegelevad sümbolilise keele õpetamisega šimpansitele. Vaadeldakse erinevusi kahe dihhotoomia — kunstlike keelte ja viipekeelte, ning nende uurijate, kes otsustasid kujundada emotsionaalse suhte enda ja ahvide vahel, ja teiste, kes nägid ahvides instrumentaalseid vahendeid — osas. Järeldatakse, et väga huvitavaid tulemusi saadi nii kunstlike keelte kui viipekeele korral, kuid eelkõige juhul, kui uurijate ja loomade vahel oli eksperimendis tihe side. Eksperimendid kõnelevate ahvidega pole niivõrd eksperimendid psühholingvistikast (s.o. millises ulatuses suudavad loomad õppida inimkeelt), kuivõrd suurepärased eksperimendid *suhtlemiskooslusest* inimeste ja suurte ahvide vahel.

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On the zoosemiotics of health and disease

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Abstract. The main feature of the signs of health in the animal habitus and behaviour can be characterised as the readiness to adequately (for a species) serve the need for impression (in animalistic elements of the Umwelt). The signs of disease, however multifarious and diverse, generally display certain lack of Umwelt-oriented attentiveness, alertness. Attention of deeply afflicted animals is strongly Innenwelt-oriented; and in some species a set of such signs, suggesting sickness or mortal disease is used as a set of traits in the mimicry of dying. The semiotic factors in health-disease relationships are apparently connected with intuition — like responses creating in the semiosphere a structure of Umwelt-Innenwelt polarized tensions, important in ecological and evolutional developments.

Speak roughly to your little boy,
And beat him when he sneezes:
He only does it to annoy,
Because he knows it teases.
Lewis Carrol (1924: 71)

... but he (the dragon) was most unmistakably alive, and proved it by having a hearty appetite and an evident enjoyment of life.
G. K. Chesterton (1970: 203)

One of the generally shared human beliefs about the dangerousness of animals is that some healthy specimens of the best “armed” species, that is well equipped with harmful facilities, are the most dangerous ones. However, this notion is not always true, at least where the danger to modern men is concerned. It would be truer to notify that in the majority of situations, leading to encounters with humans, just the sick animals, whether injured, poisoned, traumatized to a certain degree, or afflicted by infectious disease would prove to be potentially the most dangerous ones due to the severe changes in their behaviour in the first place. A healthy tiger, panther, rattle snake, cobra, black widow spider (*Latrodectes* sp.), hornet etc are the most able experts in avoidance of humans even in anthropogenically stressed environment, to say nothing about the natural habitats. But the probability of undesirable contact with sick animals, e.g. injured snakes, poisoned wasps, ornithosis infected birds, plague afflicted rodents and a most striking example, I trust, with various species of rabies affected mammals, could be quite high, in the vicinity of nidus areas at least. The behavioural changes, induced and vectorized by pathogenic factors ranging from traumas to viruses and toxins, produce profound effects on the continuum of ecological interactivities including inter- and intraspecific competition, predator–prey relations, foraging strategies, mate choice, parent-offspring relationships etc. An excellent compendium on these and related topics is presented in the volume edited by Nancy E. Beckage (1997); and also in the monograph by Robert Poulin (1998) the theme of the significance of behavioural deviations resulting from parasite–host interactions in the evolutionary ecological aspects is presented very revealingly. However, the spectrum of behavioural shifts and deviations induced by and related to pathological events and developments ranges on a scale so large, that it presents an irresistable challenge: to try a semiotic approach to those phenomena that is to make a behavioural sign–structure analysis of ecological fitness in animal associations. It is quite obvious that the biological norm in case of any animal species is much larger than the veterinarian/medical one and the notion of an absolutely healthy animal or human being is just as formal as a notion of statistically average person. However we may presume that the signs of health are these pointing to a set of the traits of ecological fitness/suitability by ecoamplitudes, including physical strength and agility, full possession of specific forms of display such as adequate comfort behaviour, habitual appearance (high level of symmetry, specific pattern and brightness in coloration etc.) and rituals in sexual, territorial and social behaviour. In the semiosis-process the signs of health are multifunctional factors which serve as means to attract and/or intensify, fortify and enhance the specific attention of cospecimens, of specimens of ecologically favourable associated species (e.g., of mutualists), in comfort, parental, sexual, foraging and defensive behaviour. At the same time these signs are means to fortify the repulsion or at least the discouragement of intra — as well as interspecific predators and competitors in the same behavioural aspects as stated above. So, the main feature of the signs of health could be described as *readiness to adequately serve the need for impression* (Turovski 2000) in animal elements of the umwelt as a holistic semiosystem.

It seems that nothing so conclusive could be proposed as a general definition of the signs of disease. The majority of various maladies have so many different and variable symptoms, arranged in innumerable syndromes, the appearance of which depends on immunocompetence of the specimen — ability in its turn being dependent on the genotype, age, sex, individual phenotypical particularities connected with learning, life history, climate, ration, etc. — that even such features as general distress are not universal enough to describe them. And for all that, animals in the main part are able to detect and recognize some of the sick cospecimens, mainly as estranged weaks or, perhaps, even as alienated ones, and also the sick/deficient specimens of prey and/or competitor species. Moreover, many species seem to be able to recognize the signs of certain maladies, not just the morbidity or great tiredness but the actual olfactory, acoustical and visual symptoms. The ultimate signs of disease are, perhaps, the symptoms of dying and of great pain, signs displaying nearly total *lack of umwelt-oriented attentiveness*, alertness. Attention of such deeply afflicted animals is mainly *Innenwelt-oriented*. Specimens in such a state are usually avoided not only by cospecimens but also by young and specifically experienced predators and scavengers. This corresponds with various cases, which possibly could be considered as mimicry in which “the mimic” performs a display of violent convulsions and spasms, revealing “total lack of attention” towards the outer world, so that the signs which the predator-selector recognises correctly as the marks of prey are inhibited in the filter of semiosis in the reverse feedback (Maran 2001) situation. Behavioural traits of this kind are observable in defence behaviour of some reptilians and mammals, including primates. Still, though a lot of examples are known of the mimicry of death (opossums, some snakes), in which mimics even produce highly specific odour (not of carrion, but of abnormally unclean and/or poisoned animal), I am not ready to declare, that the repelling behaviour described above, highly agonistic as it is, is definitely a "mimicry of dying". However, mimicry of dying or/and dead takes place in the behaviour of small reptiles and mammals mostly in North and Central America, where the rattle snakes are (or used to be) in abundance. The behavioural display of violent convulsion and images of horribly twisted corps suggests acute toxicosis in prey bitten by a rattle snake. For properly (to a degree) experienced predators such pattern of prey behaviour points, perhaps, to the high probability of the presence of preying rattle snake in the vicinity, which means that it is on its way here in search for its prey. Certainly, the highly and specifically experienced predators could remind unimpressed by such a display. But in Australia and South Asia, where respectively, tiger snakes' and cobras' preying habits are of the opposite pattern (instant kill, especially in preying on birds), the cases of the mimicry of death in convulsions are rare.

I would like to propose two more forms of behaviour connected with the signs of disease to be considered as, probable, cases of mimicry, both in the field of intraspecific activities. The first case is the mimicry of the healthy behaviour of very young, performed by older offspring or even young adults, suffering from minor injuries, traumatic and shocking experiences and/or under stress caused by early stages of some infections. Such changes in the behaviour often gain convenient parental responses in bears, hyenas and primates, at least from natural mothers.

The second case represents the imitation of sickness, the actual simulation in order to attract more attention. A particular case I would like to describe in brief took place in Tallinn Zoo in 1998. The young female chimpanzee Quinsey (5 years) was playing with me trough the bars of her cage, when I was distracted by a colleague who addressed me with some question. My attention had been averted from Quinsey for some minutes when I heard her coughing. To the trained ear the sound was unmistakably artificial: she was pretending being unwell. When my attention was restored to her, the coughing immediately ceased. She was quite healthy at this time, but a fortnight before Quinsey really had had a cold in her head and enjoyed a lot of very profitable attention from all of us. I checked on her "cleverness" from time to time for two months on and she never failed to use the trick, though all the time she was in splendid health. Certainly we cannot call every case of imitational behaviour by higher primates “mimicry”, but in the case with Quinsey I certainly performed a dutiful “dupe”.

Much more complicated forms of, so to say, “induced or inflicted conspicuity” can be found in the field of deviations in the habitus and behaviour of hosts, which are caused by specific activities of some parasites and result in the increase in the attractiveness of hosts either to predators (fish diplostomosis, gigantism in snails, parasitized by some trematods etc.) or to sexual partners (human and other species tuberculosis, for instance). It is a real challenge to recognize the unfit and unsuitable sexual partners, offspring (killed or abandoned if recognized), prey or leaders, whose incompetence is due to some disease. The ability to perform this kind of recognition and thereby to avoid or escape the dangers of contagious infections is connected with experience/learning in higher vertebrates at least, but in most successful individuals it seems to be based on some special kind of alertness, resembling very much the intuition as it is defined by H. Eysenck:

> a mode of cognitive functioning located at the opposite end of a continuum from logical thinking, characterized by speed and suddenness of reactions, small number of relevant facts known or considered, feelings of certainty about the conclusions reached, reliance on unconscious processes, not following the rule of logic, and relying on unusual associations and analogies. (Eysenck 1995)

In the encounter with a sick animal there often is still some short time to make intuitive decision on the following course of action; besides, such time exists for both parties of the contact. In many cases of predator — prey encounters the prey at least does not have time for anything else than impulsive actions and that even if the prey is lucky. So, the semiotic factors connected with health-disease relationships and related to intuition-like responses could, perhaps, play a considerable part in evolutional processes.

The signs of health displaying appeals, directed and addressed *into umwelt* and the signs of disease, searched for and defied *by umwelt*, concealed or very intricately used by the carrier or inducer, apparently create in the semiosphere a polarized structure of highly potent tensions significantly important in all aspects in ecological developments, offering special interest from evolutional aspect.

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К зоосемиотике здоровья и болезни

Основной чертой знаков здоровья в облике и поведении животных является готовность адекватно (для вида) удовлетворять потребность впечатления животных элементов среды (Umwelt). Знаки болезни при всем их разнообразии совокупно являют общую недостаточность внимания к знаковым сигналам внешней среды (Umwelt). Внимание серьезно больных животных мощно ориентировано на сигналы самого организма (Innenwelt). Ряд видов использует знаки, указывающие на болезнь как набор признаков в мимикрии умирания. Семиотические факторы во взаимоотношениях “здоровье–болезнь” явно связаны с реакциями типа интуиции, создавая в семиосфере структуру напряжений, поляризованных по оси “Umwelt–Innenwelt”, важную в экологических и эволюционных процессах.

Tervise ja haiguse zoosemiootikast

Loomade välimuses ja käitumises on peamiseks tervise märke iseloomustavaks jooneks valmisolek adekvaatselt (antud liigi jaoks) rahuldada omailma loomse osa muljete tarvet. Haiguse märgid, kogu oma mitmekesisuse juures, ilmutavad üldiselt haige looma tähelepanu puudulikkust ümbruse märkide suhtes. Tõsiselt haigete loomade tähelepanu on valdavalt suunatud organismi sisekeskkonna (subjektiivse siseilma) signaalidele-märkidele. Rida liike kasutab haigusele viitavaid märke kui tunnuste komplekte suremise mimikris. 'Tervis–haigus' suhete semiootilised tegurid on ilmselt seotud intuitsiooni tüüpi reaktsioonidega, mis loovad semiosfääris "välisilm–siseilm" pingete teljestiku, mõjutades ökoloogiliste ja evolutsiooniliste protsesside käiku.

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Does "quorum sensing" imply a new type of biological information?

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Abstract. When dealing with biological communication and information, unifying concepts are necessary in order to couple the different "codes" that are being inductively "cracked" and defined at different emergent and "de-emergent" levels of the biological hierarchy. In this paper I compare the type of biological information implied by genetic information with that implied in the concept of "quorum sensing" (which refers to a prokaryotic cell-to-cell communication system) in order to explore if such integration is being achieved. I use the Lux operon paradigm and the *Vibrio fischeri – Euprymna scolopes* symbiotic partnership to exemplify the emergence of informational contexts along the biological hierarchy (from molecules to ecologies). I suggest that the biosemiotic epistemological framework can play an integrative role to overcome the limits of dyadic mechanistic descriptions when relating the different emergent levels. I also emphasise that the realisation of biology as being a "science of sensing" and the new importance that is being ascribed to the "context" in experimental biology corroborate past claims of biosemioticians about a shift from a focus on information (as a material agent of causality) towards a focus on the world of signification.

Introduction

The debate on the concept of "biological information" has so far proceeded in an inductive manner, different concepts having been developed autonomously at specific levels and applications. The only epistemological tool that has been used across the different instances and subdisciplines is the mathematical theory of information. But the specific level that has received most attention is probably the genetic level instituting the long debated concept of genetic information in which the mathematical theory of information in the end showed up to have little application. One problem may be the specification of the emergent levels that proceed from, and simultaneously surround, the genetic one. In a "scalar" view, the next step is that of regulation, in which different kinds of "information" enter into the scene and interact with the genetic level (and will have to interact with other emergent levels).

In a penetrating analysis by Sahotra Sarkar it was implied that after 50 years of debate on the "information" concept in molecular biology what in reality has survived is the stereochemical specificity suggested by Pauling and others at the end of the 1930s (though with many antecedents; Kay 2000: 43), according to which biological interactions are mediated by a precise "lock-and-key" mechanism between the shapes of the molecules (Sarkar 1996: 190).

But as mentioned above, problems arise with signal transduction networks and regulation, where we can see the unconscious emergence of a concept of "natural regulation". By that I mean that "regulation", as the mechanism that orchestrates and directs (i.e. interprets) the signals represented by molecules that bind to each other in specific ways when their concentrations are statistically relevant, starts to look as something that exists, whereas nobody knows *where* it exists.

When it was thought that the information "problem" was solved and put aside with the cracking of the "genetic code", biologists began talking again about cracking other "codes". In this spontaneous inductive strategy (within the "spontaneous semiotics" in the life sciences described by Emmeche 1999: 274), different types of "information" emerge which may not have a clear conceptual link with previous concepts of biological information. So the need for unifying concepts prevails together with the lack of proper interfaces to couple the different "codes" that are being inductively "cracked" and defined at the different emergent and "de-emergent" levels. The informational terminology continues its exponential growth, but now, as biosemioticians had foreseen, we perceive an incipient trend that moves away from a focus on information to a focus on signification (Hoffmeyer, pers. comm.).

As an example, I will consider the broad line of research that is currently being developed around the concept of "quorum sensing" which refers to one of the many transcription regulation systems in prokaryotes, one which is coupled to intercellular communication mediated by signal molecules that are thought to constitute interbacterial communication codes. The dynamics involved in the evolution of this phenomenon represents an intriguing instance of emergence of informational contexts along the biological hierarchy from molecules to ecologies, evidencing that a linear mechanistic causality does not suffice to couple the different emergent levels. Insistence upon a reductionist explanation would require at least consideration of the code-dual nature of life (Hoffmeyer, Emmeche 1991). To overcome the ambiguous "spontaneous teleology"[1] so frequent in biology, a semiotically informed approach will be needed.

The *Vibrio fischeri* paradigm

The model organism from which the "quorum sensing" concept derived was the bacterium *Vibrio fischeri* (sometimes *Photobacterium fischeri* in the literature). This bacterium came to light (literally!) by studying a species of squid, *Euprymna scolopes*, which swims in the surface of the ocean by night, searching for food. To any predator below, the squid appears as a very dark object moving against the very bright background of the moon. Quite a dangerous situation for the squid which "to solve this problem", is said to "have evolved" a light organ in which it cultures a very pure, very dense population of *V. fischeri.*

This bacterium produces an enzyme called luciferase catalyzing a light producing reaction which makes the squid glow with an intensity and wavelenght reminiscent of moonlight (blue-green light, 495 nm). This renders the squid invisible to predators below by erasing the shadow that would normally be cast as the moon rays strike the squid from above — a sort of camouflage known as counterillumination. The mutualistic advantage is that by glowing, the squid escapes

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[1] I use here "spontaneous teleology" in analogy to "spontaneous semiotics", in the sense that although the word teleology seems to be anathema in life sciences, in their everyday language scientists customarily endorse organisms and evolution with teleological characteristics, which are often also anthropomorphic. So it is very common to find descriptions like: "to solve this problem, the squid has evolved a light organ".

getting eaten and in turn it provides food and shelter to the bacterial colony, which will be kept away from other competing bacteria (Ruby, Lee 1998; McFall-Ngai 1999; Visick, McFall-Ngai 2000).

When *V. fischeri* is inside the squid's light organ the cells reach a critical concentration at which it starts producing luciferase. When free living in the "outer" environment and at low cell density, bioluminescence becomes an expensive luxury for the bacteria and light production is quickly minimised (Greenberg 1997: 371).

The question here is, how can the bacterium (or its metabolism) know, or better yet, sense that it is inside a light organ and therefore it is time to activate the genes that produce luciferase?

A small diffusible signal molecule produced by the individuals of the colony serves as the crucial element. The concentration of this molecule inside the bacteriae depends on population density and will eventually trigger a modulation of the phenotype (Swift *et al.* 1999: 291). This is what has been called "quorum sensing"[2]. The word "quorum" is a legal term that refers to the number of members of a group required to be present at a meeting in order to legitimise a given decision. Quorum sensing can be represented as a triadic sign process as shown in Fig. 1.

Although there are many examples of environmental cues (including the concentration of different extracellular substances) that can be transduced as a signal that triggers a metabolic response, quorum sensing refers specifically to those cues that build up as the consequence of cell density.[3] Let's now take a quick overview of the molecular model for this process.

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[2] The term first appeared in a *Journal of Bacteriology* minireview written by Clay Fuqua, Steve Winans and E. Peter Greenberg in 1995. It originated with Winan's brother in law, a lawyer who was trying to understand what the researchers were talking about (Greenberg 1997: 371). Ever since it rapidly became standard in the scientific literature.

[3] As early as 1975, shortly before his death, biochemist and biophysicist Gordon M. Tomkins sketched a model for the evolution of biological regulation and the origin of hormone-mediated intercellular communication. He claimed that "Since a particular environmental condition is correlated with a corresponding intracellular symbol, the relationship between the extra- and intracellular events may be considered as a 'metabolic code' in which a specific symbol represents a unique state of the environment". He further argued for an apparent generality of such a code. (Tomkins 1975, Kilstrup 1998). In fact, quorum sensing seems to be just a specific case of Tomkins' metabolic code.

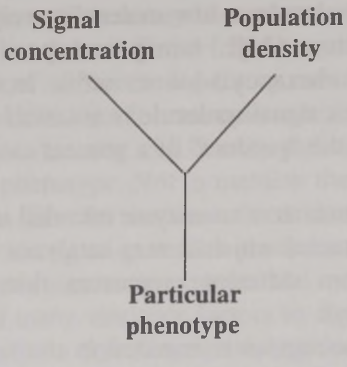

Figure 1. The quorum sensing sign triad. The concentration of a small diffusible signal molecule inside the bacteria reflects population density and may eventually trigger a modulation of the phenotype. Or, in other words, the concentration of the signal molecule acts as a sign in that it provokes the formation of a changed phenotype of the population, i.e. an interpretant, which relates to population density in a way echoing the way the concentration of the signal molecule itself relates to population density.

The Lux operon

In *V. fischeri*, the genes that encode the ingredients of luciferase and other substances necessary for the bioluminescence reaction are contained in the lux operon, consisting of (a) *luxA* and *luxB* which encode the alfa and beta subunits of the enzyme luciferase, (b) *luxC*, *luxD* and *luxE* which encode components of the fatty acid reductase complex, i.e. the enzyme which catalyzes the synthesis of the necessary aldehyde substrate for the luciferase, and (c) *luxG* which is a gene with unknown function and who's presence does not seem necessary for bioluminescence.

The products of theses genes constitute the phenotype that is to be regulated by quorum sensing (bioluminescence). In addition, the operon contains two other genes necessary for quorum sensing: *luxI* and *luxR* (Salmond *et al.* 1995; Sitnikov *et al.* 1995; Greenberg 1997; Swift *et al.* 1999).

The three main components of the quorum sensing system are produced by the very same operon that they have to regulate (in fact quorum sensing was originally known as "autoinduction"):

(1) The signal-molecule: a low molecular weight molecule of the acyl-homoserine lactone (AHL) family, and specifically in the case of *V. fischeri*, N-(3-oxohexanoyl)-L-homoserine lactone, or OHHL for short. Notice that this signal-molecule is not itself directly encoded by the operon but it is the "product" of a process catalyzed by the direct "gene product".

(2) The signal-generator: an enzyme encoded in the *luxI* gene (and thus called LuxI protein) which in turn catalyzes the synthesis of the signal-molecule from different precursors that come from other biosynthetic pathways.

(3) The response-regulator: encoded in the *luxR* gene (and thus called LuxR protein) which binds the signal-molecule to form a complex that acts as the transcription activator that in turn binds DNA near the Lux promoter, and so doing paves the way for the RNA polymerase, i.e., the enzyme which is actually producing the RNA transcript of the whole operon.

When the local concentration of signal-molecule (OHHL) is low the majority of binding sites at the response-regulator (LuxR) molecules are left open, and the luxR protein will then take on a conformation that cannot bind to the regulatory site in DNA. As a result very little luciferase can be made. When the local concentration of signal-molecule is very high the response-regulator binds the signal in such a way that a conformation change is induced in the regulator which in turn enables it to bind to the specific site in the DNA and turn on transcription of the whole operon at a higher or more efficient rate (by enhancing the RNA polymerase binding).

But before the operon is turned on, how can LuxI (the signal-generator) and LuxR (the response regulator) be made so that the operon can be turned on? Apparently the operon is never completely "shut off". LuxR is consistently transcribed at a low level so that there is always some molecules around to affect regulation, and there is always a basal level of LuxI being made that guarantees low concentrations of signal-molecule. When these low concentrations add up as the consequence of many cells getting close together (as when inside the squid's light organ) the binding of the two molecules increases, establishing a positive feedback loop that amplifies the signal and results in full production of the bioluminescence ingredients (Salmond *et al.* 1995; Sitnikov *et al.* 1995; Greenberg 1997; Swift *et al.* 1999).

It seems as if every time a regulatory network is elucidated it is always discovered that there is further regulatory complexity. There is always integration of different regulatory mechanisms depending upon many different cues like for example nutritional status, environmental stress, surface viscosity, cell density and many others, in order to elicit a complex phenotype. Not to mention the regulation of interconnected pathways like for instance those that originate the precursors from which the signal-generator produces the signal-molecule. In fact there is already mounting experimental evidence, for example in the production of many virulence factors by the bacterium *Pseudomonas aeruginosa*, for a "multilayered hierarchical quorum sensing cascade" (Latifi *et al*. 1996: 1144).

If we say that these signals are part of triadic sign-relations we can see here how the semiosphere unfolds itself in a myriad of interconnected signals (signs) and pathways of immense complexity (Hoffmeyer 1996). In the cellular processes with which we are concerned here, the cues involved in the regulation of the network are both endosemiotic and exosemiotic in nature.

Microbiologists learned to turn their attention to the "context"

In 1992 it was found that the same signal molecule (OHHL) that was responsible for the regulation of synthesis of luciferase in *Vibrio fischeri*, was also responsible for the regulation of synthesis of the carbapenem antibiotic in the terrestrial plant pathogenic bacterium *Erwinia carotovora*. The significance of this discovery lay in the fact that up to that moment OHHL-mediated autoinduction was considered to be uniquely connected with bioluminescence in the marine bacterium and its close phylogenetic neighbours. The fact that two such different organisms share a common signalling molecule (and mechanisms) led researchers to believe that they had stumbled upon a bacterial language of communication mediated by OHHL, and/or structurally similar molecules, which might be far more widespread than originally supposed (Salmond *et al*. 1995: 615; Swift *et al*. 1999: 291).

But that was not all. In experimental settings it was found that mutants of *Erwinia carotovora* that were unable to make carbapenem antibiotics on their own could do so when cross-fed with a second strain of mutants. The second strain of *E. carotovora* was supplying a signalling molecule which triggered antibiotic synthesis in the first group. This discovery hinted at the possibility that there could also be "cross-talk", i.e.: that signal-molecules produced by one species could be detected by the metabolic machinery of a different species. In fact, similar cross-talk was later observed in relation to the swarming motility behaviour of mixed colonies of *Pseudomonas putida* and *Serratia liquifaciens*. Swarming is one of six described forms of bacterial surface translocation and it has been characterised in detail in *Serratia liquifaciens* (Eberl *et al.* 1996; Eberl *et al.* 1999). Needless to say the term swarming comes by analogy to the well known behaviour of bees. Contrary to swimming, that can be achieved by individual cells, swarming colonies can be seen as specialised cells organized in subpopulations communicating through quorum sensing signal molecules. It is considered an important social phenomenon since cultures of different species in certain conditions might be able to collaborate in the process of surface colonisation. Such collaboration of two or more species of bacteria for the achievement of swarming has been observed in experimental settings in which one species differentiates into swarming mode (long hyperflagellated cells organized in an outer, motile layer), while the other(s) produces a surfactant to condition the surface for better motility. This may very well involve a species that emits a signal that triggers a response in another species in order to create a "community phenotype" (Eberl *et al.* 1996; Eberl *et al.* 1999: 1708).

During the 1990s the list of Gram-negative bacteria that possessed quorum sensing systems expanded and so did the list of phenotypes regulated in this manner and the family of homoserine lactones that serve as signal molecules (Salmond *et al.* 1995; Swift *et al.* 1999). Although presenting some differences, Gram-positive bacteria are also known to possess quorum sensing regulation systems, i.e. cell-density dependent phenotypes (Kleerebezem *et al.* 1997). Some phenotypes include a range of virulence factors and multiple exoenzymes, antibiotic production, conjugation, biofilm formation, and swarming motility.

One may wonder how these signals could evade detection for so long. Researchers now admit that the exchange of external signalling molecules between single celled organisms was unexpected and that therefore nobody was looking for them. For decades, microbiologists had been isolating cells out of the culture medium in which they had grown and throwing that medium away together with the signals. That is why some bacteria would loose their pathogenicity in the experimental settings. It was the *context* that was being thrown away!

A neodarwinian point of view may lead us to think that every time we encounter a so-called antibiotic in nature we have before us a case of biochemical warfare. Perhaps this is not something we should take for granted. For example, it has been demonstrated that one of the *Pseudomonas aeruginosa* quorum sensing signals (3-oxo-C12-HSL) could also be part of the set of virulence phenotypes exhibited by this opportunistic human pathogen, in the sense that it has been proven to have a direct effect upon the immune system, impairing the host's response to bacterial infection (Swift *et al.* 1999: 306; Pesci, Iglewski 1999: 152; Wu *et al.* 2000: 2482). If this molecule was not known to be also part of a signalling system, we could easily conclude that it was exclusively a virulence factor, a weapon. The same can be valid about many antibiotics that may turn out to be not just weapons, but also communication devices (Cundliffe 2000: 410–413).

In a narrow "struggle for life" view, it may also be tempting to think of a sort of semiotic warfare, like for example when *Vibrio anguillarum*, a fish pathogen that inhabits the same ecological niche as some *Aeromonas* species, produces an AHL (3-oxo-c10-AHL) presumably to outcompete the *Aeromonas* species by blocking the latter's quorum sensing systems (Swift *et al.* 1999: 307). The signal-molecule of the *V. angillarum* competes for the binding sites in the *Aeromonas* species' receptors, i.e.: as an antagonist of the *Aeromonas* signal-molecule, thereby inhibiting the physiological activity of its quorum sensing circuit. Perhaps more illustrative would be a case of inter-kingdom semiotic warfare. The red macroalga *Delisea pulchra* produces a range of 14 different halogenated furanone compounds that are structurally similar to the acyl homoserine lactone molecule family. These furanones specifically inhibit the quorum sensing-dependant swarming motility of *Serratia liquefaciens*, which is a deleterious bacterial trait for the alga since it is related to biofilm formation and colonisation (Givskov *et al.* 1996; Rice *et al.* 1999). In other words the alga reduces the levels of bacteria on its surface through molecular mimicry, i.e. by producing signal analogues, icons, which interfere with the bacterial endogenous signals (in fact molecular mimicry — structural and/or functional — has become a popular entry in biology journals).

But there is not only semiotic warfare. As in symbiosis in general, there are plenty of examples of mutualistic interactions via quorum sensing, not only in the symbiosis bacteria-higher organism, but also in bacterial interspecies communication, or cross-talk, as the example previously mentioned in relation to swarming motility behaviour in mixed colonies. There is also evidence that some bacteria may become virulent in response to cell signals from quite unrelated bacteria in the environment and different species have been reported to team up and communicate in order to coordinate their pathogenic response (Eberl 1999: 1708–1710). This simply means that any assessment of an organism's virulence must take into account the context and the likelihood of signalling molecules being present, i.e., an assessment of the semiotic niche (Hoffmeyer 1996: 59).

Thus, it is not surprising that from the different applications of quorum sensing currently being explored, the most promising one has to do with its inhibition given that signalling-molecules in quorum sensing modes trigger the expression of a wide range of pathogenicity determinants in many organisms that infect plants and animals. The alleged advantage of using quorum sensing for the bacterial colony is to avoid a premature detection by the host's immune system, which would give the host a chance to overcome the incipient colony. Instead the colony "quietly" grows until a sufficient number of cells have built up to release the pathogenic response when it is too late for the immune system to react. By studying molecular mimicry, like that developed by the alga *Delisea pulchra*, it might be possible to develop methods for blocking the signals so that organisms remain harmless and never express their pathogenic determinants. In this strategy one might see the beginning of a post-antibiotic age in which we would attempt to discipline bacterial pathogens by understanding their "language". The great advantage over antibiotics is that quorum sensing inhibitors do not inhibit bacterial growth. They only interfere with the expression of virulence and colonisation and therefore there is no selective pressure to "evolve" resistance. Furthermore, since the molecules are diffusible, the signals are not stopped by physical barriers (they penetrate cells, organs and even biofilms) (Givskov 1996; Rice 1999).

AHLs are not the only signalling molecules for bacterial cell-cell communication. There are many other peptide pheromones and also other bacterial signal systems which cross-talk are very commonly being reported. Certain cross-talking signals have also been identified in biological systems as different as bacteria and mammals (e.g. cyclic dipeptides found in marine bacteria have been found in mammalian systems as neurotransmitters) (Rice *et al.* 1999: 28).

It is becoming apparent that quorum sensing is just part of a complex regulatory network, where additional environmental information is transduced through other pleiotropic regulators of gene expression. Some systems are very specific while others are more promiscuous in their interactions with different types of signals. But it is now commonly accepted that the many cell to cell communication and environmental sensing systems in bacteria constitute a complexity of codes and languages. And it has been suggested that these are new codes to be cracked. The title of the review article by Salmond and his collaborators (1995) may be representative for the mood: "The bacterial 'enigma': Cracking the code of cell-cell communication".

The emergence of semiotic networks

Once more we find ourselves surrounded by concepts that imply an unacknowledged semiotic understanding of nature. Regarding the processes described above, the literature is full of words like communication, sensing, code and language.

Strangely however, I have not found equally often the word "information", although it is implicit. Maybe the reason is that biological information is tacitly accepted to be exclusively genetic information, i.e. specification of amino acid sequence. But in this new context, what is it that one can communicate? what is it that a code hides? what can be conveyed through language? and what can be sensed from the environment?

One exception in the quorum sensing literature that tries somehow to define "information" is the paper by Kleerebezem *et al.* (1997) that concentrates on quorum sensing in Gram-positive bacteria, in which the phenomena presents some differences relative to its equivalent in Gram-negative bacteria. In Gram-positive bacteria the "mechanism" is more similar to the more common two-component signal-transduction systems being routinely characterised in molecular biology. In this system the signal molecule does not bind the regulator directly in order to change its conformation so it can activate DNA transcription. Rather, in this case the signal molecule (a secreted peptide pheromone) "is recognized by the input domain of a typical sensor component of a two-component signal transduction system. Such two-component regulatory systems, consisting of a sensor and response-regulator protein which use *phosphorylation as a means to transfer information*, form a major mechanism of signal transduction in bacteria and play a key role in many of the changes in cellular physiology that result from changes in the environment" (Kleerebezem *et al.* 1997: 896, my italics, L. B.).

How does this type of information relate to other types of biological information like for instance the "genetic information" implied in the Lux operon, or the information that allows a predator to swallow a squid (the shadow), or that which allows the squid to avoid the former (counterillumination)?

Biology, lacking a unified paradigm to deal with all these communication codes, languages and sensing, and being so committed to physical reductionism, can hardly come up with a coherent picture of all these semiotic processes across the different emergent levels of organisation. The result is that as the details of the dyadic "mechanisms" of the myriad signal-molecule cocktails that constantly and dynamically poke into, or bind to, receptors are increasingly described and dissected, it becomes extremely complicated to explain the emergence of novel semiotic contexts by the addition of such mechanisms.

In 1962 the Austrian-American biochemist Erwin Chargaff noticed that although biological information might explain the highly specific relations between nucleic acid and protein, scepticism remained as to whether it would give any insight into the equally specific relations between cells and multicellular communities: "If there was no continuous 'chain of information' from the lowest level to the highest, he argued there was not justification in claiming that 'DNA is the repository of biological information'" (Sarkar 1999: 199). Perhaps his intuition anticipated the kinds of problems such a limited concept of biological information would impose upon a science that could not refrain itself from talking about communication and sensing in virtually all of its subdisciplines and in all the hierarchical levels under its lens. What Chargaff called the "chain of information" could not work in a dyadic mechanical frame of causality, but would have to be redefined as the emergence of integration levels, and, while at a given level there may be a myriad of dyadic causal relations, the emergence process is mediated by triadic causality (in this sense, should emergence and semiosis be considered the same thing in living systems? see Emmeche 2000).

As shown by Sarkar (1999), the genetic code cannot in itself account for the dynamics of gene expression, control and regulation. In this context, "information" simply means the specification of the amino acid sequence of the protein and the physics of the folding of a protein is also supposed to be taken care of by the amino acid sequence, i.e., folding is believed to be implicitly determined by the sequence (although recent findings seem to conflict with this universal hypothesis, see Eder, Fersht 1995).

In his notion of "information as specificity" Crick (1958) distinguishes only two types of specificity: (1) the specificity of each DNA sequence for its complementary strand, as modulated through base-pairing, and (2) the specificity of the relation between DNA and protein, modulated by "genetic information", understood as the specification of a protein sequence, i.e. the linear amino acid residue sequence of a protein from a DNA sequence as a process of "translation", i.e. the triplet-amino acid specificity. However, from this last specificity emerges a new one: the gene-enzyme specificity. Once we have proteins, new instances of "lock and key" mechanisms emerge: enzyme-substrate, antibody-antigen, signal molecule-receptor, activation complex-DNA, and so on. And the simultaneous and complex "activation" of an indeterminate number of these "lock and key" mechanisms determine the emergence of new informational-semiotic contexts and new and more complex "lock and key" mechanisms and specificities like for example host-symbiont and organism-niche.[4] We encounter emergent processes in which new levels and kinds of signification in biological processes appear. And these new levels of signification are not always specified by the precedent lower hierarchy process. As with many emergent properties,

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[4] This relates to the "principle of correspondences" as discussed in Uexküll *et al.* (1993: 12) which states that "in the sphere of living things each affordance presupposes a counteraffordance — that is, it can be realized only through an interaction".

one can not exclude the existence also of some kind of downward causation (Campbell 1974).

To visualise this process let us go back to the 3 main molecular actors in the quorum sensing system of *V. fischeri.* The signal-generator, the LuxI protein, possesses specific functional domains (or active sites) that serve to synthesise the signal-molecule starting from two specific substrates that must be selected and recruited from those existing in the cellular pool. It is believed that a region (in the C-terminal domain) is involved in the selection of the right acyl chain that will give its specificity to the signal-molecule, while another region (in the N-terminal domain) contains the active site where the precursors are joined together (Sitnikov, 1995: 809; Greenberg, 1997: 374).

The response regulator, the LuxR protein, to which the signal-molecule binds in order to form the complex that activates transcription of the operon, is a modular protein with individual functions carried in specific regions. The C-terminal domain contains both the DNA binding and transcriptional activation functions. The N-terminal domain carries several functional sites, and this is the binding zone for the signal-molecule. In the absence of the signal-molecule, it appears that the N-terminal blocks the ability of the C-terminal to bind the specific site on DNA and activate transcription. Binding of the signal-molecule to the N-terminal releases the inhibitory effect by unmasking the DNA-binding and transcriptional activation functions of the C-terminal domain (Salmond *et al.* 1995: 617; Sitnikov 1995: 806; Greenberg 1997: 373).

The specificities of the acyl-homoserine lactone signal-molecules can be better appreciated if we see them as a family of molecules. The several molecules identified so far in Gram-negative quorum sensing systems share a common structure. They are small molecules that have a fatty acyl group (an acyl chain) linked to a modified amino acid (homoserine lactone). The chain length vary in different signalling molecules and it is this feature that gives its specificity to the signal-molecule. They all appear to be able to diffuse through the membranes of bacteria. Some signals appear to be unique to one species while others are shared by several. Some species produce a single or few signalling molecules, others produce a range. Different signal-molecules differing only in the length of their acyl side-chains may be synthesised by a single *luxI* homologue. And more interesting, the structures of the signal-molecules from two different bacterial species can be identical but the corresponding LuxI synthetases that produced them may exhibit only 21% identity. It is therefore not possible to predict the identity of the AHL signal molecule(s) from the sequence data of a given LuxI homologue suggesting that the "shape" in the lower level process is not always the only important factor for the new emergent level (in this case the signal-molecule) (Salmond *et al.* 1995; Sitnikov 1995; Greenberg 1997).

The relative concentrations of the signals and their activities may vary according to the context, so that the right cocktail of signals triggers the right response. The threshold concentration of signal-molecules necessary for transcription of a specific set of genes also varies with the species. This means that the specific threshold concentration is a significant aspect of the sign (see Fig. 1). Or, in other words, it is the simultaneous and complex "activation" of an indeterminate number of "lock and key" mechanisms that determines the emergence of new informational contexts and new and more complex "lock and key" mechanisms. Every new emerging "state" constitutes a difference that can be sensed by some system with interpretative capacity.

In 1950 geneticist Hans Kalmus claimed that since the action of a particular gene was sometimes felt in a distant cell, genes acted more like a "broadcasting system" than "wired telecommunication" (Sarkar 1999: 203). DNA digitally encode for an analog, i.e., a protein. This analog by binding or not binding a correspondent protein (or nucleic acid), that is, by being or not being (there), may also become a digital message. But the simultaneous expression of a set of genes may constitute itself an analogical message (with its respective context). This type of message is not itself specified by digital DNA. In this sense Kalmus' "broadcasting system" "irradiates" an analogical multidimensional wave rather than the linear digital impulses of wired telecommunication. In a reductive perspective, this could be viewed as the emergence of new analogical signs (properties, contexts, pieces of information) by the aggregation of digital symbolic signs. By the same token, the analogical mode (the bulk of information) influences the existence of digital information in a sort of downward causation. Also, such analogical compound effect may constitute a "quasi-digital" piece of information to a higher level of aggregation ("to be or not to be"). Just as in human language larger narratives represent a kind of analogical information that emerges from the underlying digital code (written language), larger aggregates of digital information become analogical when its complex interactive dynamics become explicit. This dynamic up-and-down causality mediated by signs is an ontogenetic historical continuum that oscillates within the boundaries of the code-dual nature of organisms and ecosystems (Hoffmeyer, Emmeche 1991).

Let's briefly continue the road "up-scale" in the ontogenesis of the squid-bacterium-association. It has been suggested that the population-dependent regulation of gene expression can be viewed as an example of multicellularity in prokaryotic populations. Quorum sensing is nearly always symbiosic since in most known cases the colony that coordinates the simultaneous expression of a given phenotype is a symbiont of a higher organism and very often the cell-density-dependent phenotype is related to the colonisation and/or the interaction with the host. This makes this phenomenon quite an interesting case for exploring the emergence of semiotic networks and the interrelation of informational contexts at different levels of complexity. It also raises interesting questions about coevolution of the host-symbiont specificity. "Specificity in this association [squid-bacterium] is achieved through a reciprocal dialogue between the host and symbiont in a series of stages that ultimately result in the establishment of a stable relationship that endures throughout the lifetime of the host" (Visick, McFall-Ngai 2000: 1779).

Escaping the egg-hen paradox, the first two signs of this dialogue are the reciprocal presence of two "analogs": the squid and the bacterium (or rather a small colony of it). Against all odds this encounter ineluctably takes place. Of the estimated 1 million bacteria present in 1 ml of seawater in the squid's environment, only 0.1% are *V. fischeri*. It has been calculated that as a result of seawater flushing into and out of the squid during its ventilation process, only an average of 1 *V. fischeri* cell would enter and exit the body cavity every 0.3 second. However not a single aposymbiotic specimen (squid without light organ symbionts) has ever been detected (Visick, McFall-Ngai 2000: 1779f). This record of success in colonisation against all odds means that the "reciprocal dialogue" is a very precise and concrete one. The fact that when *V. fischeri* is absent, or too low in number, the light organ remains uncolonised even with high numbers of nonspecific bacteria in the environment, indicates that there is a "host-imposed" positive selection for *V. fischeri* (MacFall-Ngai 1999: 242).

When a juvenile squid hatches from the egg, it does not contain any symbionts. It needs to acquire the symbionts from the sea water. By cultivating and expelling symbionts into the environment, the squids is said to "horizontally" transmit the symbiont from one generation to the next (Ruby, Lee 1998: 807). A few hours after the squid is hatched, symbiotic colonisation rapidly begins. After contact, both organisms induce each other into a series of morphological and developmental changes which result in the enhancement of the association (Visick, McFall-Ngai 2000: 1779).

Before undergoing the developmental changes that take place exclusively in the presence of the bacteria, and which lead to the mature functional organ, the juvenile squid is able to develop its (still virtual) light organ all "by itself", but only to a point in which it is primed for the interaction. In order to develop the particular features that allow the squid to use and "manipulate" the light, it needs the presence of the bacteria. The underdeveloped organ constitutively "comes" with some features to make sure it collects the needed bacteria. It has two ciliated epithelial fields each consisting of a layer of cells on the surface of the organ that extends into two long appendages. It is believed that the function of these ciliated fields is to harvest and recruit the *V. fischeri* to initiate the symbiosis. After colonisation (and following specific signals) the ciliated fields are lost through a process of apoptosis (cell death and tissue collapse). The bacterium is also thought to play an active role in its own "recruitment" process since it has been demonstrated that nonmotile *V. fischeri* (either nonflagellated or flagellated but defective in motility) cannot initiate colonisation (Visick, McFall-Ngai 2000: 1780).

There are many different factors that determine and assure the symbiont-host specificity. Each of these "specificity determinants", which give each organism its "symbiotic competence", may belong either to the symbiont or to the host. Each determinant works through a particular specificity but it is the collective and mutual interaction of all of them that determines the compound symbiont-host specificity.

Some of these determinants include physical and chemical barriers in the path that leads to the organ and inside the organ itself, which only *V. fischeri* can overcome (Visick, McFall-Ngai 2000: 1781). The host "creates" a habitat in which only *V. fischeri* is able to initiate and maintain a stable association. Other determinants include adaptations of the host immune system to recognise the bacteria as "self". Upon entering the light organ the symbionts interact with a population of macrophage-like cells (which are part of the squid's immune surveillance system). It has not been clearly established whether the macrophage-like cells engulf nonspecific bacteria (thus helping *V. fischeri*) or whether they instead provide a mechanism to control symbiont number (and thus symbiosis health), or both (MacFall-Ngai 1999: 242; Visick, McFall-Ngai 2000: 1782).

While some *V. fischeri* cells may have contact with host macrophage cells, the majority of the symbionts in the population are eventually found in intimate association with the epithelial cells lining the crypts inside the organ. This association between the bacteria and the squid's tissue is mediated by a specific receptor-ligand "lock and key" that assures that the right symbiont binds to the epithelial cells (MacFall-Ngai 1999: 246; Visick, McFall-Ngai 2000: 1782).

Several hours after the bacteria have entered the light organ, the symbionts are induced to change; they loose their flagella and decrease their individual size while the population increases rapidly resulting in a high cell density. This is how 12 hours after the hatching of the juvenile squid, what is apparently the most relevant product of the association emerges: light.

Although dark bacterial mutants (defective in structural *luxA* or in quorum sensing regulatory *luxI* and *luxR* genes) commonly arise spontaneously in lab-culture, of the hundreds of analysed bacterial isolates from the light organs of *E. scolopes* of all ages, no non-luminescent strains have been found! (Visick, McFall-Ngai 2000: 1783). Since luminescence requires an alleged 20% of a cell's metabolic capacity, neodarwinian mechanisms demand that a strong selective pressure must be present to maintain this trait.

If bioluminescence is the *raison d'être* of the symbiosis from the squid's point of view, there must be a sophisticated and stringent mechanism to ensure that only luminescent *V. fischeri* can establish or continue the symbiotic relationship. It is believed that one possible mechanism may involve direct sensing of light by the squid (Visick, McFall-Ngai 2000: 1783). The light sensing capability of the squid points also to other directions in the semiotic network. With the first day light each morning, the squid expels 90% of its organ's bacteria into the sea in a delicate balance that avoids unhealthy overgrowth without completely eliminating the symbiont population. By doing so, the squid gets rid of the unnecessary cell-density-dependant bioluminescence during the day, and it "horizontally" provides symbionts to future generations. This pattern of behaviour is not a "programmed" circadian rhythm but depends on the animal response to the cue constituted by increasing day-light.

Final remarks

The intention of this paper was to point out that a mechanical dyadic explanation of signalling molecules suffices only at a given hierarchical level. But the subsequent relevance of these events (up or down scale) cannot be coupled or grasped through that kind of explanation. The significance of a biosemiotic kind of explanation is to put these isolated events into a hierarchical and evolutionary perspective which may make better sense when seen within a triadic logic (Salthe 1993). Evolution of light production cannot easily be accounted for by the working of the Lux operon and its evolution through a neodarwinian mechanism. When seen as the aggregation and emergence of new specificities that constitute new semiotic networks, the coevolutive nature of the association and thus of the Lux operon becomes evident.

The specific advantage to *V. fischeri* occurs only in its mutualistic relation to the squid. The squid not only utilises the bacteria's light emission as a source of camouflage, but it has itself evolved to take full advantage of such light source. The squid's light organ develops only in the presence of its specific luminescent partner; it is in an immature state until the bacteria have successfully colonised it. Nevertheless the immature organ and its predisposition to follow the developmental path induced exclusively by that specific symbiont must be somehow inherent in the squid's genome and in the fertilized egg as "tacit knowledge" (Hoffmeyer, Emmeche 1991: 137). This developmental path makes sense only in relation to the light produced by the symbiont. Within a few weeks after the bacteria colonise the squid, the fully developed light organ is present. The mature organ possesses four structures to specifically-manipulate the use of the light source provided. It has a reflector tissue to direct the light emission, a transparent lens type structure, a shutter mechanism (constituted by a black ink sack) to control the intensity of emission and it has yellow filters to shift the wavelength of luminescence closer to that of the moonlight and starlight (MacFall-Ngai 1999: 247).

It is generally supposed that bioluminescence has evolved independently many times in some thirteen different phyla (ranging from bacteria to unicellular algae, coelenterates, beetles and fishes). This is reflected not only in the gene and protein structures, but also in its biological, biochemical and functional diversity, as well as its sporadic phylogenetic distribution (Hastings 1998). It is usually inferred that the functional importance of bioluminescence is the fact that another organism detects and responds to the light. It has also been suggested that bioluminescence did not originate until after organisms possessed photoreceptors, given the fact that in a neodarwinian context there would be no selective advantage to producing light if nothing was able to detect it. So the evolution of the lux operon quorum-sensing semiotic network does not involve only cell-to-cell communication, or the evolution of the squid's own photoreceptor to control its light organ, but of course it involves also the predator whose photoreceptor do not perceive the "difference" because of the camouflage.

This brings me back to the question of my title: does quorum sensing imply a new kind of biological information? Maybe not. Biochemical specificities, whether nucleotide to nucleotide, triplet-amino acid or response regulator-signal molecule, when seen in a hierarchical and emergent triadic perspective are just differences that make a difference to a system with interpretative capacity. The realisation of biology being a "science of sensing" in which being or not being makes a difference — a "being" that is susceptible of mimicry — supports without any doubts the claim that there is an ineluctable trend in biology that shifts the attention from information as a material agent of causality towards the world of signification. This could have profound pragmatic consequences in a time in which biotechnology is considered to be the industrial use of "biological information". A semiotic approach may turn out to be quite relevant when characterising the causal links that go from molecules to ecosystems, from labs to the environment.

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Представляет ли "чувство сообщества" собой новый тип биологической информации?

При описании биологической коммуникации и информации необходимы унифицирующие понятия, чтоб соотносить разные "коды", которые индуктивно "открывают" и определяют на разных уровнях биологической иерархии. В статье сравнивается биологическая информация генетического типа с информацией типа "чувство сообщества" (указывающее на прокариотную межклеточную коммуникацию). Использование в качестве примера парадигмы Lux-operon и симбиотической системы *Vibrio fischeri – Euprymna scolopes* позволяет описывать появление информационных контекстов на уровнях биологической иерархии (от молекул до экологии). Утверждается, что эпистемологическая сетка биосемиотики может обладать интегрирующей силой, способной преодолеть границы диадного механического описания при сопоставлении разных уровней организации. Подчеркивается, что реализация биологии в качестве "науки ощущений" и учитывание важности "контекста" в экспериментальной биологии подтверждают утверждения биосемиотиков о переключении внимания с информации на мир означивания.

Kas 'kvoorumitaju' kujutab endast uut tüüpi bioloogilist informatsiooni?

Bioloogilise kommunikatsiooni ja informatsiooni käsitlemiseks on vajalikud ühendavad mõisted, et seostada erinevaid "koode", mida induktiivselt "avatakse" ja määratletakse bioloogilise hierarhia erinevail tasandeil. Artiklis võrreldakse geneetilise info tüüpi bioloogilist informatsiooni 'kvooriumitaju' (mis viitab prokarüootsele rakkudevahelisele kommunikatsioonile) tüüpi informatsiooniga. Kasutades näitena Lux-operoni mudelit ja *Vibrio fischeri – Euprymna scolopes* sümbiootilist süsteemi, kirjeldatakse informatsiooniliste kontekstide ilmumist läbi bioloogilise hierarhia tasandite (molekulidest ökoloogiani). Mööndakse, et biosemiootika epistemoloogiline raamistik võib omada integratiivset rolli ületamaks diaadilise mehhanistliku kirjelduse piirid erinevate organisatsioonitasemete seostamisel. Rõhutatakse, et bioloogia realiseerimisel "tajumisteadusena" ja "konteksti" tähtsuse arvestamine eksperimentaalses bioloogias kinnitavad biosemiootikute varasemaid väiteid tähelepanu nihkumisest informatsioonilt tähendusmaailmale.

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Pragmatics and biosemiotics

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Abstract. Pragmatics, i.e., a system of values (or goals) in agent behavior, marks the boundary between physics and semiotics. Agents are defined as systems that are able to control their behavior in order to increase their values. The freedom of actions in agents is based on the distinction between macro-characters that describe the state or stage, and micro-characters that are interpreted as memory. Signs are arbitrarily established relations between micro- and macro-characters that are anticipated to be useful for agents. Three kinds of elementary signs (action, perception, and association) have been developed in agents via evolution and learning to support useful and flexible behaviors. The behavior of agents can be explained, predicted, and modified using the optimality principle, according to which agents select those actions that are expected to increase their value. However, agents may select actions based on their own model of the world, which have to be reconstructed in order to predict their behavior. Pragmatics in agents can be induced, learned from individual experience or natural selection, or adopted.

Introduction

Charles Peirce (1955) viewed a sign as a triadic relationship between a sign vehicle, an object, and interpretant, which is a representation of the object. For example, smoke is a sign vehicle, fire is an object, and the idea of fire that appears in the mind of the interpreter after seeing the smoke is the interpretant. The relationship between a sign vehicle and an object is arbitrarily chosen, i.e. it does not follow from their physical properties or interactions. A sign vehicle may resemble an object (i.e., an icon) but this resemblance is not necessary, it is optional.

The Peircean triadic scheme of a sign works well for human signs and even for animal signs in zoosemiotics (Sebeok 1972). Animals have brains and obviously can interpret simple signs similar to humans. But brain is not the only organ that can interpret signs. Sign communication can be found in plants, cells, and even molecules (Uexküll 1982, Sharov 1992). These are non-mental signs, and they are of main interest for biosemiotics, because biosemiotics attempts to understand the origin of signs and their evolution towards mental signs. The idea of non-mental interpretation of signs can be found in the writings of Peirce (1955). But only recently after advances in molecular biology it became clear how vast, complex, and meaningful is the information coded in a DNA. We looked for alien intelligence on other planets, but it appears that a kind of alien intelligence exists in our own bodies. It uses the genetic language for communication, which we mostly do not understand. Thus, the thesis of Dawkins (1986) that there are no creative and intelligent agents in nature besides humans may be wrong.

The major problem with non-mental signs is to determine the boundary between sign interpretation and other interactions of objects (i.e., the boundary between semiotics and physics). Several answers have been proposed.

1. According to a pan-semiotic approach, any physical interaction is semiotic. For example, according to Deely (1992), a bone of a fossil animal is a sign vehicle that points to the original animal, and the rock formation in which the bone was fossilized is the interpreter. There is no doubt that any physical interaction can be used by human interpreters to determine past events, but the claim that rocks themselves are interpreters seems questionable.

2. According to a biological approach, a particular class of living systems is capable of interpretation. For example, Sebeok (1972) considered animals as interpreters of signs. Uexküll (1982) and Hoffmeyer (1996) considered living cells as minimal interpreters. According to Hoffmeyer (1996), neither viruses nor genes are interpreters; they only carry information that becomes interpreted by living cells. The first problem with this biological approach is that artificial non-cellular interpreters are not considered. But robots can perceive signals from the outer world and modify their actions accordingly in the same way as animals do. Second, evolutionary systems (evolving lineages) do not fit to Hoffmeyer's biological definition of an inter-

preter. I agree with Hoffmeyer that a single virus does not interpret anything, but a population of viruses is capable of perception (via natural selection) and interpretation (Sharov 1998). In the same way, a population of genes can be viewed as an interpreter, which follows from the "selfish gene" idea of Richard Dawkins (1976).

3. According to a system theory approach, interpretation is performed by self-reproducing systems. I have been supporting this approach (Sharov 1992, 2000) and tried to overcome several problems associated with it. The first problem is that some systems do not reproduce but are definitely capable of sign interpretation. For example, a mule can interpret signals at the organism, cellular, and molecular levels. Robots can interpret primitive signals also. The second problem is that primitive self-reproducing systems (e.g., patterns in cellular automata) are not agents because they do not control their actions. And, as we will see below, only agents can use signs.

4. According to a pragmatic approach presented in this paper, the necessary attribute of a sign is its anticipated usefulness for some agent. Pragmatics, which deals with usefulness, values, and goals, is definitely outside of the domain of Newtonian physics. The success of the Newtonian physics is largely due to the idea that dynamics can be separated from pragmatics. For example, the trajectory of a falling rock does not depend on the goals of a person who threw it. But physics is not sufficient for solving problems related to economy, evolutionary biology, artificial intelligence, and biosemiotics, where the pragmatic aspect of agent behavior is very important. I believe that pragmatic/semiotic methods will be useful in these areas.

Agents

I suggest to replace the notion of interpreter in semiotics by the notion of agent. The term "interpreter" is anthropomorphic and does not imply any active feedback to the world, whereas the term "agent" refers to active interaction with the world and can be applied to a wide variety of systems: organisms, lineages, robots, and even computer programs. I define agents as systems that are able to control their behavior in order to increase their values or achieve goals.

Agents cannot function without signs, which are responsible for storing the information on agent preferences, perceiving the environment, and controlling the behavior. Sign relationships are set arbitrarily depending on the needs of agents who use them. Arbitrariness (or freedom) in agents can not be distinguished from randomness unless an agent has values or goals. This is the main reason why semiotics should be linked with pragmatics. Notions of probability and randomness work well with passive systems that do not learn from their experience. But only agents, who can control their actions, exhibit arbitrariness. Obviously, the probability theory is too simple to describe agents.

Somebody may argue that the possibility of an agent to perform alternative actions can be detected if we change the environment. Then arbitrariness of actions can be determined without using pragmatics. I think that there is a hidden fault in this logic. A system that performs differently in various environments does not necessary responds actively to the environment. It may happen that the environment simply induces these changes in a system, which remains entirely passive by itself. For example, water takes the shape of a vessel but it does not respond to vessel's shape. In other words it does not select a shape that will fit this particular vessel. We know this from the fact that water fills the vessel without any learning. In contrast, when an agent happens to be in a new environment, it goes through a learning period trying various actions until it finds a satisfactory one.

But how do we distinguish learning from other transition processes? Water does not fill the vessel instantly; instead there is a process of change that ends when the system reaches a stable state. This process can be easily confused with learning. The difference between transition processes and learning is that the system remembers the results of learning and selects the appropriate action faster when exposed to the same environment or situation repeatedly. But water does not fill the vessel faster after it is poured into the same vessel many times.

Agents are autonomous systems because they control their own behavior. But the degree of autonomy, which can be defined as the proportion of behaviors that are learned and controlled, may be different. Some agents (e.g., humans) are highly autonomous, and others (e.g., robots) are only slightly autonomous. But analogous to the Gödel's theorem, it is impossible for a system to be fully autonomous; i.e., it can never control all its behaviors. To control a behavior, the system should first develop a representation (formalization) of this behavior, but not all behaviors can be formalized.

Freedom in agents is based on a limited causal determinism, which means that the dynamics of an agent is not fully determined by its state. Also there should be a kind of "memory" that controls agent's behavior but it is not included into the description of state. Thus, all characters of an agent can be separated into two groups (Sharov 1992):

(1) *macro-characters* that correspond to agent's structure, phenotype, or hardware, and

(2) *micro-characters* that correspond to agent's memory, genome, or software.

The dynamics of macro-characters is determined by its macro-state except certain unstable points where the trajectory bifurcates, and the direction can be affected by micro-characters. The idea of the role of bifurcations in the dynamics of living organisms goes back to Waddington (1968). If we do not distinguish between macro- and micro-characters, then there would be no control of actions, no freedom, and hence no agents.

Signs

I consider signs as relations between micro- and macro-characters that are anticipated to be useful for agents. Peirce did not distinguish between micro- and macro-characters in his theory of signs; thus, it may be difficult to compare his definition of a sign with mine. But some similarity can be found. According to my definition, a sign is triadic because it is not just a relation between a micro- and macro-characters, but a relation that is anticipated to be useful for an agent. Thus an agent can be viewed as an object for the sign relation. At a closer look, living activities of an agent can be classified into various functions, and these functions are often focused on specific objects (e.g., parts of the body, food items, enemies, etc.). Then, sign relations can be associated with particular functions and objects rather than with an abstract usefulness for the whole agent.

Elementary signs can be classified into three categories (Fig. 1):

(1) *Action sign* is a relationship between a micro-character and an action (function) that changes macro-characters. For example, a

gene is a micro-character that is responsible for some metabolic function.

(2) *Perception sign* is a relationship between a macro-character of an agent or state of the environment and a micro-character. For example mammals can measure the concentration of CO_2 in their blood.

(3) *Association sign* is a relationship between two or more micro-characters. For example, perception of a signal can be associated with a specific action sign.

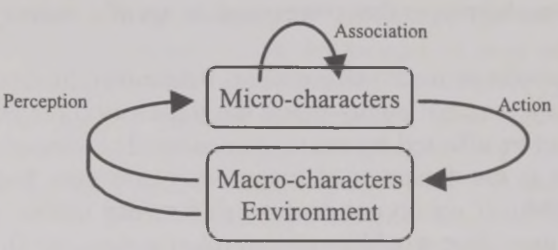

Figure 1. Action, perception, and association signs in agents.

In this classification I combined the perception of the environment with the perception of agent's state because simple agents do not recognize the existence of the environment. They treat the environment as a part of their own macro-state. For example, an agent may have a thermoreceptor that measures body temperature, but it may be unaware that body temperature is the same as in the environment. Advanced agents distinguish environmental characters as those that are not affected by their activity. Hence, they can recognize which receptors measure the internal state, and which measure the environment.

Peircean signs can be represented by a combination of elementary signs (Fig. 2). In this example, the visual perception of a smoke is the immediate interpretant, which activates the smoke concept (the second-level interpretant). At this point, the object is recognized as smoke and the fire concept (the third-level interpretant) is activated via the association sign. Finally, the fire concept may materialize in fire-related actions.

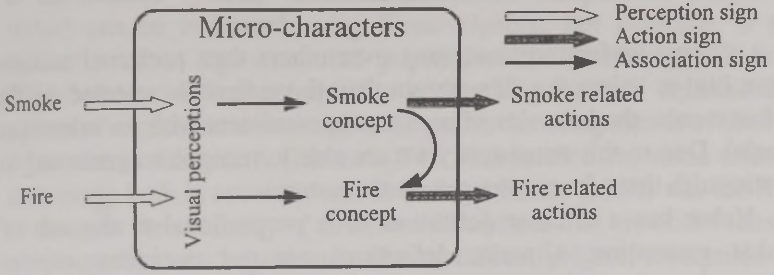

Figure 2. A combination of elementary signs that form a Peircean sign.

The arbitrariness of actions and perceptions in living organisms exists both at the individual and evolutionary levels. Animals have control over their immediate perceptions, e.g., changing their field of view. But they cannot increase the sensitivity of their sense organs, or change the spectrum of perceived signals. However, sense organs may change in the evolutionary time scale.

Evolving lineages should be viewed as agents in whom micro-characters are preserved from one generation to another via inheritance. Besides fast actions and perceptions at the level of individuals, lineages have a long-term "perception" in the form of natural selection (Sharov 2000). Perception in individual organisms is based on a selective excitation of receptors. When some photoreceptors in the eye become excited, we see an image that gives us information about the environment. In the same way, selective survival of organisms provides information for the lineage on what genomes are most successful in a given environment. Natural selection is often erroneously compared with a passive sieve. This is a misleading metaphor because living systems develop mechanisms that control their variability, avoid death, and ensure reliable reproduction. The evolution of adaptability (Conrad 1983) is not compatible with the sieve metaphor. However, natural selection is a very ineffective way of collecting information. Each bit of information literally cost lives. Individual perception is a mechanism that substitutes natural selection and makes life more efficient.

Values

If a system prefers some actions over others then preferred actions have higher values for this system than those that are rejected do. In other words, the behavior of an agent is consistent with its values (or goals). Due to this consistency we are able to recognize agents and to distinguish them from mere stochastic systems.

Value has a circular definition: it is proportional to the rate of value generation. Circular definitions are not necessary corrupt because mathematics can easily handle equation where the same variable is present both in the left and right side. If a state has a high value then it will generate even more additional value in the future compared with states that have a lower value. In Fig 3A, values are consistent with dynamics because all preferred transitions increase the value. In Fig 3B, values are not consistent with dynamics because state *b* has a smaller value than state *d*, but in the future it generates more value than state *d*.

Because agents have control over their transitions, their values depend on their knowledge. In Fig 3C, an agent *a* can change into *d* but it does not know a transition to state *b*. If it learns how to reach the state *b*, then it will prefer the transition to *b* over the transition do *d*; and its value will increase due to this knowledge. Values are consistent with behaviors that are selected by the system, rather than with objective dynamics based on laws of physics. Thus, knowledge represented by a system of signs may increase the value of the system.

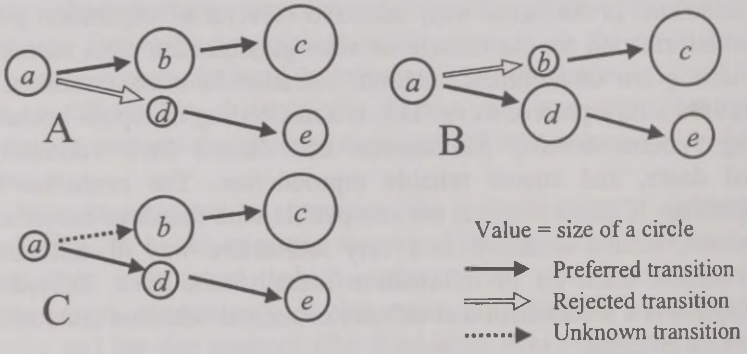

Figure 3. Consistency of agent values with preferred transitions between states.

In an isolated system, values of individual components (stages or states) can be estimated using linear algebra. For example, if the dynamics of an age-structured population is described by a liner differential or difference equation with matrix **A**, then reproductive values of organisms at each age are equal to the components of the left eigenvector of matrix **A** (Pielou 1974). This method for value estimation works both in economy and in biology. Fisher (1930) was the first to discover the similarity of these two disciplines that are both focused on pragmatics. An organism is like a business project; it requires an initial investment in the form of an egg, parental care could be an additional investment. Then an organism produces progeny, which is equivalent to the profit from a business project. The value of a business project or an organism is the left eigenvalue of the matrix for system dynamics and estimated using the same equation. In economy it is called "present value" and in biology it is called "reproductive value".

The calculation of values may become more complicated in nonlinear systems. If may require linearization at an appropriate time scale, at which the dynamics becomes more or less stationary. In cyclic populations, some behaviors may be beneficial at low population density and harmful at high density. The true value of each behavior can be estimated only by averaging its outcomes over large time periods

Optimality principle

Values can be used to explain, predict, and modify agent's behavior based on a set of assumptions called "optimality principle". The most simple formulation of this principle is that an agent selects a behavior that generates maximum value. The role of signs is to help agents to select best actions. Thus, the optimality principle is based on semiotics rather than physics.

Consider a question "why a caterpillar turns into a butterfly?" Evolutionary biologists will answer that a caterpillar turns into a butterfly because a butterfly can lay eggs. But this answer is not satisfactory because it only leads to another question: "why butterflies have to lay eggs?" The correct answer is that a caterpillar turns into a butterfly because the reproductive value of a butterfly is higher that the reproductive value of a caterpillar. Developing into a butterfly is a way to increase organism's value. Of course, an individual caterpillar does not have many other options rather than to develop into a butterfly. The only other option would be to die. But the lineage of butterflies may have more freedom: it may generate a mutation so that the caterpillar will turn into a different kind of butterfly. It may also control the rates of development, diapause, and other life-cycle characteristics.

Now let us consider another question: "why butterflies lay eggs?" The reproductive value of a butterfly may decrease after laying an egg. Then, why to produce it? The answer is that we need to count the sum of values of all products, i.e., the value of the butterfly plus the value of an egg. If this sum is greater than the value of the butterfly before egg laying, then the production of an egg is justified.

The optimality principle can be formulated in a variety of ways from "hard" to "soft". The hard optimality principle assumes that systems select their best action within given constraints based on the true model of the world that coincides with our (human) model of the world. Thus, the behavior that is optimal from our point of view is really optimal for the agent. The hard optimality principle is easy to apply and it works fine in many cases. However, its assumptions are too strong and may be not satisfied in many systems. The soft optimality principle assumes that a system selects an acceptable action based on its own local understanding of the world and its control abilities. We (researchers) also have a limited and local understanding of the world. And it may happen that the agent, whose behavior we study, understands the situation better than we do. The soft optimality principle is definitely more universal, but also it is more difficult to use because it requires the reconstruction of agent's model of the world. This can be done if we read the optimality principle backwards: we observe agent's behavior and then predict a world model in which this behavior is optimal.

Agents interpret signs because they anticipate to increase their value. By anticipation I do not necessary mean an emotional state of an organism, but rather an evolutionary-confirmed association between a sign and additional value obtained from its interpretation. For example, male moths are attracted to the pheromone emitted by a female, and this behavior increases their chances to mate. Thus, the interpretation of pheromone signals increases the reproductive value of male moths. Perception signs also increase the reproductive value not via immediate actions, but because the agent may be able to perform additional activities in the future based on obtained knowledge about its environment. Some agents are able to produce signs anticipating to get additional value in the future. Female moth emits pheromone to increase mating chances.

Sources of agent pragmatics

Agent's system of values (pragmatics) can come from the following three sources (Fig. 4).

1. It can be *induced by another system*. For example, parents induce inherited behaviors in their offspring. In some cases a non-parent can induce pragmatics. For example, larvae of parasitic wasps can change the hormonal status of their hosts in a way that is beneficial for the parasite. Viruses induce a different behavior in their host cells. Induced behavior in man-made automata fits into this category too.

2. Pragmatics can be *learned from experience*. There are two levels of learning: simple learning is based on tries and errors, and more effective learning can be done using models. Simple natural selection and simple conditioning correspond to the try/error mode of learning. Multilevel selection and conditioning correspond to models of different degree of sophistication.

3. Finally, pragmatics can be *adopted from other systems*. The difference from induced pragmatics is that here an agent has a choice which system of values to select. In other words, pragmatics is accepted consciously. For example, if a person becomes a member of some organization he/she often accepts the pragmatics of this organization.

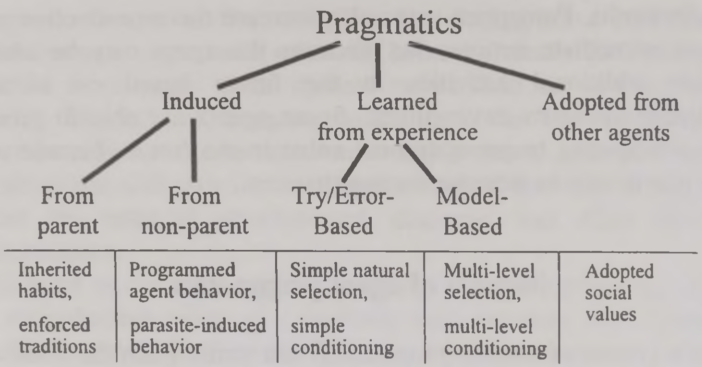

Figure 4. Sources of pragmatics in agents.

Pragmatics of any system may be partially induced, partially learned, and partially adopted. These portions do not necessary generate a consistent system of values. If values do not match, then the system may represent different agents at the same time. For example, an animal has its own pragmatics learned during its lifetime; but it also behaves according to the values of the lineage tested over long evolutionary times.

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Прагматика и биосемиотика

Прагматика, т.е. система ценностей (или целей), которая проявляется в поведении действующего [*agent*], проводит границу между физикой и семиотикой. Агенты дефинируются как системы, способные контролировать свое поведение с целью увеличения собственной ценности. Свобода действия агентов основывается на различии между макровсойствами, характеризующими положение или уровень и микросвойствами, которые интерпретируются как память. Знаки — арбитрарно установленные связи между микро- и макросвойствами, причем предполагается их полезность для агента. В ходе эволюции и обучения у агентов выработались элементарные знаки трех типов (действие, ощущение и ассоциация) для обеспечения полезных и гибких способов поведения. Поведение агентов можно объяснить, предсказать и модифицировать в соответствии с приципом оптимальности, согласно которому агенты выбирают такие действия, которые предположительно увеличивают их ценность. Но агенты могут выбирать действия и в соответствии с собственной моделью мира, которую нужно смоделировать для предсказания их поведения. Прагматика агентов может быть индуцирована, выучена в ходе индивидуального опыта или естественного отбора или заимствована.

Pragmaatika ja biosemiootika

Pragmaatika, s.t väärtuste (või eesmärkide) süsteem, mis avaldub toimija [*agent*] käitumises, tähistab piiri füüsika ja semiootika vahel. Toimijad defineeritakse kui süsteemid, mis on võimelised kontrollima oma käitumist enese väärtuse suurendamise eesmärgil. Toimijate tegevusvabadus põhineb eristusel ühelt poolt olukorda või taset iseloomustavate makro-omaduste ja teisalt mäluna tõlgendatavate mikro-omaduste vahel. Märgid on arbitraarselt loodud suhted mikro- ja makro-omaduste vahel, millest eeldatakse, et need on toimijatele kasulikud. Evolutsiooni ja õppimise käigus on toimijatel arenenud kolme liiki (tegevus, taju ja seostamine) elementaarsed märgid kasulike ja paindlike käitumisviiside tagamiseks. Toimijate käitumist on võimalik seletada, ennustada ja modifitseerida vastavalt optimaalsuse printsiibile, mille järgi toimijad valivad selliseid tegevusi, mis eeldatavasti suurendavad nende väärtust. Ent toimijad võivad valida tegevusi vastavalt oma maailmamudelile, mis tuleb nende käitumise ennustamiseks rekonstrueerida. Toimijate pragmaatika võib olla indutseeritud, õpitud individuaalse kogemuse või loodusliku valiku käigus, või üle võetud.

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Evolution of the "window"

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Abstract. We propose a general model that integrates meta-system transition theory with biosemiotics on the basis of an "evolvable window" metaphor. The evolution of the "window" proceeds via meta-system transitions, during which new windows are created iteratively on the "inner" side of the pre-existing ones, generating a "telescope" growing inwards starting from the "outside". The tendency of "inwards growth" of the "telescope" can be explained in terms of the following circular causality: (1) the tendency leading from unity towards individualisation, (2) individual learning providing a basis for more complex semiotic interactions, (3) creation of additional, non-conflicting "values" leading to habit formation, (4) strong control bringing forth a unification at a higher (meta-system) level. Using the proposed metaphor we hope to provide clarity to the fluctuation between objectivity and subjectivity inherent to the circular causality loop described above.

Introduction

Different authors have argued that there is an evolutionary trend towards increasing complexity by meta-system transitions (Turchin 1977, 1995, Heylighen 1999, Karatay, Denizhan 1999). The general ideas underlying such arguments have previously been proposed as the "meta-system transition theory".[1] On a different but related track, there is a growing field called biosemiotics, which among other things

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[1] For an extensive review and references, see the *Principia Cybernetica Web* (http://pespmc1.vub.ac.be/DEFAULT.html).

emphasises the evolutionary trend towards increasing semiotic interactions — or the "unfolding of the semiosphere" (Sharov 1992, Hoffmeyer 1996a, 1997a, 1998a). In spite of the fact that they are closely related in their focus of interest, proponents of the two fields seem to remain rather unaware of each other's works. In agreement with Alexei Sharov (1998), we believe that a merger of these two approaches can be promising with respect to the construction of a generalised model of biological evolution, particularly in dealing with issues like symbiosis and symbiogenesis (for a good review, see Margulis 1998), evolution of multicellular organisms, evolution of cellular differentiation and complex physiological systems, such as the immune system and the nervous system in higher organisms, etc.

According to Peirce the word "symbol", to which he attached the signification of a sign, has the meaning of a convention or a contract in its original use in Greek (Peirce 1998: 9). In our opinion, the closest link between biosemiotics and meta-system transition theory is related to the establishment of objectivity during meta-system transitions through conventions, which result from and further the mediatory role of the (growing) signs.

The route towards a meta-system transition

We propose an evolutionary model driven by meta-system transitions going through the following circular causality loop (Figure 1):

(1) a well-accepted tendency of nature leads from unity through proliferation/ reproduction towards individualisation,

(2) individual learning provides a basis for more complex semiotic interactions,

(3) creation of additional, non-conflicting "values" by those semiotic interactions leads to habit formation,

(4) in the long run, stabilised habits lead to strong control, which brings forth a unification at a higher (meta-system) level on which evolution proceeds according to (1).

The first step consists in the proliferation/reproduction of evolving agents followed by the achievement of some inter-agent difference (in the context of biological evolution, agents refer to organisms). This difference can either arise by intra-group variation — say genetic and blind — or by independent evolution of agents, which later on take part in a symbiosis (actually, this possibility is not mentioned by Turchin). Such diversification from unity to individualisation has a fundamental role in evolution and it may ultimately be related to the symmetry-breaking tendency in the universe ever since the big bang (Hoffmeyer 1998a).

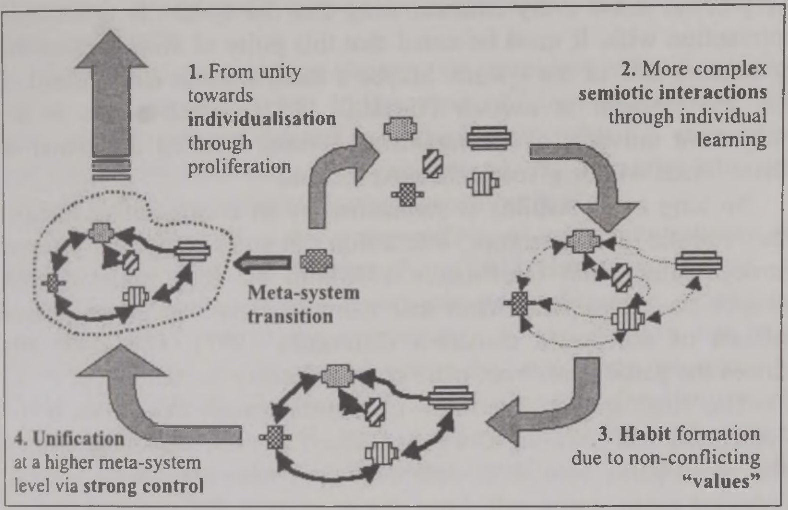

Figure 1. Meta-system transition by intra-group variation.

Following this first step, some of those different — or individualised — agents may form semiotic interactions. Under suitable conditions, especially when there is complementarity between participants, it is likely that some of those semiotic interactions prove to be synergetic due to mutual benefits of the participants, thus conferring selective advantage upon them (Campbell, Heylighen 1995). In other words, cooperative interactions may evolve when the participating agents receive additional, non-conflicting "values" from those interactions (Sharov 1997[2]).

At this point, maintenance of the stability of the synergetic interactions gains importance. There is a continuing threat from the

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[2] Sharov, Alexei 1997. Signs and values. http://www.gypsymoth.ento.vt.edu/~sharov/biosem/txt/isas98.html.

"others" who do not participate in the alliance, such as parasitic neighbours (in case of symbiosis) or parasitic variants (in case of intragroup variation). Thus, the synergetic interaction can only be stable if a boundary or a surface (either physical or semiotic and usually selectively-permeable) is drawn separating the inside (the self) and the environment (non-self). Here, the environment is meant to denote in a very broad sense every external thing that the system is in semiotic interaction with. It must be noted that this point of view stresses the subjective side of the system. Maybe a more suitable term instead of the environment is *umwelt* (Uexküll 1982), which refers to the subjective universe of an organism. A more detailed discussion of these issues will be given in the next section.

So long as its stability is maintained by an encapsulating surface, the semiotic (and synergetic) interaction can go on to become an even strengthening habit (Hoffmeyer 1998). In the long run, the habit shapes the participants more and more strongly due to the phenomenon of downward causation (Emmeche 1997). This eventually drives the participants even more complementary to each other.

The final step in the route to a meta-system transitions is the emergence and growing stronger of shared control, eventually making the participants lose their autonomy and integrate into a unified, coherent agent, a new self. Loss of autonomy as outlined will make it very unlikely that inter-dependent participants can quit the alliance and revert to their earlier, relatively autonomous states. This comes close to the model suggested for the easier acceptance of additional components (in mutants, during development) than component deletions (Saunders, Ho 1976, 1981). An integration of this scale must surely include the precise control over the reproduction of the emergent whole. The means of such control can be genetic, as in the case of social insects (Campbell 1983, Campbell, Heylighen 1995) or *memetic* (Dawkins 1976) at biological and post-biological levels, respectively. But in any case it can be safely accommodated under the term semiotic.

Now, the new agents can proliferate/reproduce as in the first step, thus closing the circular causality loop.

Stability and nested, selectively permeable surfaces

In a certain sense, biology has always been a science of complexity (Emmeche 1997). Attempts to comprehend living things with reductionist, mechanistic models have been, for the most part, unsuccessful. 20th century science has gradually come to recognise that self-reference and (operational) closure are essential in understanding life (Schwarz 1997).

Yet, for a more complete picture, one should consider the imperfectness of that closure, too. In the words of Claus Emmeche (2000: 195), when "used and defined in the biological realm, [... closure] is not merely informational, or organisational, but also material and energetic, and thus biologic closure is never perfect".

Also, the issue of "other reference" is of crucial importance in addition to self-reference (Merleau-Ponty 1945, Hoffmeyer 1996b).

An encapsulating surface, selectively permeable as it usually is, not only contributes to the maintenance of the stability but also provides a means of interaction between the "inside and the outside". Organisms can hardly be thought of in isolation from their "extended phenotypes" (Dawkins 1999, Karatay, Denizhan 1999). Furthermore, this consideration is likely to be valid for each level of their nested, hierarchical organisation.

The existence of other-reference opens a door for the emergence of "objectivity" through inter- (or meta-) subjectivity. The meta-system transition offers a mechanism for the establishment of "objectivity" by confining the semiotic relations of agents to a set of conventions valid within the meta-system. The hence established objectivity is solidified via the further development of shared control. Although this process limits the semiotic freedom of the participating agents, it also creates a totally new meta-system level where the emergent, new agents can exercise their semiotic freedom. The scene is ripe for the repetition of the above sequence of events, but this time among the emergent new agents.

In summary, successive meta-system transitions lead to the origination of more complex, swarm-like agents (or agents like *swarms of swarms* — Hoffmeyer 1997b) in the universe. This in turn leads to the unfolding of both the semiosphere and the biosphere. A visual metaphor of this process may be a "widening spiral" of evolutionary expansion, which can be causally linked to the "law of maximum entropy production" (Swenson 1989).

The scenario described above gives a general account of how initially autonomous agents can spontaneously form a cooperative interaction that eventually results in a meta-system transition, which produces a new, presumably more complex agent at a higher meta-system level. This actually seems to be a recurring motif in evolution that has given rise to most novelty and complexification. The successive repetitions of the meta-system transition produces nested, encapsulated structures — or *surfaces inside surfaces* (Hoffmeyer 1998b) — that retain the unity of a single agent or organism.

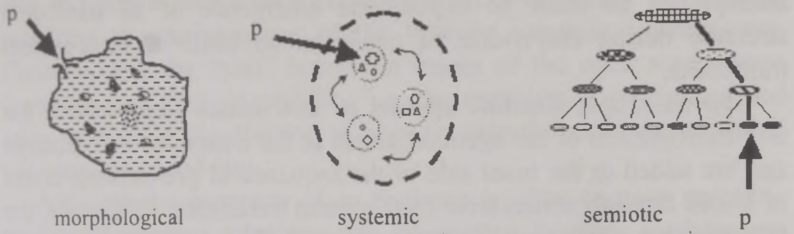
The "window"

The existence of an organism depends on its producing the "correct" actions as a response to external perturbations which *make a difference* for the organism (Bateson 1979). In that sense, such perturbations can be said to be "interpreted" by the organism. Such an interpretation is at the core of biosemiotics. A way of describing such an interpretation is to say that the organism "sees" its environment through a "window", which stands for the totality of its semiotic interactions.

Keeping in mind that the organism consists of a nested hierarchy of sub-systems formed by consecutive meta-system transitions, it should be asked which hierarchical level is first affected by an external perturbation. We claim that the external perturbation first affects entities at the lowest level (in the biological context this can be the molecular or sub-cellular level) and "makes a difference", i.e. is "interpreted". This, in return, constitutes a perturbation for the next hierarchic level and so on.

This consideration leads us to the conclusion that the semiotic interpretation goes "upwards" through successive meta-system levels. In other words, the living system "sees" its environment "through" the sequence of its lower meta-system levels.

Depending on whether one is interested in the morphological, systemic or semiotic aspects of this process, different representations can be employed (Figure 2). It should be noted that although (unavoidably) similar graphical tools are used in the different representations, these designate different levels of abstraction. For instance, while the outer boundary in the morphological representation stands for the cell membrane, the outer boundary (dashed line) in the systemic representation symbolises the "wholeness" of the cell as an organisation and includes relational constraints in addition to physical ones.



morphological representation of a cell

systemic representation of a cell

semiotic representation of a cell

Figure 2. Different representations of a cell.

The semiotic representation in Figure 2 gives a more detailed look at what we have referred to as a "window". The window consists of different layers of "lenses". If for the sake of convenience we should continue with the cell example, the small "lenses" at the bottom row represent the semiotic functions of the ion channel or membrane receptor molecules. Each of these lenses can be considered as different selective filters for the incoming perturbation (*p*). For example, an extra-cellular signalling molecule (such as a lipid-insoluble hormone), upon binding to a membrane receptor, changes the conformation of the intra-cellular side of the receptor, which in turn triggers a cascade of intra-cellular reactions resulting in a perturbation on the organelle level. In that sense, a "lens" at a given level has the task of transforming a received perturbation *p* into a higher level one, *p'*. In view of this cascade structure, the "window" might better be described as a "telescope".

Although it is not shown in the simplified representations in Figure 2, it should also be noted that the virtually infinite diversity of small perturbations entering the telescope is reduced through this cascade of diversity is strongly reminiscent of, if not principally identical to, the phenomenon of “complexity reduction” in the theory of Niklas Luhmann regarding social systems (Luhmann 1987).

The evolution of the “window”

Now that the basics of what is meant by a “window” are given, an attempt can be made to explain the emergence of its telescopic structure during the course of evolution on basis of meta-system transitions.

The telescopic structure appears as new lenses (representing the unified cognition of the agent/organism at the innermost end) emerge and are added to the inner side of the sequence of pre-existing layers of lenses through consecutive meta-system transitions. Obviously, the telescope has a tendency of growing inwards (Figure 3).

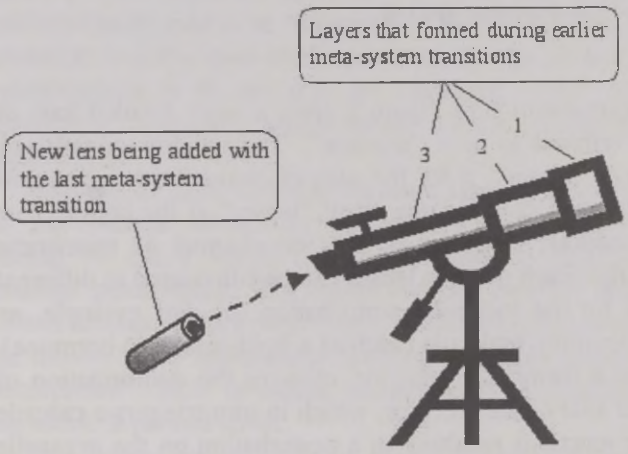


Figure 3. How the “telescope” grows.

This kind of mechanism for the evolution of the “window” is consistent and simultaneous with the previously described circular causality loop that leads to meta-system transitions (see step 4, above).

In fact, an essential element of that "unification" is the creation of a new lens at the inner side of the pre-existing telescope, representing the unified cognitive self of the emergent agent.

It should also be pointed out that the innermost layers of the telescope do not emerge in their full-fledged stable form. Rather than that they are "soft" at the time of their emergence, allowing the organism to learn about and adapt to different possible states of its environment. Only when (and if at all) this organism gets integrated into an even higher-level meta-system, its environment is stabilised rendering the maintenance of the learning capability unnecessary. Consequently, the "soft" innermost lenses of the once autonomous organism lose their adaptability, i.e. the organism is specialised and takes its place in the division of labour within the new meta-system it has been integrated into.

Although the metaphor of an evolving window or more precisely an inward-growing telescope can be applied to other evolutionary processes like individual, social or technological evolution, one should be aware of the specific conditions of those fields. For instance, in the case of social evolution it might not be appropriate to speak of a real meta-system transition (Campbell, Heylighen 1995). In our opinion social systems are more likely to be found at the 2nd or the 3rd stage of the 4-staged causality loop given above.

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Эволюция “окна”

Мы предлагем обобщенную модель, интегрирующую теорию превращения метасистем и биосемиотики, используя метафору “открывающего окна”. Эволюция “окна” происходит посредством превращения метасистем, в ходе которого неоднократно создаются новые окна на “внутренней” стороне уже существующих, создавая таким образом “телескоп”, который растет “снаружи” внутрь. Склонность “телескопа” “расти внутрь” можно в терминах циркулярной каузальности объяснить как: 1) тенденцию, которая ведет от общности к индивидуализации, 2) индивидуальное обучение, которое создает основу для возникновения более сложных семиотических связей, 3) оформление новых, неконфликтных “ценностей”, которое приводит к возникновению привычек, 4) сильный контроль, что приводит к унификации на более высоком (метасистемном) уровне. С помощью предлагаемой метафоры мы надеемся внести ясность в флуктуацию между объективностью и субъективностью, что характерно для описаннного выше круга циркулярной каузальности.

“Akna” evolutsioon

Me pakume välja üldise mudeli, mis integreerib meta-süsteemide muundumise teooria biosemiootikaga, kasutades “areneva akna” metafoori. “Akna” evolutsioon toimub läbi metasüsteemide muundumise, mille käigus luuakse uusi aknaid korduvalt juba eksisteerivate “sisemisele” küljele, luues nii “teleskoobi”, mis kasvab “väljastpoolt” sissepoole. “Teleskoobi” kalduvust “kas-

vada sissepoole" võib selgitada tsirkulaarse kausaalsuse terminites järgnevalt: (1) suundumus, mis viib ühtsusest individualisatsioonile, (2) individuaalne õppimine, mis loob aluse keerukamate semiootiliste seoste tekkeks, (3) uute, mittekonfliktsete "väärtuste" kujunemine, mis viib harjumuste tekkele, (4) tugev kontroll, mis toob kaasa ühtlustumise kõrgemal (meta-süsteemi) tasandil. Kasutades esitatud metafoori, loodame me tuua selgust objektiivsuse ja subjektiivsuse vahelisse fluktueerumisse, mis on sisemiselt omane ülalkirjeldatud tsirkulaarse põhjuslikkuse ringile.

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Biological evolution — a semiotically constrained growth of complexity

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Abstract. Any living system possesses internal embedded description and exists as a superposition of different potential realisations, which are reduced in interaction with the environment. This reduction cannot be recursively deduced from the state in time present, it includes unpredictable choice and needs to be modelled also from the state in time future. Such non-recursive establishment of emerging configuration, after its memorisation via formation of reflective loop (sign-creating activity), becomes the inherited recursive action. It leads to increase of complexity of the embedded description, which constitutes the rules of generative grammar defining possible directions of open evolutionary process. The states in time future can be estimated from the point of their perfection, which represents the final cause in the Aristotelian sense and may possess a selective advantage. The limits of unfolding of the reflective process, such as the golden ratio and the golden wurf are considered as the canons of perfection established in the evolutionary process.

Semiotic causation of evolution

The living process is self-referential: living system in its development and reaction to external stimuli makes an internal choice by reducing indeterminacy of the potential field in interaction with the environment (Igamberdiev 1992, 1993). In other words, the system measures itself as embedded into the recognised part of the environment, the Umwelt. This reflective action is based on the semiotic structure of living system, which includes the inherited description with rigid grammar and flexible combinatorial rearrangements generating possibilities of internal choice. The inherited description itself can evolve towards incorporation of environmental inputs as recognised (i.e. signified) by the system. Thus evolution of biological systems is semiotically constrained ('*semiokinesis*') (Igamberdiev 2001): it includes the recognition and signification of external stimuli within the internal structure of biosystem. Recognition and adequate reacting on external inputs will be a final cause of evolution, the point of attraction for evolutionary movement of the system.

According to Aristotle, any movement is constrained by four causes. The material cause corresponds to an uncertain potential field from which the system evolves (the timeless matter). The formal cause is the structure of the system inherited from the time past. The efficient cause will represent non-equilibrium input to the system, an action in the time present. The final cause is the state in time future to which the movement is attracted. Such subdivision of causes is an intrinsic property of the description of the temporal appearance of spatial objects. The final cause will represent an optimal state of biosystem in a given environment, changed by inclusion of modified system into it, with the maximal fitness. It will mean an observability of environmental inputs as a possibility to recognise them (via adequate reacting on them, i.e. imprinting and encoding). Evolution moves towards incorporation of all potentially being observable and this corresponds to the process of adaptation via complication of organisation of living systems.

The self-referential living system originates as divided into phenotype (dynamical image) and genotype (embedded set of symbols). External influences are non-digitally recognised (imprinted) by the metabolic system of phenotype. The digital genetic information forms an internal programmable structure of biosystem. The encoding digital system is not static — it exists as a set of possible superpositions. Thus living system possesses the trinitary semiotic structure including (a) the metabolic network based on specific recognitions (imprints), (b) the genome as a signifying embedding within the metabolic network, and (c) the superposition of genome rearrangements as a potential whole of the system.

The evolutionary increase of complexity becomes possible when the genotype appears as a system distinct from the phenotype and embedded into it, which separates energy-degenerate rate-independent genetic symbols from the rate-dependent dynamics of construction that they control (Pattee 2001). The flexibility of genetic system is based on induction/repression of genes and on combinatorial rearrangements of the genetic material. What is not recognised at time present (outside the limits of metabolic and genomic flexibility) may be evolutionary incorporated when new structures arise (new reflective configurations are established) and the non-observable transforms into the observable. This corresponds to a metasystem transition (Turchin 1977; Sharov 1999) being possible if the system is redundant (both in the phenotype, which gives rise to new metabolic pathways under the efficient cause — and in the genotype, which memorises this).

Self-reproducing systems have to contain complete descriptions of themselves (Neumann 1966). According to Kolmogorov (1965), the complexity of an object (system) *s* is a minimal length of a program *p* for the universal Turing machine *T* that would print out a detailed description of this object. Increasing this length for the digital internal description of living system will correspond to an increase of its complexity. A newly generated structure being defined just in the process of its establishment cannot be computed from the state existing at time present/past. It therefore cannot be recursively deduced from the previous state and therefore evolution cannot be predicted unambiguously. But it could be forecasted from the time future, i.e. from the most optimal configuration that could be achieved in the concrete context situation. This optimal configuration will represent an Aristotelian final cause for the evolutionary process. The process of movement will be attracted to this point (or the set of points in a general case).

Heredity as a memory

Biological system is able to recognise certain environmental inputs and incorporate their images into its internal structure (Barham 1990). The flexibility of metabolic system means that it responds to changing environment by redistribution of fluxes within it, e.g., the externally caused excess of metabolite *A* triggers the emergence of reaction for which *A* is a substrate (Kampis 1996). Memorisation of this redistribution will occur in the genetic system, e.g., via specialisation of different isoenzymes specifically catalysing appearing metabolic fluxes (Igamberdiev 1999a). This will lead to the growth of complexity of the genetic system. Thus living organisms as self-modifying systems utilise (via memorisation) these persistent shifts in their defining interactions and variable composition (Kampis 1996).

Memorisation of the changes in metabolic systems provides new broader limits of adaptation. It occurs via the formation of self-reflective loops, i.e. mappings between the newly appeared feature and certain genetic elements. The latter will acquire a property to reflect it (via combinatorial events) after which the non-recursive process becomes recursive. In accordance with the Baldwin effect, the changes in the organism precede the changes in the hereditary system that fixes them (Baldwin 1896). This corresponds to the Baerian theory of evolution (Baer 1864; Kull 1999). The process of adaptation via recognition (semiotic fixation) of new environmental inputs means that living systems themselves form their adaptive niches in the course of evolutionary process of increasing their complexity. Since the connection of the *signifiant* and *signifié* is arbitrary, the formation of new structures appears as a casual, we cannot predict (recursively follow) it. In other words, it will be formed via language game — an open process without frames (Wittgenstein 1953).

The language game however has restrictions implied by the structure of genetic system. These restrictions, following Chomsky (1965), we can define as the universal or generative grammar. It will be a computational system restricting the field of non-computable events. In general, grammar is a computational system that mediates a mapping between the *signifiant* and the *signifié*. Chomsky (1965) introduced the concept of preformed linguistic theory denoted as universal grammar, i.e. a system that specifies a form of concrete grammar and provides a strategy for selecting such a concrete grammar. This universal grammar in living systems has high generative capacity and includes constraints of the genetic code, together with constraints of rearrangement of the genomic system such as splicing, sticking and insertion/deletion (Georgescu 1997). These constraints allow obtaining universal computability models (language generating devices equivalent in power with Turing machines) (Paun, Salomaa 1997).

The universal grammar will be a formal cause for concrete grammar generation: combinatorial events will provide a search space for choosing of appropriate grammar. Probably the universal grammar includes to some extent the mechanism of internal evaluating input sentences, not only in conscious beings but also in all living systems. This will provide deviation from randomness in evolution of semiotic system e.g. in the case of directed mutations. The ways of such evaluation may include some possible selections in the potential field before reduction in the whole system operating as a quantum mechanical observer (Ogryzko 1997). The whole of the system in this approach will correspond to the set of all its potential superpositions. This set will be a semiotic interpretant of the system's adaptive behaviour: by genomic reconstruction the system fits to the acquired change in the set of imprints (metabolic organisation) thus incorporating it. Evolutionary reconstruction of the genome thus interprets the acquired change by memorising it and allowing its use when it is necessary.

Formal incorporation of the final cause into the description of biological evolution

In physics, in frames of the anthropic principle, the final cause means observability, thus a framework is needed to explain observability of the world. The approaches to describe evolution of the system towards observability are based on understanding of quantum measurement (as opposed to the classical measurement of external objects) as a measurement of the environment together with embedded measuring system, which cannot be separated from it. The assimilated part of environment as recognised by the system can be defined as the Umwelt. Recognition of new observables during this measurement will generate a simultaneous complication of the measuring system itself and the Umwelt, it will correspond to the Gödelian enumeration within sets and lead to the possibility of measurement of a newly formed system plus environment (Igamberdiev 1998, 1999b). Although the measurement itself is not recursive, it will generate enfolded embedding structures viewed as appeared in the continuous recursive embedding process after it takes place. The appearance of a new description means that the system memorises its optimal state in the concrete environment, i.e. it measures not the external environment, but itself plus the environment (itself embedded into the environment). This is the difference of the quantum measurement from the classical measurement, which views the environment as external: the system views itself as embedded into the Umwelt, the recognised part of environment. It should have a memory as a distinct set (embedded set) which will constrain its movement (as a formal cause). Attraction to the most optimal states (canons) takes place during the recursive embedding. These most optimal states will include fundamental values (constants) inherent for the unfolding process.

For the description of observable world, which consists of the systems perceiving both outer objects and an inner self, an apparatus of the set theory was applied (Bounias, Bonaly 1997a). A special type of sets (closed sets) exists upon intersection of topological spaces owning different dimensions. This intersection will incorporate a contradiction (fixed point) in the description. Fixed points will generate internal choice accounting for the biological self. This description provides theoretical justification for the existence of memory. The closed sets in this approach are similar to the monads of Leibniz (1965) which constitute and observe the Universe. The empty set will correspond to a vacuum that is still not allotted by features (Bounias, Bonaly 1997b). The memory appears as a 'sign-creating activity' (Hegel 1971), linking sets with different dimensions.

A concept with emphasising the fixed point as a central element of the contradictory structure uniting parts and a whole was applied to biological systems by Gunji *et al.* (1996, 1999). Following this approach, an uncertainty in interaction between biosystem and environment is reduced via formation of a self-reflective loop, which leads to establishment of emergent computation such as primitive recursive functions. Time in this approach separates contradictory statements allowing them to appear in a sequential order. In this model, all interactions encompass the notion of detection. The latter can be expressed as a process generating a contradiction. The process of internal choice in the course of adaptation includes inducing a fixed point and addressing a fixed point. It can be compared to indicating an element with indicating a set consisting of elements, that is, to Russel's paradox. Evolution as a formation of reflective loops during measurement is generally relevant to resolving a paradox or a logical jump.

Dubois (1997) introduced a concept of the incursive computation, in the sense that an automaton is computed at the future time $t+1$ as a function of its neighbour automata at the present and/or past time steps but also at the future time $t+1$. The development of this concept for inclusion of multiple states led to the concept of hyperincursion, which is an incursion when several values can be generated at each time step. The series of incursive and hyperincursive actions will produce fractal patterns defined by functions of the past, the present as well as the future states. External incursive inputs cannot be transformed to a recursion. But they can be internalised and thus transformed to recursive inputs via self-reference (as being memorised in the system as signs). Interference of inputs in fractal generation gives rise to various fractal patterns with different scaling symmetries. These patterns have however some fundamental symmetrical rules at different scales, corresponding to potential existence of certain canons in incursive computation. Hyperincursion means superimposition of states similar to that in quantum computation (Dubois 1998). In incursive and hyperincursive fields (which are viewed as hypersets, i.e. sets including themselves), undecidabilities and contradictions occur (in the Gödelian sense): the fractal machine operates in a non-algorithmic way and the formal system cannot explain all about itself (undecidability). The transformation of a non-local incursive system to a local recursive system leads to a folding of each automaton to the other ones from the future time to the present time. We will show later that the internal evolutionary process can be modelled as a function of the system's state at time past, present and future with fundamental consequences for biological perfection.

Perfection and final cause

The newly generated structure attains the value in changed Umwelt. This means that it is embedded in a whole system interacting with the environment as a part of a new established harmony. This is possible if a new configuration fits to a certain canon. Organism constructs itself via certain harmony principles, used also for pragmatic goals (Lyubischev 1973, 1982). The problem of form is generally not only pragmatic: it needs aesthetic criteria, primary and absolute to any concrete adaptive harmony. According to Lyubischev (1973: 46), evolution passes through the change of canons. "A small deviation from the canon is a cacophony, while a significant deviation can lead us to a higher canon, to a new degree of beauty". Evolution of canons includes the period of initial primitivism (simplicity of form, brightness and contrast of colours), the classical period with most harmony and finely balanced forms and colours, and finally the manieristic period with some unusual and unbalanced structures. Style unity is the highest level of wholeness non-reducible either to the adaptive harmony or to the correlation between parts.

Interaction between the whole and the parts can be viewed as an intersection of the sets with different dimensions forming a contradiction in the sense of Russel's paradox (the fixed point) (Bounias, Bonaly 1997a). This intersection may represent a harmony or a disharmony, depending on how parts are observed within a whole observing it. A harmony appears as a threshold for establishing a connection between local and global periods of iteration in recursive embedding (Mignosi *et al.* 1998). When viewed as a recursion (reflected from incursion), the preceding motif unit is transferred into the subsequent one by a certain fixed similarity transformation g: $S_{k+1} = g(S_k)$. The resulting domains (having certain quantitative values) are hierarchically embedded into one another and function at every level with different clock time periods (Petukhov 1989). The limit of actualisation fits optimality of the structure being actualised thus it provides the existence of most optimal solutions for design.

In internal evolutionary process, which includes formation of self-referential loops, the evolving state is determined by the two (in the simplest case) contradictory values of the system separated by time interval, and the value in time future acquired after addressing them. Addressing the fixed point means that the two contradictory statements taken as sequential values separated by time interval and equally probable are composed to get the third statement. Thus the next statement (quantitatively modelled as having correspondent value) is composed from the two previous statements when they are memorised within the reflective loop: $F_{n+2} = F_n + F_{n+1}$. This formula corresponds to the Fibonacci series if neighbouring elements are just natural numbers. This will lead to important evolutionary consequences: in the transformation of a non-local incursive system to a local recursive system, certain recursive limits (e.g. the golden ratio, $Q_n = F_{n+1}/F_n$ at n growing to infinity) will appear as fundamental canons of perfection formed as memorisation within reflective loops.

Other useful series appear when three neighbouring elements F_n, F_{n+1}, F_{n+2} are taken as lengths of three sequential segments (as appeared in the sequential past (t–1), present (t) and future (t+1) times). In this case we get the golden wurf

$$W_n = (F_n+F_{n+1})(F_{n+1}+F_{n+2})/[F_{n+1}*(F_n+F_{n+1}+F_{n+2})]$$

as a limit of the recursive process when n increases to infinity (Petukhov 1989).

The golden ratio and the golden wurf constants represent fundamental values of infinite recursion when the next element is formed by the operation on the two previous sequentially appearing elements memorised within the reflective loop. They always occur in morphogenetic patters appearing as limits of the infinite process of recursive embedding arising from the reflective action (internal quantum measurement).

The classical description of evolutionary process views the latter as occurring in the external Newtonian time. The real evolutionary process forms time by itself — it appears as a tool for the separation of contradictory statements in the infinite embedding process. The Newtonian external time occurs when the internal incursive/hyperincursive process is transformed (via memorisation in self-reflective loop) to recursive rules. Thus originally time is a semiotic phenomenon. This view arises to Aristotle who defined in *Physica* (IV, 12) that there is the time (external) which *is* measured and the time (internal) *by* which an observer measures. Evolution in the semiotic time represents a contradictory process of growing complexity, which includes both fundamental principles of perfection of canons regarded as its nomogenetic laws in the sense of Berg (1969) — and free creativity for their construction based on internal choice in the sense of Bergson (1917).

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Семиотические основания возрастания сложности в процессе биологической эволюции

Любая биологическая система включает внутреннее описание самой себя и существует как суперпозиция различных возможных реализаций, которая подвергается редукции в ходе взаимодействия с окружающей средой. Процесс этой редукции не может быть рекурсивно выведен из состояния системы в настоящем времени, но включает непредсказуемый выбор и требует моделирования с учетом предполагаемого состояния в будущем времени. Подобное нерекурсивное установление возникающей конфигурации после запоминания посредством формирования рефлективной обратной связи (создающая знак деятельность) становится наследуемым рекурсивным действием. Это ведет к увеличению сложности внутреннего описания, представляющего законы генеративной грамматики системы и определяющего возможные направления открытого эволюционного процесса. Состояния биологических систем в будущем времени могут определяться с позиции их совершенства,

представляющего конечную причину в Аристотелевском смысле и облающего селективным преимуществом. Конечные пределы развития рефлективного процесса, такие как золотое сечение и золотой вурф, рассматриваются нами как основные каноны совершенства, устанавливающиеся в ходе эволюции.

Bioloogiline evolutsioon — semiootiliselt piiratud keerukuse kasv

Iga elav süsteem kannab endas enesekirjeldust ja eksisteerib kui selle kirjelduse erinevate võimalike realisatsioonide superpositsioon, mida piiravad või vähendavad suhted keskkonnaga. Seda vähendust pole võimalik rekursiivselt tuletada olemasolevast seisundist lähtudes, kuna ta sisaldab ka ettemääramatuid valikuid — modelleerimisel tuleb seega arvestada ka tuleviku seisundeid. Mitterekursiivselt tekkiv uus konfiguratsioon areneb päranduvaks ja rekursiivseks toimimiseks pärast mällujätmist reflektiivse tagasiside tekkimise kaudu (mis loob tegevuse märgi). See omakorda viib süsteemisisese kirjelduse keerukuse tõusule, mis vastavalt generatiivse grammatika reeglitele määravad avatud evolutsiooniprotsesside võimalikud edasised suunad. Bioloogiliste süsteemide tulevikuseisundeid on võimalik hinnata nende täiuslikkuse suhtes — see on lõpp-põhjuseks Aristotelese tähenduses ning võib kanda ka valikulisi eeliseid. Reflektiivsete protsesside arengu piirväärtusi (näiteks kuldlõiget ja kuldpööret) vaadeldakse kui evolutsiooniprotsessides püstituvaid täiuslikkuse kaanoneid.

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Biosemiotic knowledge — a prerequisite for valid explorations of extraterrestrial intelligent life

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Abstract. The scientific search for extraterrestrial intelligent life is probably one of the most ambitious projects ever taken in biology. The article discusses methodological problems associated with the search. It is emphasized that investigators of extraterrestrial intelligence, in contrast to investigators of terrestrial matters, have no valid pre-understanding of their subject matter. In this barren setting, utilization of semiotic knowledge is shown to be a prerequisite for achievement of valid data. Owing to methodological shortcomings, it is concluded that the NASA funded project SETI (Search for Extraterrestrial Intelligence) has little if any relevance for the detection of intelligent life in other worlds.

> *It is a capital mistake to theorise before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.*
> Arthur Conan Doyle (1976: 3)

Intelligent life in other worlds has been a major theme of 20th century science and popular culture. For a long time inadequate technology and immense spatiotemporal distances hindered proper scientific investigations of the universe, and human ideas of extraterrestrial intelligent life were based largely on theories abducted from ambiguous and sometimes irreproducible observations (Dick 1996). Much of this changed during the latter half of the 20th century with the advent of more sophisticated technology and scientific methodology. A new discipline, astrobiology, evolved to study life's origin, evolution, distribution and interactions. The subject's current scientific credibility is reflected by an increasing number of papers in leading journals and by the recent establishment of two new journals, Astrobiology and International Journal of Astrobiology. In addition, the NASA Astrobiology Institute, a partnership between the National Aeronautics and Space Administration (NASA) and a number of academic research organizations in the USA, was recently established to promote, conduct, and lead integrated multidisciplinary astrobiology research.

Whereas the improbability of extraterrestrial life has been proclaimed by biologists of many stripes, some scientists believe on statistical grounds that life has arisen independently several places in the universe. For example, Robert Bieri (1964: 277), who holds an extreme Panglossian and deterministic view of evolution, believes that extraterrestrial intelligent beings will evolve by necessity and that they "will look an awful lot like us". In contrast, the evolutionary biologist Ernst Mayr (1988: 67–74) holds a probabilistic view and denounces Bieri's idea of a straight line from the origin of life to intelligent man. Mayr pictures evolution as a branching tree full of chance nodes and makes clear how incredibly improbable it is that intelligent life, as we know it, has appeared. Mainstream biology of today endorses the probabilistic view, holding the deterministic view as misguided.

The scientific search for extraterrestrial intelligent life is perhaps the most ambitious initiative ever undertaken in biology. As of today there are no certain observations of life beyond Earth, and some scientists therefore claim that astrobiology in reality is a subject without subject matter. However, encouraging scientific observations, especially concerning probable presence of microbiological life in space (Thomas-Keprta *et al.* 2001), have motivated further explorations. Ever increasing technological sophistication combined with research funds of astronomical proportions and an almost obsessive wish to learn whether we are alone in the universe or not may well turn astrobiology into the major scientific enterprise of this millennium.

Appropriating unknown life forms

Rationality and methodology are intimately connected; to be rational in science is to select good means to pursue scientific goals. Thus, before approaching their subject matter rational scientists set out to validate the methods used for their investigation. This enterprise is made explicit when they design experiments to discriminate among a set of competing hypotheses, during which care is taken to include relevant negative and positive controls that may serve as a frame of reference for the experiment. It is central to experimental methodology that controls and other background knowledge of the subject matter are not independently tested in the experiment. Rather, scientists try to find auxiliary assumptions that they have good reasons to believe are true regardless of what the experimental observations may bring to bear on the hypotheses (Sober 1999).

A challenge for investigators of extraterrestrial intelligent life is that they, in contrast to investigators of terrestrial matters, have little valid pre-understanding of their subject matter. Even though the physical properties of the elements and the laws of physics may be regarded as universal (Wilczek 2002), astrobiologists have no scientifically grounded idea of what physical realizations intelligent life in other worlds may have. Since there is no assurance that life beyond Earth will be Earthlike, terrestrial biological principles and data do not necessarily provide valid information when inferring life in other worlds (Conrad, Nealson 2001). Paradoxically, extrapolation of terrestrial principles to other worlds may preclude any chance of finding new principles of life.

The unavailability of valid background knowledge of extraterrestrial intelligent life makes it irrational to proceed further with a scientific practice that relies explicitly on such knowledge. It is therefore necessary to establish a basis for investigations of extraterrestrial life that does not rely on ontological claims. In an ontologically barren setting it is appropriate to investigate whether founding principles can be grounded in epistemology — whether it is time to invoke and revitalize the Cartesian epistemic cut. When confronting a world full of untruth and scepticism, René Descartes (1968) sought and found in the existential *cogito ergo sum* a first principle that he could utilize as a basis for his further studies. Although Descartes (1968: 54) believed that "the things we conceive very clearly and very distinctly are all true", he also realized that "there is nevertheless some difficulty in being able to recognize for certain which are the things we see distinctly". By the latter qualification he acknowledged uncertainties as regarding the status of auxiliary assumptions.

Unlike Descartes' principle the founding principle in studies of extraterrestrial intelligence can not be grounded in an existential claim. The existence of extraterrestrials is, after all, what astrobiology pursues. It therefore seems reasonable to look for a founding principle in the practice and methods used to appropriate unknown life forms.

It is conceivable that an essential characteristic common to all kinds of intelligent life will be transfer of information through communication. Even though this would appear rational, science has no idea of what kind of communication extraterrestrials engage in. Science should therefore be cautious not to dismiss as ill adapted any of the imaginable physical realisations that extraterrestrial communication channels and sense organs may take. There may be multiple realisations of the same communication channel, as is known from terrestrial biology where eyes have evolved independently at least 40 times during evolution (Mayr 1988). Furthermore, extraterrestrials may have sense organs that are quite unimaginable to humans. Man's limited abductive powers were illustriously revealed during the explication of the lateral lines in fishes: "The fact that man does not have this sense organ himself, and had not perfected artificial receptors in any way analogous, was a handicap in the attempt to understand the organ" (Williams 1966: 11).

The kind of anthropocentrism discussed in the previous paragraph may be a hinder to man's endeavour to obtain a deeper understanding of communicative life. It would thus appear necessary to transgress the constraints imposed by anthropocentrism and substitute it with a broader biocentric perspective. Jakob von Uexküll (1982) made an attempt at this when he used the term umwelt to depict the subjective features of an animal's environment. An animal's umwelt includes all the meaningful aspects of the world it inhabits. Various species of animals, like rat and man, will by consequence have different umwelten. A similar insight was captured in Martin Heidegger's (1962) distinction between two types of being, being-in (with a hyphen) and being in. Whereas the common understanding of being in is of something physically enclosed, being-in is not a physical property but relates to the organisms concerned dealings with its surroundings.

Heidegger holds that biology, which is concerned with causal explanations, can not study the way life is lived. Life is to be understood as a practical activity and not as a scientific entity or process defined in biochemical terms. A condensed and clear exposition of these thoughts were captured in a famous aphorism by Ludwig Wittgenstein (1953: 223) who stated that if a lion could talk, man would not be able to understand her. The combined insights of Uexküll, Heidegger and Wittgenstein allow us to conclude that two species with homologous sense organs that perceive the same physical stimuli may still inhabit different lifeworlds. The possibility of achieving meaningful communication with extraterrestrial intelligent life having other evolutionary trajectories and umwelten than human beings should therefore, accordingly, be very small.

One can of course argue that terrestrial animals are neither conscious nor intelligent, thereby being irrelevant to discussions of extraterrestrial intelligence. However, this counterargument misses the point since the issue addressed by Uexküll, Heidegger and Wittgenstein is philosophical, not scientific. The issue at stake concerns scientific methodology, not ontology. Whether animals have consciousness or not is therefore only indirectly relevant. Even so, scientific elucidation of animal consciousness may have bearings on the philosophical question. As it is, animal consciousness is a matter about which science is very vague. Donald Griffin, who discovered how bats navigate in the dark using their own sonar, recently stated when discussing animal consciousness: "In the face of very weak evidence we scientists tend to make very strong, negative statements [...] when we really don't know" (Vines 2001: 50). Furthermore, he proclaimed that the key to understand the minds of other animals lies in the communication systems, but that it is "very, very difficult to get convincing evidence" (Vines 2001: 51).

Unprejudiced information about other life forms can only be appropriated by using a scientific method that does not rely on specific physical realisations of that life. I believe that this methodological demand can be met by combining sound biological principles with semiotics. Tønnessen (2001: 689), although sceptical to speculations about what may constitute universal characteristics of living beings, likewise argues that "one should presume that semiosis is a universal characteristic of living beings, because without semiosis, there can be no recognition". A main advantage when utilising biosemiotics to study communication is that semiotics, although relying on the physical attributes of objects, is not dependent upon their specific physical realization. According to Peirce (1998) semiotic communication involves the sign, the object that the sign refers to, and the interpretant. For something to be a sign it must be understood as such — a sign is a sign only in context. Signs must be interpreted in relation to each other in a context, otherwise they may not even be acknowledged as signs. It is a fundamental principle in Peirce's semiotics that indexical and iconic signs, and especially symbolic signs, have no meaning in isolation. The puzzles connected with background knowledge are therefore explicitly taken care of and acknowledged by biosemiotics.

SETI — a misguided scientific approach

Communication with extraterrestrial intelligence poses semiotic problems of both philosophical and physical character. If the semiotic problems are not explicated and solved at the philosophical level, solving the technological problems may be a futile endeavour having no bearings on the problem at hand. Such reasoning sets the background for my own scepticism towards the evidential bearings of one of the most ambitious astrobiological projects ever, the NASA funded project SETI (Search for Extraterrestrial Intelligence). SETI has consumed enormous amounts of resources in an attempt to get in contact with extraterrestrials. Since the early 1960s SETI has dealt with the communicative problem in two ways. First by sending a message into deep space that would allow any intelligent extraterrestrial to figure out that it was produced by intelligent designers, and second by scanning the night sky for narrow-band radio emissions hoping to detect signs of intelligent life elsewhere in the universe. SETI concentrated on listening for electromagnetic signals in the centimetre waveband, the reason being purely practical since that is where the background noise from the universe and the Earth's atmosphere is lowest (Dick 1996).

The SETI engineers search for radio emissions, not because this is an *a priori* sign of intelligence, but because they know the sorts of mechanisms that are needed to produce radio waves. It thus appears that fundamental semiotical problems are relayed to the background because of the practical convenience of radio waves. The earthcentric presumptions of the SETI project was explicitly articulated when the journal *Nature* on October 21, 1993 on the front page asked "Is there life on Earth?", a question that was answered in the affirmative by Carl Sagan *et al.* (1993) in the same issue. Carl Sagan and the other scientists reported results obtained from experiments performed in December 1990 when the Galileo spacecraft flew within 960 km of Earth. As Galileo passed by the Earth it made a series of observations to test its onboard instruments. It detected abundant oxygen in the Earth's atmosphere. In addition, narrow-band radio transmissions from Earth were detected. Taken together, this evidence implied that not just life, but intelligent life existed on Earth. Although the experiments were technically successful, it is arguable whether the experiments have any relevance for the detection of intelligent life in other worlds. Rather, it can be argued that the only conclusion that can be drawn from the experiment is that creatures on Earth send radio signals that can be received in space. That the same creatures are intelligent can not be inferred from the experimental data without a concomitant background knowledge that explains how narrow-band radio transmissions are generated and by whom.

The biological rationale for the SETI project can be found in certain assumptions derived from an interpretation of evolutionary theory explicated and defended most vehemently by Richard Dawkins (1983: 35). He claims that "The Darwinian law [...] may be as universal as the great laws of physics", and holds that complex structures found anywhere in the universe are/were either alive or are/were artefacts created by something that is/was alive. According to this theoretical framework one can envision extraterrestrial radio signals as artefacts generated by humanoids on other planets (H_1). Although evolutionary theory is opposed to the design argument for explaining biological diversity, the theory is not opposed to deployment of the design argument for explaining artefacts. As such, the design argument is valid for scientific inference. Radio signals could therefore be looked upon as valuable signs of meaning in the universe. However, when regarded as a scientific hypothesis, I hold that we have little reason to believe H_1 rather than the opposite hypothesis — that the signals are not generated by humanoids on other planets (H_2). Since there are no valid data to support the hypotheses, both hypotheses have identical likelihoods, $p(\text{signal} \mid H_1) = p(\text{signal} \mid H_2)$. It is only earthcentric background knowledge that inclines us to believe that the likelihood of H_1 is higher than H_2.

Although not explicitly acknowledged, the SETI project appears to be based on the abandoned deterministic model of evolution, not the endorsed probabilistic model. For example, SETI implicitly expects that humanoids are equipped with receivers among their sense organs that respond to the same auditory signals that humans do. Furthermore, since the reception of any message is dependent on prior knowledge of the possibilities, it is expected that humanoids have a similar evolutionary history to the one that occurred on Earth. I find both assumptions incomprehensible, and consequently find the utilization of radio waves as means for contact with extraterrestrial intelligence dubious also from an evolutionary angle.

Concluding remarks

At face value the SETI project, by focusing on signs of meaning in the universe, may be regarded as a project testing the hypothesis of universal Darwinian evolution (Dawkins 1983). The investigations may also seem to have bearings on the biosemioticians' claim that life is based entirely on semiosis, on sign operations (Hoffmeyer 1996; Emmeche 1998). Finally, the SETI project may be looked upon as a test for the claim of universal biosemiotics. However, given the philosophical and semiotic criticisms raised against the SETI project I find it rather unlikely that the results of the project will have any bearings on the issues raised. The several unjustified background assumptions of the SETI project need to be thoroughly discussed and revised before any scientific meaning can be bestowed to data. These discussions should be conducted on a biosemiotic footing.

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Необходимость биосемиотического знания при поисках внеземного разума

Научный поиск внеземного разума один из самых амбициозных проектов, когда-либо предпринятых в биологии. Данная статья рассматривает связанные с этим проектом методологические проблемы. Подчеркивается, что искатели внеземного разума не обладают, в отличие от исследователей земных материй, нужным предварительным знанием об объекте своего исследования. В качестве предпосылки получения заслуживающего доверия результатов автор видит использование семиотической методологии. Делается вывод, что финансируемый НАСА проект СЕТИ (Поиск внеземного разума) не может из-за своих методологических недостатков иметь успех при поиске внеземного разума.

Biosemiootilise teadmise tarvilikkus maavälise mõistusliku elu usaldusväärseil otsinguil

Maavälise elu teaduslik otsimine on tõenäoliselt üks ambitsioonikamaid projekte, mis bioloogias kunagi ette võetud. Siinne artikkel arutleb otsingutega seotud metodoloogiliste probleemide üle. Rõhutatakse, et maavälise mõistuslikkuse otsijad ei oma, erinevalt maiste asjade uurijatest, arvestatavat eelteadmist oma uurimisobjektist. Selle piirava teguri tõttu nähakse semiootilise metodoloogia kasutuselevõttu kui eeldust usaldusväärsete tulemuste saamiseks. Järeldatakse, et NASA poolt finantseeritud projekt SETI (Maavälise mõistuslikkuse otsing) ei saa tänu metodoloogilistele puudujääkidele olla maavälise mõistusliku elu otsimisel kuigi edukas.

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Why and how to naturalize semiotic concepts for biosemiotics

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Abstract. Any attempt to develop biosemiotics either towards a new biological ground *theory* or towards a *metaphysics* of living nature necessitates some kind of naturalization of its semiotic concepts. Instead of standard physicalistic naturalism, a certain kind of *semiotic naturalism* is pursued here. The naturalized concepts are defined as referring only to the *objects of our external experience*. When the semiotic concepts are applied to natural phenomena in biosemiotics, there is a risk of falling into anthropomorphic errors if the semiotic concepts remain mentalistic. It is suggested that there really is an anthropomorphic error or "hidden prototype fallacy" arising from Peirce's prototype for semiosis: the research process of an experimental scientist. The fallacy lies in the concept of the object of representation — it is questionable whether there are any objects of representation for bacteria and whether the DNA-signs have any objects. The conclusion is that Peircean semiotic concepts are naturalizable but only if they are based on some more primitive concept of representation. The causal origins of representations are not relevant, only their anticipative consequences (i.e. meaning).

Three possible roles of biosemiotics in biology

The paradigmatic examples of semiotic phenomena are signs mediated by human languages and thought. To talk about biosemiotics is to make a hypothesis that the anthropocentric concepts of semiotics are also applicable in the non-human domain that is studied within the biological sciences. Because human beings are just one species of living beings, biosemiotics can be seen as a generalization or extension of semiotics. When semiotics is generalized into biosemiotics, it has at least three possible roles in biology:

1. We can use (originally) anthropomorphic semiotic concepts (like sign, interpretation or agent) *merely as metaphors and analogies* that make biological phenomena more comprehensible or lively in popular texts — or that give new insights for new biological hypotheses and experiments.
2. We can see the value of biosemiotics as *an alternative philosophy of biology*, an alternative way to integrate "folk biology" and "scientific biology" (cf. Emmeche 2000: 188), or as an alternative *metaphysical* interpretation of biological phenomena.
3. We can see it (in its present state) as a potential ground for a *new ground theory of biology*, a theory in which the vertical and horizontal aspects of biosemiosis[1] are integrated.

The first role is so obvious and common that no one should have much against it. However, if biosemiotics merely adheres to this role, we cannot expect much progress in characteristically *biosemiotic* thought. Metaphoric talk is often fruitful at the beginning of a new research program, but if the meanings of the concepts used are not defined more precisely, it will rather die out than survive as a scientific research program. Thus, I suggest that biosemiotics should be developed to fulfil either the second or the third role (or both) — otherwise, it will eventually become either extinct or assimilated into other approaches in vitiated form. Its most fruitful novel ideas will be hijacked into other programs closer to the mainstream and afterwards it can be passed over because "it says nothing new".[2] On the other hand, metaphoric talk *per se* is inescapable, all our concepts, even the most "scientific" ones, are based on metaphors.[3] My concern here is what kind of *experience* the biosemiotic metaphors are based on, what kind of hidden or implicit presuppositions are smuggled into bio-

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[1] Cf. "dual code theory of life" (e.g., Hoffmeyer, Emmeche 1991: 126; Hoffmeyer 1996: 32).

[2] If the main goal of biosemiotic talk is not in science but in politics, journalism, or applied ethics (or in religious apology), then biosemiotics understood as weaving fancy stories about biological phenomena may be powerful enough.

[3] Not only our *concepts* but also our *theories* are based on metaphors and even whole *paradigms* are often symbolized by a specific term that guide the interpretation (e.g., the *selectionist* paradigm of evolution). Cf. Emmeche, Hoffmeyer (1991: 8–9) about "the levels of metaphorical 'signification-transfer' in science".

semiotic concepts within these metaphors. I will conclude that some of these hidden presuppositions are not justified if we are to make natural science or general metaphysics of living nature.

Here I mostly discuss the second and the third roles and suggest that a *certain* kind of *naturalization of the semiotic concepts* of biosemiotics might be beneficial in both cases. By naturalization, I do not refer to standard physicalism but rather a certain kind of "public accessibility" of the objects of semiotic concepts. Physicalistic naturalism would mean a reduction to non-semiotic (i.e. "reduction to secondness") with the consequence that biosemiotics would be driven into the first role. I am looking for a new (or at least a different) kind of naturalism, a *semiotic naturalism* that would preserve the (originally non-naturalistic) idea of *purposive* (or *end-directed*) *habitual action* (i.e. *thirdness* or loosely taken *final cause*), but considers it as a natural phenomenon. Most of the argumentation in this paper does not directly concern biosemiotic "theory" but its *methodology*. Some consequences to biosemiotic theory are illustrated in the last section.

Naturalistic methodology for biosemiotics

1. Concepts and objects of experience

In order to create a proper method for the naturalization of our concepts, we need to consider how our concepts refer to nature. Concepts can be divided into two classes:

1. *natural concepts* that refer only to the objects of our *external experience*, and
2. *mentalistic concepts* that are comprehensible only through reference to some objects of *internal experience* (or "*inner sense*").

Semiotic naturalism would mean primarily the *naturalization of all mentalistic concepts* that are used in biosemiotic theory. This means a certain kind of re-definition of mentalistic concepts as natural concepts, i.e. concepts whose comprehension is not dependent on the objects of internal experience. This re-definition should be extensive rather than restrictive or eliminative — the extension of a concept should be enlarged in the naturalization.

Objects of external experience are objects that the experiencing person can assume to have been analogously experienced by any other person who has similar cognitive and perceptual capacities. If I see a flying bird, it is reasonable to suppose that other people (if there were any) could see the *same* object regardless of possible differences in background knowledge about birds. A fellow observer might even see it as an airplane although I consider it an eagle. What qualities or properties are connected to the object perceived may vary in the interpretations of the sensation, but whatever they are, they are connected with the *same* event or occasion of the object.

Objects of internal experience (or *inner sense*) are objects (or events) to which no one else but the person actually experiencing them can have access except mediately, somehow through the internal experience of that experiencing person. Others can have access to these objects only by drawing an *inference* from *externally perceivable signs* (words, gestures, readings of measuring devices, etc.) that are intentionally or non-intentionally communicated. Internal experience refers to *subjective* objects. Some examples of the objects of internal experience and mentalistic concepts might be:

(1) The concept of experience is in itself a mentalistic concept. The qualitative content of any experience in itself is always an object of internal experience (regardless of whether this experience is external or internal).

(2) The concept of pain is a mentalistic concept. A feeling of pain is internal experience — it refers to the "state of one mind/body" that no one else but the person in pain can directly experience.[4]

(3) Most commonly, the use of the concept of *consciousness* or *self-awareness* is mentalistic — it is ultimately understood through our subjective and internal experiences of being aware of oneself. The self-awareness of another person cannot be directly perceived, only inferred.

(4) Likewise, such semiotic concepts as "interpretation", "sign" or "representation", "reference", and "meaning" in their normal use are ultimately (or originally) mentalistic concepts.

The main reason why the naturalization of mentalistic concepts would be beneficial is purely methodological, not metaphysical. Although

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[4] A doctor can never be absolutely sure if his patient is just pretending to feel pain; only the patient himself has direct access to his own pains. It is also impossible to compare the amount of pain between two different persons. What the doctor can do is only to interpret external signs, like the account of the patient and other externally perceptible symptoms in the patient.

the concepts refer only to the objects of external experience in semiotic naturalism, no physical theory about (the composition of) the objects of external experience is necessarily assumed. Regardless of whether such concepts as pain or consciousness should (or can) be naturalized, I have no doubt that they are *real* concepts (as well as *useful*). They refer to real phenomena and they are certainly necessary in successfully directing our everyday action. The benefit of naturalization is, most of all, communicational, to make the meanings of the concepts used clearer and intersubjectively controllable. The naturalization of semiotic concepts is set to diminish the tacitness of subjective assumptions included in what Claus Emmeche (2000) calls *experiential biology.*[5] Mentalistic concepts involve the risk of producing an *anthropomorphic error*, to predicate qualities peculiar to humans (or even only to *myself*) to natural phenomena. (This error is relative to ego-, ethno-, and logo- or "ratiocentric" errors.[6]) It can also be called a *hidden prototype fallacy* in the sense that Emmeche (2000: 190) has presented — the "hidden prototype" of semiotic perspective just appears to be mental and intellectual. It seems to me that much of the opposition and hostility of typical natural (or medical) scientists to the biosemiotic approach originate in suspicion about this kind of hidden prototype fallacy.

2. The "hidden prototype" of semiotic perspective

The intellectual "hidden prototype" of biosemiotic approach dates back to the Peircean origin of semiotic concepts like representation, semiosis, etc. Peirce's semiotics, *semeiotic*, was *a* theory of *logic*, a *normative* science of *self-controlled thought*, although logic, for

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[5] "[...] *experiential biology*. This includes the domain mentioned above as folk biology (common, conventional, public, everyday notions of plants and animals) *plus* the subjective field of our own experiences of what it means to be a growing, feeding organism, a moving feeling animal, a sensitive human being. [...] first and foremost, experiential biology includes a kind of subjective and qualitative knowledge of the feeling of life, of sentience, of the moods of passive laziness or active engagement, and so on" (Emmeche 2000: 189).

[6] It would be better to call these "ego-, ethno-, and logo- or ratio*morphic*" than "-centric" errors. While anthropo*morphic error* (in the above mentioned sense) can be avoided by naturalization (although not all anthropomorphisms are necessary errors), antropo*centrism*, peculiarly human *interest*, cannot be completely avoided.

Peirce, included most of what is nowadays studied under the disciplines of methodology, epistemology, and philosophy of science. The relation of logic (semeiotic) to other sciences is studied under Peirce's classification of sciences (Figure 1). This classification is not a mere typology, but is hierarchically ordered:

> I would classify the sciences [...] in the order of abstractness of their objects, so that each science may largely rest for its principles upon those above it in the scale while drawing its data in part from those below it. (EP 2.35, 1898)

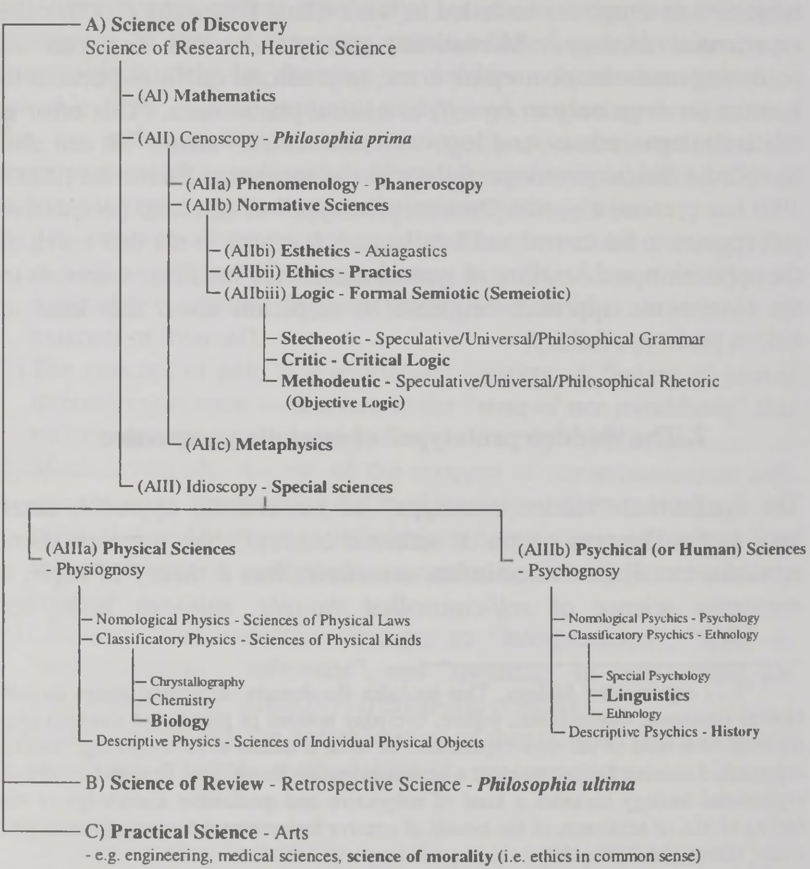

Figure 1. Peirce's outline classification of sciences (~1903, EP 2.18).

It is essential that logic cannot be dependent on metaphysical principles, like Peirce's "objective idealism" (cf. footnote 14), or on the principles of special sciences including biology, although these sciences may offer data for the abductive and inductive inferences drawn within logical science. Biosemiotics cannot be pure logic according to this classification, because it has *real* subject matter, living systems on earth. It must be either metaphysics, e.g. the study of logical phenomena appearing in metaphysics (or general nature) of living things (cf. the second role of biosemiotics), or natural science[7], e.g. the study of logical phenomena appearing in experimentally accessible living nature (cf. the third role of biosemiotics).

The form of Peirce's triadic concept of sign or representation was discovered from the point of view of *thought thinking of itself*, thinking how its *representamen* refers to its *object* (this falls more or less within the discipline of *Critic* or *Critical Logic* in Figure 1). In this introspective[8] point of view, the *interpretant* mediates the relation between the representamen and its object (cf. Peirce's "On a new list of categories", EP 1.1–10, 1867). In this philosophical and introspective *perspective*, the subject matter of study, thought, is necessarily a conscious human thought-sign although it is intended to be considered in a very abstract manner. If biosemiotic concepts are based on that perspective, anthropomorphic error is more than likely. Therefore, I suggest that the semiotic concepts of biosemiotics should be based on the *phenomenology of the other one*[9] rather than on introspection (the self-reflective analysis of internal experience). What the phenomenon means, signifies, etc. *for us* should not be the object of study but rather the way it is meaningful, significant, accessible etc. for the "other one". This "other one" in focus can be called the *object-agent*. *We* as

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[7] It can be noted that in biosemiotics, the division between subclasses of "physical" and "psychical" sciences becomes exceeded — biosemiotics is about biological phenomena, but on the other hand, it studies "mind" or "thought" (i.e. "psychics") in nature by applying semiotic concepts in biology.

[8] I use the term "introspection" here to mean a kind of self-observation as a method of study. Introspection understood as a search for intuitively self-evident truths was heavily criticized by Peirce (e.g. in Articles 2 and 3 (1868) in EP 1).

[9] The phrase "phenomenology of the other one" is borrowed from Donald T. Campbell (1969), the founder of (modern) evolutionary epistemology. Campbell more often used the term "epistemology of the other one" — phenomenology is preferred here because the word 'epistemology' refers more narrowly to some knowledge-like cognition.

readers, writers, observers, researchers, etc. can respectively be called *meta-agents* (Figure 2). If the concept of agent is found useful in biosemiotics, agents should be considered as object-agents, not as meta-agents. Meta-agents are considered in methodology (as in this paper) or epistemology. The distinction between meta-agent and object-agent is only methodological and comparable to distinction between meta- and object-language in classical logic.

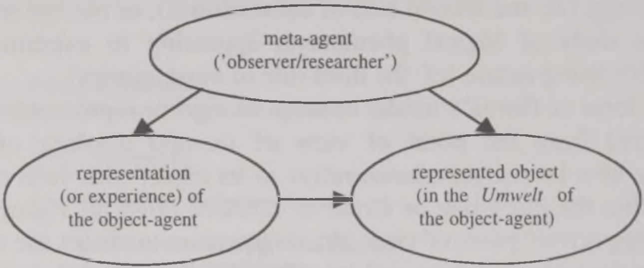

Figure 2. The phenomenology of the other one, 'a thought (meta-agent) thinking of the other one's thought (i.e. thinking of the representation of the object-agent)'.

In the "phenomenology of the other one", both the object-agent and the objects of the phenomenon that the object-agent experiences must be possible objects of *our* external experience. This is not yet necessarily naturalistic, because the concept of agent may be (moreover, is usually) taken as an intuitive mentalistic concept. If we are to make a *naturalistic* "phenomenology of the other one", the conception of what makes the object-agent a *real* agent, cannot be conceptually dependent on our internal self-experience or our subjective feelings "of what it means to be a growing, feeding organism, a moving feeling animal, a sensitive human being" (Emmeche 2000: 189). The naturalization (or alternatively, the *elimination*) of the concept of the semiotic agent is essential for biosemiotics.[10] Intuitive feelings that this or that

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[10] There have been a number of different more or less naturalistic accounts of defining the concept of living agent by Mark Bickhard, John Collier and Clifford Hooker, Claus Emmeche, Jesper Hoffmeyer, and Stanley Salthe, to mention only a few (I happen to know best). These definitions and characterizations contain such defining concepts as anticipation, autonomy, autopoiesis, process or topological closure,

is apparently an agent are not enough — what is needed is formal (i.e. non-substantial) and naturalized criteria for agentiality. In order to avoid anthropomorphic error, the vague pre-model of agent could be *organism* rather than conscious human subject (even though it may later appear that not all organisms are agents).

In his logic Peirce also included the point of view of "the phenomenology of the other one" (although he does not use the term), "a thought (meta-agent) thinking of other thought" (and not itself), which meant thinking of the whole *development* or *course* of this "object-thought". (This is the point of view in Peirce's *Methodeutic*, see Figure 1.) A whole *chain of signs*, a whole semiosic process, was put under the observer's eyes, i.e. was considered as an object of a representation of a meta-agent. Therefore, it is convenient to call this *objective logic* (as Peirce occasionally did), a study of *life of signs*. At the point of view of "methodeutic" or objective logic, it is the *representamen* that mediates between the object and the interpretant (at the "object-level"). Although the objective logic means the adoption of the point of view of an external observer or experimenter, Peirce's methodeutic (and philosophy as a whole) is not naturalistic in the sense of semiotic naturalism. He was still talking mostly about phenomena for *us*, i.e. for *me* and for *others like me*. One reason why naturalization obviously was not the central purpose of Peirce is that his central (and not at all "hidden") prototype for semiosis was clearly a *research process of an honestly truth-seeking experimental scientist* (cf. Peirce's papers about his *pragmaticism*, e.g. Articles 24–28 in EP 2).

Still, the point of view of objective logic (i.e. of a meta-agent) made it possible to continue the generalization and abstraction processes of the concepts of sign and semiosis to be applicable to wider and wider domains. One common line of interpretation is that Peirce

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cohesion, (self)-functionality, inside-outside -asymmetry, self-organization, self-maintenance of far-from-equilibrium system, etc.

Although the distinction between meta-agent and object-agent is methodological, it must be noted that the concept of the (object)-agent is not necessarily appropriate at all. It may appear that it is not naturalizable or that agential semiosis is only a narrow special type of all semiosic processes which is not the sufficient object of study for the general biosemiotics. However, if agential theorizing brings some positive results, it may be easier to draw some implications (whatever they are) to classic existential-philosophical questions like "what is man", "what is the meaning of life", "how should I behave" etc.

eliminated the need for the concept of semiotic agent (that is erroneously associated with Peirce's notion of "interpreter") and that his concepts of sign, mind, and thought are therefore essentially non-agential concepts. I doubt if he ever tried to do it, or if he tried, he did not succeed in it (see the next section). Whether successful or not, the quest for abstract or naturalistic objective logic leads to a shift from logic to metaphysics, or even further to special sciences, because some kind of pre-conception about the *real nature of mind* or *thought* which is observed must be assumed. This question, which contains the question about the agentiality of mind (cf. footnote 10), is essentially either metaphysical or "idioscopical" (see Figure 1). Consequently, objective logic can be seen as an intermediate between the *logical* science of methodeutic and the *real* sciences of metaphysics and idioscopy (i.e. special sciences).[11] As I see it, the central research area of biosemiotics could be described as being objective logic understood as a theory of *mind operative in nature* (regardless of whether the "mind" is considered agential or not). Some support can be found in Peirce's writings. In his most abstract characterization, Peirce concluded that mind (as an object of external experience!) should be found (loosely speaking) in any end-directed system:[12]

> Mind has its universal mode of action, namely, by final causation. The microscopist looks to see whether the motions of a little creature show any purpose. If so, there is mind there. [...] But the being governed by a purpose or other final cause is the very essence of the psychical phenomenon, in general. (CP 1.269, 1902)

Without the naturalization of semiotic concepts, it may be possible to effectively study the horizontal biosemiosis of object-agents (like

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[11] The table of contents of Peirce's famous "Carnegie application" (Peirce 1902) also supports this hypothesis (see http://members.door.net/arisbe/menu/library/bycsp/L75/Ver1/toc.htm).

[12] However, note following rejection: "[...] if the thermometer is dynamically connected with the heating and cooling apparatus, so as to check either effect, we do not, in ordinary parlance, speak of there being any *semeiosy*, or action of a sign, but, on the contrary, say that there is an 'automatic regulation', an idea opposed, in our minds, to that of semeiosy" (CP 5.473, 1907). This mentalistic *common sense*(!) intuition about "semeiosy" (i.e. thought) can be taken into account by insisting that a system has to be end-directed *for the system itself*, i.e. at the "'object-level". This means that the system must have at least some control over its ends — it must be capable of modifying its own ends (cf. the final chapter).

primates) that appear similar enough to us. But *with* naturalization, it is possible to study also the possible agents *not so similar to us*, like ants (or colonies of ants), amoebae, bacteria. Moreover, it will be possible to study whether and in what conditions such "may-be-agents" as populations, lineages, ecosystems, and perhaps even self-controlling man-made machines and devices like thermostats[13], are real agents. A naturalized conception of mind or thought must be closely interlinked with the naturalized concept of the semiotic agent (although the naturalized concept of mind may appear to be definable independently of the concept of the semiotic agent).

It is a big step from the study of "mind in me" to the study of "mind out there". The application of the concepts of the former in the latter is the potential source of an anthropomorphic error — Peirce himself was aware that it is a risky move (CP 2.111–115, 1902). In biosemiotics (and in related research areas) there have been a number of fairly successful attempts at the complete naturalization of central semiotic concepts. Mind, thought, or agency is considered in terms of anticipation, closure and self-organization. Purposefulness, intentionality, or finality, in turn, is considered in terms of function or self-functionality, and further on of self-maintenance of far-from-equilibrium systems. (Cf. Bickhard 1998a, 2000, and Emmeche 2000.)[14]

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[13] Many self-controlling man-made machines can be said to use kinds of representations in their functioning, although no thermostat (etc.) can be said to be an autonomous agent in itself.

[14] This kind of naturalizing interpretation may also give a promising perspective to Peirce's *objective idealism* if someone (like Collier 1999: 123) has trouble with it. Objective idealism can be characterized by the doctrine of objective logic: "that ideas really influence the physical world, and in doing so carry their logic with them" (Peirce 1902, Memoir §33). Objective idealism falls to materialism if only the "'mind" or "thought" in nature are studied and described within naturalized concepts, i.e. with concepts that refer only to the objects of external experience (of us as meta-agents). Peirce's rejection of materialism is compatible with this interpretation, because his rejection was only a rejection of *mechanical* materialism (cf. EP 1.292, 1891), not of materialism that confronts chaotic and self-organizing phenomena, like self-maintaining far-from-equilibrium systems, etc.

The hidden anthropomorphic error in semiotics

Although I expect the concepts of agent and mind are naturalizable along Peircean lines, I see more trouble with the concept of sign itself. I have a suspicion that there is a hidden anthropomorphism in the Peircean concept of the *object of representation.* This anthropomorphism does not necessarily make any error in anthroposemiotics or even in the zoösemiotics of relatively "intelligent" animals, like primates etc. Problems emerge when the concept of the object of representation is applied to biosemiotic agents not so similar to us.

In anthroposemiosis Peirce's description of the more detailed structure of sign in objective logic makes sense. The structure of sign considered in objective logic or methodeutic includes further division of both objects and interpretants (Figure 3). The *immediate object* (iconicity, indexicality or symbolicity in case) is the *ground of representation*, the way in which a sign refers to its *real* or *dynamic object* in the mind of a scientist.[15] The dynamic object, which must have been a real effective cause of the sign, is not present (like the immediate object) but *re*presented in the sign. The *immediate interpretant* includes (at least) the immediate feeling of recognition of representamen being a sign.[16] The *dynamic interpretant* is the next real sign in the chain, the actual result of "interpretation" that is further interpreted as the semiosis proceeds. The *final interpretant* is the conclusive interpretation about what was the real object of the sign (and if it is achieved, it will be adopted as a new "embodied belief" or "habit of mind").

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[15] Compare following quotes: "The sign stands for something, its object. It stands for that object, not in all respects, but in reference to a sort of idea, which I have sometimes called the ground of the representamen." (CP 2.228, 1897) and "The Mediate Object is the Object outside of the Sign; I call it the *Dynamoid* Object. The Sign must indicate it by a hint; and this hint, or its substance, is the *Immediate* Object." (EP 2.480, 1908).

[16] Cf. the quote: "The first proper significate effect of a sign is a feeling produced by it. [...] This 'emotional interpretant', as I call it, may amount to much more than that feeling of recognition; and in some cases, it is the only proper significate effect that the sign produces" (CP 5.475, 1907). Emotional interpretant can be held a psychological counterpart of the immediate interpretant.

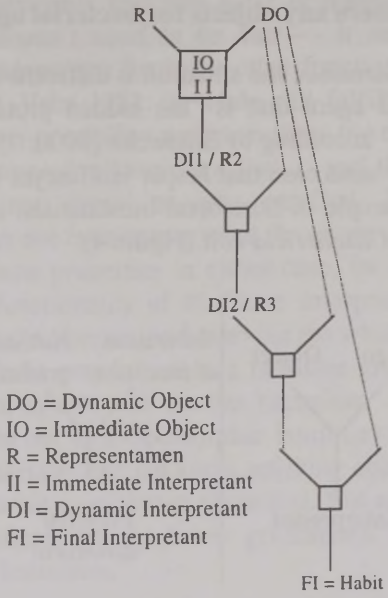

Figure 3. Thought (the chain of signs) as an object in Peircean objective logic.

It is essential that the sign be treated as a *representation* and not as a perceived (or sensed) thing in itself — it must be recognizable as a representation that represents something (its object) that is not present or otherwise directly sensible. Any sign has causal effects that are not its interpretants (i.e. further signs that refer to its object) — the whole point of semiotics is to make a distinction between mediately directed effects (thirdness) and brute reactive effects (secondness).[17] I may get cancer because of watching TV but the cancer (and my death) cannot be said to be the final interpretant of the signs I was interpreting (but just a brute effect of radiation).

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[17] This nevertheless does not imply that brute reactive causality could not be involved in sign-mediated processes.

1. Are there any objects for bacterial agent?

Unlike in anthroposemiosis, the situation is different if we move on to consider a bacterial agent that is “the hidden prototype of a basic biosemiotic system” according to Emmeche (2000: 194). We can take a look at the widely used case that Jesper Hoffmeyer (1997, 1998) has also used as an example of horizontal biosemiosis: a directed movement, chemotaxis of *Eschericia coli* (Figure 4).

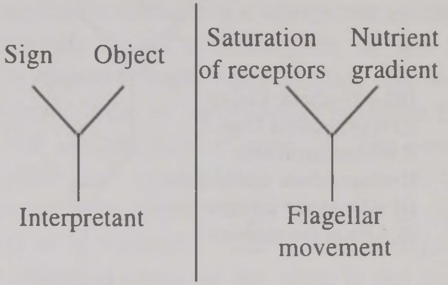

Figure 4. “Bacterial chemotaxis as a case of semiosis. Left: a graphical representation of the triadic Peircean sign-relation. Right: The flagellar movement seen as an interpretant of the degree of saturation of chemoreceptors at the bacterial surface. Due to the regulatory activity of an elaborate system of cellular proteins flagellar movements come to represent the chemical environment in the same way that saturation of chemoreceptors represent this same environment” (Hoffmeyer 1997).

I have no doubt that the behavior of *E. coli* is purpose-oriented (self-functional) and sign-directed, but certain non-desirable conclusions will follow if we think that the nutrition gradient is the object of a chemical sign — a sign interpreted by the bacteria concluding appropriate flagellar movements. The problem is that there is no immediate object, no ground of representation *for the bacterium*. At first glance, it looks as if there were an indexical sign relation because the assumed object and the sign are causally related (they are in a *real* relation). However, in order to be a real or dynamic object of the representation, nutrient molecules should have had a role in the formation of the “interpretive” structure that the chemoreceptors are part of, i.e. in the formation of the “habit of bacterium”. In this case, it happens to be plausible that this habit is really an adaptation "for eating", but *it doesn't need to be that* — it might as well be an *exaptation* (i.e. adaptation for some other function, or not adaptation at all, cf. Gould, Vrba 1982: 6) while still fulfilling the function of eating. If this latter possibility were somehow the case, the connection between the "interpretive" structure (habit) and the object would be accidental and not causal as was required. Moreover, for the bacterium, it does not even matter what the origin of its structure is — it would have same properties in either case. Its functionality in the *future*, i.e. the functionality of its future interpretation is all that is significant for the bacterium (and even for the whole lineage). Thus, it is more plausible to conclude that a nutrition gradient is the object only *for us meta-agents*, not for the bacterium — it is *our choice* (corresponding to our anthropomorphic intuition) to call it the object of sign. The bacterium does not know anything about what satisfies its hunger — it does not *need* to care about that. But whether its hunger is satisfied is significant for the *future* generations, it is the *existential condition* of the bacterium.[18]

2. Are there any objects in vertical biosemiosis?

The situation is even worse if we consider vertical biosemiosis. What is the object of a DNA-sign, how distant a past should be included in it? (Moreover, in contrast to the case of *E. coli*, it is more complicated to determine what the *real* object-agents of DNA-signs are. Are they cells, organs, organisms, populations, lineages, or are there no such object-agents at all?)

If we look back to the early 1990s, to Hoffmeyer's and Emmeche's (1991) formulation of signs mediating vertical biosemiosis (Figure 5), they may paradoxically point at the right direction. Although there are certain terminological confusions — they are not Peircean signs as stated — the content of the idea seems to me better than a few years

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[18] However, I do not want to suggest that past history does not matter for the whole process of semiosis and habituation (cf. the end of the final chapter). The point is that to expect that there always would be a real object for the object-agent is to fall into the adaptationist fallacy, to cook up "just so stories". The logic is the same as in sociobiology in the 1970s and 80s (cf. Gould 1978; Lewontin 1979; Gould, Lewontin 1979).

ago (Vehkavaara 1998). If we transform those "signs" closer to Peircean terms (objects should be renamed as interpretants and interpretants as interpreters or agents), we find that *there are no Peircean objects of representation* in the scheme.

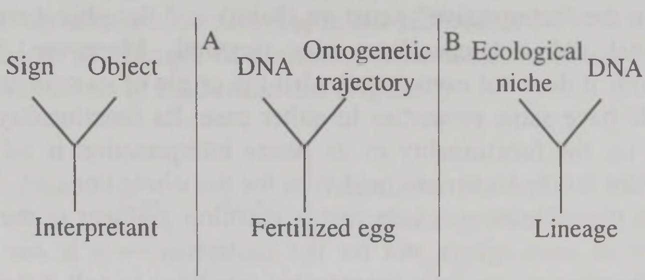

Figure 5. Signs of vertical semiosis in the dual-code theory of biosemiosis (according to Hoffmeyer 1993: 19–22).

If we compare them with Alexei Sharov's (1998) suggestion (Figure 6) which is more faithful in words to Peirce's terminology, we can find some degree of arbitrariness in the choice of the objects of representations.[19] Why are they only ancestors that are determined as objects of a DNA-sign, why not the environments of ancestors as well? I suggest that this arbitrariness is a sign that they, *as here presented*, are not signs in themselves, i.e. for object-agents, but *only for us meta-agents*. The determination of what the *real* object of a sign is should not be a matter of meta-agent's choice (or knowledge), the property of being an object of a sign needs to be a *real property*. It should be determined at the "object-level" (i.e. from the point of view of an object-agent). Otherwise, there is not much that we are justified to say about the origins of life, mind, language, consciousness, etc. (unless we adopt Bishop Berkeley's solution and count on the existence of God as a meta-agent).

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[19] Also, the proposed representamen (differential reproduction) does not differ from the proposed interpretant (change in gene frequency) in the "back-translation from analog to digital" (Figure 6B). They are the same process but only described in different terms (cf. Vehkavaara 1998: 212).

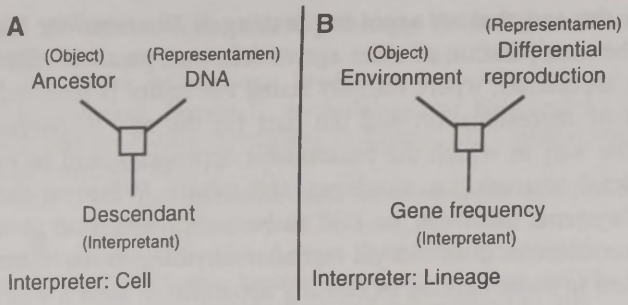

Figure 6. Signs of vertical semiosis (according to Sharov 1998: 407, from Vehkavaara 1998).

The conclusion, however, is not that I would like to put the Peircean concept of representation out of office. The Peircean object of representation is a *real concept,* but only in context with sufficiently complex-structured object-agents — agents that have an *Umwelt* constructed of phenomenal objects. To be the basic concept of representation for biosemiotics, the Peircean concept of sign is still too anthropomorphic.[20] It must be based on a more primitive concept of representation. One promising candidate is Mark Bickhard's model of *interactive representation* (see Bickhard 1993, 1998b). The causal origin of a representation is not important for the object-agent, only its possible consequences (i.e. its potential interpretants, its meaning).

Despite the skeptical conclusion about the significance of historicity for the concept of *representation*, it does not mean that historicity is not essential in the formation of semiotic agents. The most promising feature in biosemiotics (e.g. in the dual code -theory of life) is how "horizontal" and "vertical", "synchronic" and "diachronic", "structural" and "dynamical", or "developmental" and "evolutionary" perspectives are bound together. My suggestion is that representations and purposes or ends should be considered separately. Although the causal origins of representations are not relevant, the origins of the ends or purposes that are embodied in the (physical) structure of the object-agent and according to which those representations are interpreted are crucial for the object-agent. It may be most crucial

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[20] However, it is much less anthropomorphic than the dyadic sign of structural semiotics (semiology etc.).

whether the end that an agent is pursuing is "its own" or "foreign", due to the manipulation of other agents (cf., e.g., parasitic relations).

This separation, where roughly stated the future is reserved for the concept of representation and the past for the end or purpose, also points the way in which the biosemiotic approach could be extended to artificial systems, i.e. machines and robots. Wherever there is a control system, there can be said to be a representation at work. A mere thermometer does not yet represent anything in itself, but if it is connected to some heating or cooling apparatus in such a way that we get a thermostat, it starts to represent the temperature for the system. But it makes no sense to call a thermostat an agent, the goal or purpose of a thermostat is set from outside the system — the purpose of a thermostat is not its own but that of its constructor. This applies both to mechanical thermostats and to the internal thermo-regulation systems of mammals. As hinted in footnote 12, a genuine semiotic agent should be able to control its purposes, it must be some kind of open self-organizing system so that it has at least some self-organized purposes "of its own". Only after we build a robot that starts to find new ways of re-building itself in order to "stay alive", have we created real artificial life. But should we ever build it if we could — what other *human* purposes but curiosity could such a creature ever fulfil, a creature whose purposes were no more in human control?

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Зачем и как натурализировать семиотические концепты для биосемиотики

При любой попытке развивать биосемиотику — в качестве новой биологической *теории*-основы, или в сторону *метафизики* живой природы — нужно каким-либо образом натурализировать семиотические концепты. Вместо стандартного физикалистского натурализма здесь исходят из определенного *семиотического натурализма*. Натурализированное понятие дефинируется как понятие, которое означает только *объекты нашего внешнего опыта*. Когда семиотические концепты используются в биосемиотике при изучении явлений природы, возникает риск допустить антропоморфистские ошибки, если семиотические концепты остаются ментальными. Считается, что ошибка, вызванная антропоморфизацией, или “скрытая ошибка прототипа” действительно существует и исходит из прототипа пирсовского семиозиса, которым является исследовательский процесс ученого-экспериментатора. Ошибка кроется в концепте объекта репрезентации — остается под вопросом, существуют ли объекты репрезентации для бактерий или соответствуют ли знакам ДНК какие-либо объекты. Можно сделать вывод, что пирсовкие семиотические концепты можно натурализовать, но только в том случае, если они исходят из более примитивной концепции репрезентации. Причинное происхождение репрезентаций при этом несущественно, зато важны предполагаемые результаты (напр. значение).

Miks ja kuidas naturaliseerida biosemiootika jaoks semiootilisi kontsepte

Iga katse puhul arendada biosemiootikat — kas kui uue bioloogilise *alusteooria*, või kui elusloođuse *metafüüsika* suunas — on vaja mingil viisil naturaliseerida semiootilisi kontsepte. Standardse füsikalistliku naturalismi asemel lähtutakse siin teatavast *semiootilisest naturalismist*. Naturaliseeritud mõiste on defineeritud kui mõiste, mis tähistab üksnes *objekte meie välises kogemuses*. Rakendades biosemiootikas semiootilisi kontsepte loodusnähtustele, peitub siin risk teha antropomorfistlikke vigu, kui semiootilised kontseptid jäävad mentalistlikeks. Siinkohal arvatakse, et antropomorfiseerimisest tulenev viga ehk ‘prototüübi varjatud eksitus’ on tõesti olemas, ja see tuleneb Peirce’i semioosi prototüübist, milleks on eksperimentaalteadlase uurimisprotsess. Eksitus peitub representatsiooni objekti kontseptsioonis — on küsitav, kas bakteri jaoks on olemas mingeid representatsiooni objekte, või kas DNA-märkidele vastavad mingisugused objektid. Võib järeldada, et Peirce’ilikud semiootika kontseptid on küll naturaliseeritavad, kuid üksnes juhul, kui nad lähtuvad veelgi primitiivsemast representatsiooni kontseptsioonist. Representatsioonide põhjuslik päritolu ei ole siinkohal oluline, küll on seda aga nende poolt ennustatavad tulemid (st. tähendus).

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Understanding life: Trans-semiotic analogies

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Abstract. This paper sketches a network of analogies reaching from linguosemiotics (including theory of reference in analytical philosophy of language) to biosemiotics. It results in the following proportion: attributive use of referring expressions : referential use of referring expressions : 'generative' use of referring expressions = signifying : referring : 'poetic pointing' = 'functional' semiosis : 'adaptational' semiosis : semiosis in the narrow sense.

Can the essence of life — or, at least, our concept of life — be understood in a semiotic framework? An obvious difficulty for such an enterprise seems to be the problematic character of the extension of the semiotic concepts outside of the realm of the human. Any talk of life in semiotic terms is often regarded as merely metaphorical[2]: semiosis or signs in a proper sense presuppose consciousness, that is, human agents.

This paper aims at suggesting that the plainly metaphorical character of the attribution of semiosis to life could be avoided by means of a network of analogies extending from within the human realm to life in general. First, a fragment of a theory of referring will be sketched, providing a distinction between uses of referring expres-

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[2] However, the metaphorical character of some conception need not imply its inferiority. For a discussion of the constitutive role of models, analogies and metaphors in science see Emmeche, Hoffmeyer (1991).

sions. Then, an analogy will be suggested, extending the form of this distinction to a distinction of reference from some similar linguosemiotic relations. And finally, the analogy will be extended to yield a general semiotic distinction between types of semiosis involving both anthropo- and biosemiotics.

Referring

In analytical philosophy of language, referring (also called denoting[3]) is usually construed as a relation[4] between a linguistic expression (the referring expression) and an existing[5] object referred to (called the reference of the referring expression). Of course, referring expressions have to be provided by a certain language.[6] Further, it should be noted that in the relation of the referring expression and its reference, the first member may be construed either as a type or as a token. The referring expression can be regarded to be a type when its reference is determined plainly by its linguistic form. E.g., whenever the referring expression '2+2' is used in the language of arithmetic, its reference is 4. In general, however, the reference of a referring expression depends on the context of its use. Every token (i.e., occurrence) of a referring expression is involved in a certain act of referring along with a certain use of the expression. Think about the variety of (deictic and anaphorical) referring uses of the expression 'this' and the huge amount of the possible references of its tokens.

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[3] These terms sometimes are experienced to have different nuances of meaning, see footnote 8, below.

[4] The nature of this relation is described as "standing for" or "picking out".

[5] The existence of an object is not clearly defined. One can speak of present physical existence (as of the Pope), present mental existence (as of my present thought that semiotics lacks enough system), past or future physical (or mental) existence (as of my grandparents or grandchildren), or abstract existence (as of numbers according to Platonist philosophy of mathematics, or meanings (senses) and concepts according to Frege (1892a, 1982b)). Fictional objects (like unicorns or Shakespeare's Hamlet) usually are regarded as non-existent, but one also may speak of their fictional existence. The author of this paper holds that in an adequate theory of referring, referring expressions refer to objects in some model.

[6] The linguistic resources underlying a referring expression vary. Typically, referring expressions are nominal phrases ('my home'), proper names ('Italy') or pronouns ('this').

A class of referring expressions is constituted by what Russell (1905) introduced as "definite descriptions".[7] A definite description is meant to determine its reference by specifying a condition met by precisely one object, which is the reference. E.g., the expression 'the present President of France' refers to the unique object being at present (September 7, 2001) the President of France — a person called Jacques Chirac. Donnellan (1966) distinguishes between the "attributive use" and the "referential use" of definite descriptions. In the attributive use, the reference is strictly determined by its fitting the description, i.e., meeting the specifying condition. In the referential use, the definite description merely has to identify the reference, independently of its meeting the description or otherwise. Donnellan uses an example which goes as follows. At a party I introduce a person to my friend, saying "That man drinking martini is married to Jane" and pointing to a drinking man sitting in the corner. Now, in all probability, I succeed in referring to the right person even if he, in fact, is drinking water. So, a definite description is used to refer to its reference in a non-attributive way, the referential way. In another example by Donnellan, Mr Smith has been brutally murdered. "Smith's murderer must be insane, "a woman who knew him comments. Whoever murdered Smith is insane because Smith was a very kind man. Here the definite description 'Smith's murderer' is used attributively. Later on, Jones is on trial, charged with Smith's murder. His behaviour in the court is very queer, and people say: "Smith's murderer must be insane." Whoever the real murderer may be, here the expression 'Smith's murderer' refers to Jones; this definite description is used referentially.

Attributive use and referential use are not restricted to definite descriptions. They also can be distinguished in the case of proper names. Kripke (1980: footnote 3 of the main text) gives the following example. Two men are watching a remote man whom they hold to be Jones. "What is Jones doing?" "He is raking leaves." But in fact the distant man is Smith, and the name 'Jones' here refers to Smith. The name 'Jones' here is used referentially.[8]

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[7] Russell himself denied that definite descriptions really were involved in the relations of referring ("denoting").

[8] Kripke opts for reserving the term 'referring' to the 'attributive' use of names (in this example Jones, in this use, refers to Jones, and in general, 'x''s reference is x) and wonders if he should use the term 'denoting' instead.

How general can we make the distinction between the attributive use and the referential use of referring expressions? Are there any limits in terms of the appropriate type of expressions, or again, in terms of what causes the possible apparent inadequacy of the referring expression in the case of the referential use?

The proposal of an answer to be given in this section proceeds from the assumption that the relation of referring relates a referring expression to an object in a model[9] in the user of the expression or in the audience, and not to a "real" object.[10] Then, for the definite descriptions the following distinctive criterion is suggested: in the case of a model switch (transition from one model (source model) to another (target model)[11]), in the attributive use, the reference of the expression in the target model is the object fitting the description[12] in the target model; in the referential use, the reference of the expression in the target model is the same as in the source model.[13] A model switch can occur both as a change in actual beliefs and as a consideration of a possibility held to be counterfactual and a switch from one possibility to another.

Reconsider the example about Smith's murderer. The standard interpretation of the attributive use (in principle shared by Donnellan

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[9] By a model, a stock of potential objects along with a system of potential beliefs about them is meant. The objects and beliefs in a model are potential in the sense that the objects need not be meant to be real and actual, and the "beliefs" need not be believed but they could be believed or "as if" (fictitiously) believed. The ways objects may be constituted in models is precisely the subject matter of the classification of the uses of referring expressions.

[10] An independent argument for this assumption is that such a relation lacks the "mystical" character of a relation between a referring expression and its "real" reference. Besides, this assumption renders the theory of referring less complicated and more natural, and unties it from metaphysical problems.

[11] The typical instances of model switch are change in beliefs (some actual belief(s) become(s) disbelief(s) and/or vice versa) and consideration of possible worlds (construed as modifications of the actual world by counterfactual conditions as in Kripke (1980)) held to be non-actual (transition from the actual world to another possible world; both worlds are represented as models).

[12] Target models without a unique object fitting the description are excluded in the attributive use.

[13] Target models in which this object does not exist are excluded in the referential use.

(1966)[14]) presumes that the expression 'Smith's murderer' refers to Smith's actual murderer in the actual world and to Smith's murderer in any possible world in which someone else (a definite person) murdered Smith. According to my own interpretation, in the case of the attributive use, "Smith's murderer" refers to Smith's murderer in any model in which a definite person murdered Smith. And in the case of the referential use, "Smith's murderer" refers to a certain person who, in some model, murdered Smith. In Donnellan's example, the model switch in the case of the attributive use must be based on the woman's presumption (probably as a belief) that a definite person murdered Smith (otherwise she probably would not have said "Smith's murderer" not mentioning that Smith could not have been murdered or that there could be more than one person participating in the murder). This presumption need not specify who the murderer is, and leaves room for different models based on mutually incoherent versions. Switching between those models shifts the reference of "Smith's murderer" according to the model's version. And in the case of the referential use, the model switch is based on the belief that Smith's murderer is Jones. Should this belief be replaced with an alternative belief, a model switch would occur, not affecting the reference.

The concepts of attributive use and referential use could be generalized, rendering them independent of the linguistic form of the referring expression and reasons of model switches: independently of the linguistic form of the referring expression, it is used attributively if after a model switch its reference is meant to be the object fitting the description in the target model and it is used referentially if after a model switch its reference is meant to be the object fitting the description in the source model. The generality of this formulation is limited by the requirement that the referring expression imply a definite description, or in other words, specify a condition uniquely determining its reference.

Reconsider Kripke's example. When two men speak about Jones raking leaves they have a model in which the man they are watching is Jones. In the case of a model switch to a model in which the man watched is Smith, in the target model "Jones" does not pick out the

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[14] Admittedly, Donnellan (1966) attributes the attributive use of definite descriptions to Russell (1905), thus involving Russell's denying of definite descriptions as referring expressions.

man they are watching because he is not Jones. “Jones” is used referentially because after the model switch it cannot be used to refer to the person meant. Further, “Jones” implies a specifying condition because otherwise there would be no criterion for telling that the man watched is not Jones.[15] Here we have another formulation of a general definition of the attributive use and the referential use of referring expressions: a referring expression implying a definite description is used attributively if it can be used to refer to the reference meant after any model switch with a target model in which there is precisely one object fitting the description, and is used referentially if there is a model switch with a target model in which this expression cannot be used to refer to the reference meant.

The attributive use and the referential use of referring expressions allow further interpretation: they correspond to different ways of identification of objects in models. The attributive use corresponds to a functional way of identification: the object meant is the object having such and such function (under the presumption of the uniqueness of such an object). We also can say that this is a conceptual way of identification because the reference is determined by its concept. Then the model simply declares an object by its definite description. The referential use corresponds to a way of identification such that the identity of the object referred to is independent of descriptions picking it out in one or another model, concepts we have of it, and functions we mean it to fulfil. What counts is the object itself: its identity is borne by itself, and not by our concept of it. So in the case of the attributive use, the reference as an object through models is tied to a concept, whereas in the case of the referential use, the reference as an object is free from any particular concept, though in any given model it can be picked out by some concept.

Can an object in a model be even more independent of and free from the referring expression? I am going to introduce such a use of referring expressions — the “generative” use. In the case of the generative use, an object in a model is introduced or “generated” or declared implying no definite description or specifying conception. Instead, the identity of the object is meant to be maintained without any identifying character or essential property, and it can be identified

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[15] Kripke (1980), in fact, deals with in proper names used referentially, but only regard to model switches due to transition from the actual world to possible worlds, not due to changes in beliefs.

only by a "name"[16]. The generative use of referring expression is quite frequent in mathematics where often objects are introduced in such a way: "let A be a set consisting of a and b". In a model, the elements a and b are created, and they are created as different though there is no other means of distinguishing them than their different names 'a' and 'b'.[17] We also may imagine a world containing several exactly similar physical objects with symmetrical relations to each other. Then the names identifying them are used generatively. Such names need not have the linguistic form of a constant or of a proper name: any expression, in principle, may be used creatively.

So we have built a base for analogies: the attributive use, the referential use and the generative use of referring expressions.

Signifying, referring and beyond

Let me take the next step: constructing an analogy within linguo-semiotics.

I proceed from the distinction between signifying and referring.[18] In signifying, the role played by models in referring, is played by languages. A signifying expression signifies an item in a language. So the signifying/referring distinction reduces to the language/model distinction. I am going to describe this distinction in analogy with the distinction between the attributive use and the referential use of referring expressions.

Leaving aside the communicative aspect, a language belongs to a signifying subject just as a model belongs to a referring subject. A model contains objects meant to be independent of and free from the

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[16] Unlike the names in Kripke (1980), these names do not imply distinctive marks in the actual world (neither in some possible world), as a person's precise date and place of birth.

[17] What if we introduce a relation R such that aRb holds, whereas bRa does not hold? The relation R also is introduced generatively. What beyond its name distinguishes it from the relation Q such that bQa holds, whereas aQb does not hold (for unambiguity, let aRa, bRb, aQa and bQb hold)?

[18] This distinction is not received. Sometimes what I call referring is referred to as signifying. My points of departure in fixing this distinction are Saussure's (1916) use when he introduces the terms 'signifier' (*significant*) and 'signified' (*signifié*), the concept of referring in analytical philosophy of language, and my proposal to take the references to belong to models (above, previous section).

linguistic form of referring to them. However, they need some referring expression in order to be identified. A language contains items meant to be tied to the linguistic forms signifying them as the sides of a sheet of paper or a coin are tied together (the relation between the signifier and the signified as described in Saussure (1916)).

How is the analogy structured? In distinguishing between the attributive use and the referential use of referring expressions, we referred to the degree of the tiedness of the objects referred to to the referring expressions. In distinguishing between the signifying relation and the referring relation, we compare the degree of the tiedness of the objects referred to their referring expressions and the degree of the items signified to their signifying expressions. So far, we have two degrees of tiedness. The first degree of tiedness is "like a sheet of paper". It applies to the way signifiers are related to their signifieds with regard to their unconcern in extralinguistic reality, and to the way referring expressions used attributively are related to their references with regard to their unconcern in the identity of the references. The second degree of tiedness could be called "one-end looseness"[19]. It applies to the way referring expressions are related to their references with regard to their concern in extralinguistic reality accessible via models[20], and to the way referring expressions used referentially are related to their references with regard to their concern in the identity of their references accessible via definite descriptions.

So signifying and referring stand in the same "proportion"[21] as the attributive use and the referential use of referring expressions. To complete the analogy, it remains to find a linguosemiotic relation similar to signifying and referring and analogous to the generative use of referring expressions. The third degree of tiedness, characteristic of the generative use of referring expressions, could be called "floating looseness"[22].

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[19] In the referential use, the identity of an object is tied only to its definite description in one model.

[20] Concerning referring, extralinguistic reality is linguistically describable, that is, representable by models. Models are limited in that they are meant to consist of really or fictionally existing objects.

[21] If the relation between *A* and *B* is analogous to the relation between *C* and *D* then we could say that *A* and *B* stand in the same proportion as *C* and *D*, or, $A:B=C:D$.

[22] In the case of the generative use of referring expressions, the identity of an object referred to is not earthed by any definite description in any model.

The reference is generated along with the referring expression referring to it, that is, its name. Analogously, in the case of the third degree of tiedness between linguistic expressions and their content, using language is a creative activity with regard to reality. The linguistic expressions 'poetically point' to the reality being created, a reality not captured in models. The successive loosening of the tie could be illustrated by telling that, typically, signifying centres around words, referring centres around sentences, and poetic pointing centres around texts. Further specification of the relation of poetic pointing transcends the limits of this article. However, following the leading idea of this article, new concepts can be introduced by means of analogy, placing them into blanks in proportions. So, poetic pointing could be introduced as the missing member x in the proportion:

attributive use : referential use : generative use = signifying : referring : x.

Life

Now we are approaching the central concern of this article: how can life be understood in a semiotic framework? Let me start from the conclusion: two types of biosemiosis are related to anthroposemiosis as the first, the second and the third members of our proportion.

How is floating looseness characteristic of the human realm? All anthroposemiotic means, including languages and models, belong to humans in a peculiar way. They depend on being maintained by humans, having no independent existence. They are untied from the humans' physical existence. I call the types of semiosis corresponding to one-sided looseness and to "like a sheet of paper", adaptational semiosis and functional semiosis. The life of the subject of adaptational semiosis (the adaptational subject) is constituted by its efforts to survive. It adapts itself to its environment by changing its properties. Its properties constitute a "natural model" (in contrast of the model proper, not reducible to properties, as described above in the context of referring). The life of the subject of functional semiosis is constituted by functional circles (Uexküll 1973, 1980, 1982, 1992).[23]

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[23] For my interpretation of the functional circle see Luure (2001).

It has no properties it can change, and so all meanings belong to its life as its reverse side.

The functions fulfilled by semiotic, non-bodily "expressions" belong to properties in the case of the adaptational subject and to parts (a reverse side is a part) in the case of the functional subject. Functioning and adaptation are aspects of life, also belonging to humans. Therefore, in a broader sense, these biosemiotic functions also belong to anthroposemiotics, the proportion "functioning : adaptation : expression" being part of the anthroposemiotic network of analogies.

Concluding comments

After suggesting this network of analogies I would like to sketch its further connections.

The nodes of the proportions here have the metaphorical names "like a sheet of paper", "one-ended looseness" and "floating looseness". Perhaps no straightforward unambigous formulation can be given to them, and perhaps their logical foundations coincides with that of Peirce's (1998) categories of Firstness, Secondness and Thirdness. They stand in proportion with Type One, Type Two and Type Three in Luure (2001) where the number of nodes is extended to six.

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К понимаю жизни: транссемиотические аналогии

В статье начертана сеть аналогий, простирающаяся от лингвосемиотики (включая теорию референции в аналитической философии языка) до биосемиотики. Получается следующая пропорция: атрибутивное употребление референтных выражений: референциальное употребление референтных выражений : "генеративное" употребление референтных выражений = означение (сигнификация) : референция :"поэтическое указывание" = "функциональный семиозис": "адаптационный семиозис": семиозис в узком смысле.

Elu mõistmise poole: transsemiootilised analoogiad

Artikkel visandab analoogiate võrgustiku, mis ulatub lingvosemiootikast (sealhulgas osutusteooriast analüütilises keelefilosoofias) biosemiootikasse. Tulemuseks on järgmine proportsioon: osutavate väljendite atributiivne kasutus : osutavate väljendite referentsiaalne kasutus : osutavate väljendite "generatiivne" kasutus = tähistamine (signifitseerimine) : osutamine : "poeetiline viitamine" = "funktsionaalne semioos" : "adaptatsiooniline semioos" : semioos kitsas mõttes.

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A sign is not alive — a text is

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Abstract. The article deals with the relationships between the concepts of life process and sign process, arguing against the simplified equation of these concepts. Assuming that organism (and its particular case — cell) is the carrier of what is called 'life', we attempt to find a correspondent notion in semiotics that can be equalled to the feature of being alive. A candidate for this is the textual process as a multiple sign action. Considering that biological texts are generally non-linguistic, the concept of *biotext* should be used instead of 'text' in biology.

> *If we put together many branches and great quantity of leaves, we still cannot understand the forest. But if we know how to walk through the forest of culture with our eyes open, confidently following the numerous paths which criss-cross it, not only shall we be able to understand better the vastness and complexity of the forest, but we shall also be able to discover the nature of the leaves and branches of every single tree.*
>
> U. Eco (1990: xiii)

In this note I would like to pay attention to the importance of non-oversimplification in applications of semiotic concepts in biology. This infers from the threshold of the type of diversity (the categorised diversity) that the contemporary biology describes as characteristic to all living systems.

There is not only Floyd Merrell, who has written about "the *Life ≈ Signs* equation" (Merrell 1996: 315n1).[1] Particularly in that part of semiotics which is strongly influenced by Peircean ideas, the expressions like 'living signs' have become quite frequent in recent years. Another factor behind these claims is the influence of biosemiotic studies, including its basic assumption that semiosis and life are coextensive.[2] That the issue is not of secondary importance for semiotics, is evident from Thomas A. Sebeok's statements:

> I postulate that two cardinal and reciprocal axioms of semiotics — subject, as always, to falsication — are: (1a) The criterial mark of all life is semiosis; and (1b) Semiosis presupposes life. [...] Further semiosic unfoldings — such as the genesis of ordered oppositions like self/other, inside/outside, and so forth — derive from, or are corollaries of, the above pair of universal laws. (Sebeok 2001: 10–11)

The idea about the identity of life and semiosis, no doubt, has been a productive core hypothesis, considerably assisting in the attempts to find a correspondence between biology and semiotics. In a more detailed analysis, a question arises, whether biology itself can learn anything from these ideas; e.g., whether it may be possible to give a more profound description to the concept of life using its semiotic features.

The claims above can be easily interpreted as if a sign, being an element of life, is itself alive. Still, one has to keep in mind that the problem of elements in sign science is very different from the problem of elements in chemistry.

A discussion about the relationship between the concepts of 'life' and 'sign' is complicated due to the fuzziness of the 'life' concept altogether. A collection of life definitions provided by Barbieri (2001: 235–242) perfectly demonstrates the diversity of these definitions. However, the problem is inescapable for biology, and I suggest that a semiotic approach will be very helpful in achieving a more clear understanding (if not a solution) of it.[3]

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[1] See also Merrell 1992, 1994, 1998, 1999.

[2] See Deely 1992 on a discussion of this statement.

[3] The problem of defining life as a semiotic phenomenon has been extensively analysed by Emmeche (1998, 2000).

Biotext

Sign, however an absolutely necessary element of any semiotic system, still cannot be taken as a fundamental semiotic unit, because sign cannot exist as a single sign — sign is always a part of a bigger system, sign is always accompanied by another sign(s). This is not because signs always just happen to be placed not far from each other and in multitude, but because it belongs to the very nature of sign to be 'a part of', to be a *meron*.[4] At least in some traditions in semiotics, this bigger system can be called 'text'.

Comparing the above statement (that sign cannot exist as a single sign), by analogy, to a biological key idea that the minimal living unit is cell, one may conclude that the same should be applicable here — 'cell cannot exist as a single cell'. However, this comparison is not exact, and not true. Because, the cell, on the one hand, being "the simplest entity to possess real semiotic competence" (Hoffmeyer 1997: 940), on the other hand always includes a whole multitude of signs.

This contradiction can be solved if to speak on 'semiosis' instead of 'sign' (as actually is the case in most biosemiotic writings): cell is a minimal *semiosic* unit.[5]

Semiosis is — according to its common definition — the action of signs, the sign process. "According to Peirce, semiose is a continuous process that is based on the interpretation of one sign through another. Jakobson described this process as translation" (Krampen *et al.* 1987: 244). Since semiosis is not an action of just one sign, since semiosis involves always a multitude of signs, it is a textual process like translation is. In this way, it has to be concluded that semiosis is not an action of *a sign*, but an action of *signs*, and accordingly a more complex structure than that of a single sign has to be present in a simplest semiosic system. If to call this *text*, one should consider that

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[4] On the biological interpretation of this statement, see Kull 2000, Emmeche 2002.

[5] This, again, raises the problem of intracellular semiosis in prokaryotes. If a closure is required for the minimal semiosic unit, then we still can speak about its parts, merons (and, accordingly, signs), but without a possibility to add a lower level of semiosis. Prokaryotic cell is a minimal organism. In such an interpretation, we can even find a fit to Lotman's view that sign communication assumes the impenetrable elements for which the physical contact becomes insufficient (Lotman 1984: 216).

it may be a non-linguistic text, and therefore it is more proper to call it a *biotext*.

If so, then the following conclusion becomes necessary — the basic semiosic unit is biotext. Each text is a composition of signs, however, signs are nothing more than functional parts of text that cannot exist without or outside a text.

This can be seen as a reference to a contradiction between the Peircean (or American) and Saussurean (or French, or European) traditions in the development of semiotics throughout the last century. This is a contradiction between 'sign semiotics' and 'text semiotics' (M. Lotman, 2002).

Whether 'text' is a proper term in this status, is of course discussable, because a common interpretation of this term assigns to text the stability, linearity, and fixity. However, e.g., J. Lotman's usage of the term is much more general when he writes, for instance, about "iconic (spatial, non-discrete) texts" (Lotman 1990: 77).

Sign becomes a meaningful entity only due to its relationship to a sign process, semiosis. Accordingly and analogously, text can be seen as a semiotic entity only if a textual process is considered — a text interpretation, a translation in any of its forms.

Thus, in analogy with the term 'semiosis' for sign process, we seem to require a term for text process. On the one hand, this may be a false conclusion, because semiosis always assumes the participation of number of signs, semiosis already is a textual (*s. l.*) process. If single signs can be distinguished, then, in contrary, semiosis never concerns only a single sign. Therefore, it seems that there is no need for an additional term. On the other hand, it is possible to distinguish between semiosis that occurs in particular parts of a text, and the semiosis of the whole text. This is the process in which the whole text, including its multiple codes and levels, *in toto*, interprets itself. The whole text process, or total interpretation (or perhaps total translation, according to Torop 1995), is what also occurs, for instance, when a new organism is born. 'Giving birth' means that a complete set of conditions and patterns is created ('transferred') that guarantees the independent life for a new organism. This is the same as in case of total translation, when the life of a text can be transferred into the life of a new text. Quite often, the term semiosis has been used in so general meaning that the total text interpretation has also been termed with it. However, it seems to be reasonable — in order to leave less place for misunderstandings — to distinguish between semiosis as an 'organ' process,[6] and 'something else' as an 'organism' process. This 'something else' being equal to — life.

A comparison between the concepts of biological function and sign action (Emmeche 2002) demonstrates that the functional differentiation within a self-referential system is equivalent to the appearance of signs. This is because the functional differentiation means the existence of other-reference. Moreover, "it is the stable integration of self-reference and other-reference which establishes the minimum requirement for an umwelt and thereby sets living systems apart form all their non-living predecessors" (Hoffmeyer 1999: 156). Without functional differentiation there is no signs (like Lotman expresses it — in case of identical partners, there is nothing to communicate about). Therefore it is reasonable to say that an organism is always a biotext.

Speaking in this way on semiosis of biotexts, it leads to at least an interesting research program to apply the concepts and tools of holistic biology in text analysis. Several notions, like, e.g., archetype, homology, analogy, etc., are already in use in both areas.

Organism as a self-interpreting biotext

In case of single (simple) tokens, their recognition is based primarily on the existing categories an interpreting system possesses for signs. Therefore, a token is recognised as a representative of a category, and accordingly, its individuality becomes lost in transmission. Categorisation is a phenomenon that is always accompanying sign processes; it is a precondition of the existence of codes.[7]

In case of compound tokens, their recognition is also a compound process. The particular combination of the element signs in the compound token may be unique, therefore the recognition process can also leave a unique trace.

Since compound token is not the same as a set of signs, one has to ask what turns it into one sign. Another aspect of the nature of the compound signs is that there is more than simply a recognition that occurs in the compound sign interpretation.

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[6] It becomes interesting to note here that if there is a correspondence between 'sign' and 'biological function', then 'organs' can be seen as 'categories'.

[7] On the role of categorization, see also Stjernfelt 1992.

A remarkable idea of Jakob von Uexküll concerns the distinction between the two kinds of signs — *Merkzeichen* and *Wirkzeichen*.[8] The former ones are related to perceptual categories, whereas for the latter ones the operational (effectual), or motor categorisation takes place. A code between perceptual and operational categories makes it possible for a compound sign to become one whole sign. This occurs if several perceptual categories converge in one operational category. A similar idea has been proposed by Gerald Edelman by his concept of senso-motor categorisation. Mechanism like this means that a principal difference is achieved from just an automatic response to certain factor in environment — this is an ability to recognise individuality. It is a process of interpretation, which, as we saw, requires more than a single sign process — it deals with text (Kull 1998).

Operational categories are the categories of behavioural acts, of body movements, etc. In case of humans, the operational categories can be those of spoken words.

Due to the complex inner structure of organism, consisting in a large number of cells and many tissues, all being in a communicative relationship, there can be the perception–operation cycles that are entirely embedded in the body. This means, inside the body a sequence of perception–operation–perception–operation may include several sequential systems of communication. Accordingly, several levels of categories and categorisation can be developed between the perceptual and the effectual ones. Which means the development of internal texts, the models.

Biosemiotics means biology

It is appropriate to remind here few formulations by T. A. Sebeok.

> The aim of biosemiotics is to extend the notions of general semiotics to encompass the study of semiosis and modeling in all species. The premise which guides biosemiotics is, in fact, that the forms produced by a specific species are constrained by the *modeling system(s)* which has evolved from its anatomical constitution. The aim of biosemiotics is to study not only the species belonging to one of the five kingdoms, *Monera, Protoctista, Animalia,*

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[8] Uexküll 1928. It should be mentioned that Uexküll's terms like 'Empfindungsgruppe', 'Gegenstandkerne', etc. (e.g., Uexküll 1907) can be put into correspondence to 'categories' in our sense.

> *Plantae*, and *Fungi*, but also to their hierarchically developed component parts, beginning with the cell, the minimal semiosic unit. [...] In a phrase, the target of biosemiotics is the semiosic behavior of all living things. (Sebeok, Danesi 2000: 15)

The basic claim of Sebeok, that the semiosic phenomena begin with the first cell, is certainly consistent with the view of many biologists that cell is the elementary unit of being alive — a fundamental statement in biology since mid 19th century. This also means that the simplest mechanism of sign can be found in a system which has at least the complexity of living cell.[9]

The next statement above says that the sign relationship, which is constituted by a modeling system, evolves from the anatomical constitution of cellular life. I would state it more broadly, using the term morphology instead of anatomy — the morphological units of living systems are semiosic.

In order to understand the nature of organic forms, we need to consider that these forms are very weird if we would like to get them from the mixing of non-living particles. A key to decipher the diversity of organic forms, both the inter-organismal and intra-organismal, is (according to a biosemiotic approach) to look at these as communicative forms, as the forms which are a result of categorisation, of various types. Then, for instance, biological species appear as categories in inter-organismal semiosis, and tissues as categories of intercellular communication within a multicellular organism. These principal objects of biological research being semiosic in their nature, we have to conclude that whole biology unavoidably becomes influenced by the understanding of semiosis.

When looking at biology as a whole, we can recognise a meta-semiosic process in it, as represented in Fig. 1 via two capacious triads. It shows morphology and biological systematics as dealing with main intra-organismic and inter-organismic communicative structures, or categories, respectively. Physiology and ecology represent the synchronic, developmental biology and evolutionary biology the diachronic dimensions. However, of course, these can be interpreted also as the three dimensions of sign in the Peircean sense. Or, as a great chain of semiosis with alternating endosemiotic and exosemiotic steps.

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[9] For an analysis of this statement see Emmeche 2000.

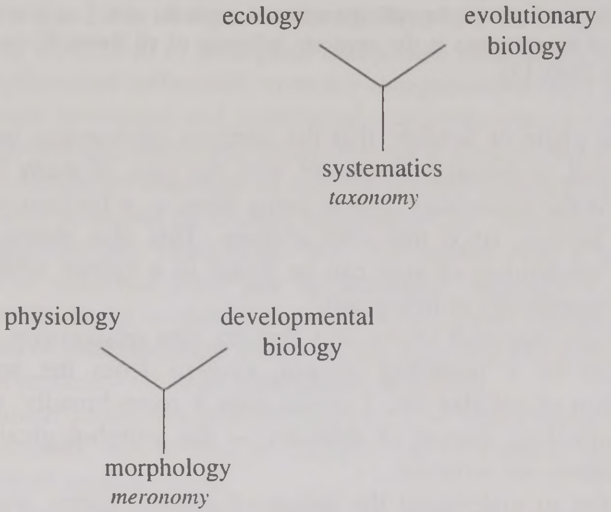

Figure 1. A metasemiosic structure of biology, with endosemiotic (left) and exosemiotic (right) domains.

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Знак не живой. Текст — живой

В статье анализируется соотношение жизненного и знакового процессов, при этом подвергается критике их простое приравнивание. Исходя из положения, что организм (и его простейшая разновидность — клетка) является носителем качества, называемого “жизнь”, в статье предпринимается попытка найти семиотическое соответствие свойству быть живым. Кандидатом на роль такого соответствия может быть текстуальный процесс как знак. Учитывая нелингвистичность биологических текстов, в биологии можно было бы заменить понятие “текст” на “биотекст”.

Märk ei ole elus. Tekst küll

Artiklis analüüsitakse eluprotsessi ja märgiprotsessi mõistete vahekorda, kritiseerides nende lihtsat võrdsustamist. Eeldades, et organism (ja selle lihtsaim erijuht — rakk) on ‘eluks’ nimetatava kvaliteedi kandja, püütakse leida semiootilist vastet, mis oleks võrdsustatav elusolemise omadusega. Sellise vaste kandidaadiks võib olla tekstuaalne protsess kui mitmene märk. Silmas pidades bioloogiliste tekstide mittelingvistilisust, tuleks bioloogias kasutada bioteksti mõistet teksti asemel.

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Tractatus Hoffmeyerensis: Biosemiotics as expressed in 22 basic hypotheses

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Abstract. This paper briefly outlines the main ideas of biosemiotics in 22 hypotheses, with special regards to the version of it claimed by Jesper Hoffmeyer.

In honour of T. Sebeok (1920–2001)

In this paper,[1] I shall attempt to summarize the basic ideas of the nascent science of biosemiotics in 22 brief statements. Generally, it is based on ideas circulating in the biosemiotic community,[2] but with special reference to the version developed by the biochemist and semiotician Jesper Hoffmeyer, the founder of the Copenhagen school of biosemiotics. Still, the position presented here does not hesitate to draw conclusions and involve corollaries not explicitly stated by Hoffmeyer, in which he might not agree. In so far, the hypotheses are the author's responsibility — they should be seen as a vademecum of a Hoffmeyerian biosemiotics, according to me.

1) Signs and life are coextensive.[3]

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[1] The article is a tribute to Jesper Hoffmeyer's 60th birthday February 21st 2002.

[2] On the history of biosemiotics, see Kull 1999.

[3] This idea is of course *the* core idea of biosemiotics and has been forcefully claimed by Thomas Sebeok, cf. e.g. "... *semiosis* is at the heart of life ..." (Sebeok

2) As biology is a historical science (maybe even *the* historical science par excellence), (1) calls for a natural history of meaning[4].

3) As biology is a structural science (maybe even *the* structural science par excellence), (1) calls for an inventory of biology's structural concepts.[5]

4) If we accept punctuated equilibrium as a basic structure in biological evolution,[6] we should expect the semiotic evolution to follow the same structure, hence displaying a ladder of increasingly complex sign types.

5) The basic forms of biological signs are those exchanged between the organism and its environment, its *Umwelt*, in an Uexküll functional circle, *Wirkzeichen* and *Merkzeichen* respectively.[7]

6) The umwelt, in sufficiently complex life forms, is not genetically determined through and through, but must be formed in the individual case selecting paths in its own chreod landscape under impression of the interaction with the particular surroundings.[8]

7) Such an experience-based umwelt makes possible genetic assimilation (Waddington), because individuals with better genetic bases for coping with the particular surroundings will have a selection advantage. This so-called Baldwin effect will be especially efficacious in social animals where one individual may learn such umwelt competences from others.[9] Thus the species' virtual reality as represented by its umwelt's set of inner representations of typical, merely potential

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1991: 85), "semiosis is the criterial attribute of life" (Sebeok 1991a: 124), or "semiosis presupposes life" (Sebeok 2001).

[4] Hoffmeyer draws this conclusion in his 1992 and takes it further in his 2001b.

[5] Biology thus forms a crucial part of the "structural ontology" claimed by Jean Petitot (e.g., 1992). I have myself (1999) tried to sketch a network of those concepts.

[6] This premiss rests, of course, upon Stephen Jay Gould's concept of punctuated equilibrium (Gould 1972).

[7] This idea in Uexküll (1928, 1982) has formed a core idea in biosemiotics and is widely discussed in a special issue of *Semiotica* (ed. K. Kull), 134(1/4) (2001), including Hoffmeyer 2001.

[8] Hoffmeyer gives this idea in (2001: 388) in a Waddingtonian conceptual apparatus: the *Umwelt* is taken to be constructed ontogenetically in a chreod of branching possibilities formally analogous and correlated to that proposed by Waddington to explain the epigenesis of the organism.

[9] The Baldwin effect is nicknamed after the American psychologist J. M. Baldwin (1902) who pointed out such a non-Lamarckian mechanism for inheritance of acquired properties. Deacon (1997) takes up the idea and applies it to the proposed co-evolution of language and brain in early hominids.

relations in the organism's surroundings, may become genetic reality — "only the well-prepared will profit from chance".[10]

8) Generally, any new such habit taken exposes the organism to new challenges in a never-ending chain of interpretations.[11]

9) The role of selection remains decisive, but basic biological phenomena like multiplication[12] as well as order[13] are prerequisites to selection and hence cannot be products of it. Multiplication and order are inherently meaningful.

10) Both are thus more primitive than genes and pertain to the analogous side of the organism's double code (which is a not so lucky expression as only the former of them is really, strictly speaking, a code): digital, genetic information on the one hand, and analogical, morphological information on the other, provided by the cell's architecture and metabolism as well as multicellular structure and communication.[14]

11) Another prerequisite to the functional circle is organism's character as an agency equipped with a point-of-view. This may be defined as a "stable integration of self-reference and other-reference"[15] (the former maintaining and defining the self as such; the latter facilitating its orientation and survival in its umwelt).

12) Agency presupposes, in turn, the existence of an inside-outside defining boundary, a membrane, characterizing all life forms (except for certain marginal parasite types like virus). Membranes thus make possible the crucial organism-environment asymmetry — facilitating the constrained traffic across the membrane boundary in the form of signs.[16] Autocatalytic closure of chemical reaction loops in the primordial soup[17] thus needs a further topological membrane closing in order to result in organisms. The controlled traffic across the membrane permits the emergence of strictly constrained "inner outsides" (due to perception in a broad sense of the word) in the organism as well as

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[10] Hoffmeyer 2001; Pasteur's bonmot is quoted from p. 393.

[11] Hypothesis (8) is a slightly abbreviated Hoffmeyer quote (from 2001: 392).

[12] Hoffmeyer (1999: 332), referring to Rod Swenson (1999).

[13] The argument that self-organized order is logically anterior to selection is made by Kauffman, e.g. 2000.

[14] Hoffmeyer, Emmeche 1991.

[15] Hoffmeyer 1999: 332.

[16] Hoffmeyer 1999: 333–336; 1998; 2001.

[17] Kauffman 2000.

"outer insides" (due to its interaction with and influence on specific aspects of the environment).

13) Such signs embed the organism in its ecological umwelt comprising other organisms with umwelten. A mutualism much more widespread than strict symbiosis[18] thus forms what Uexküll calls "a natural symphony" of mutual communication between species as well as between them and their surroundings.

14) Such communication necessarily involves, for economy reasons, categorical perception. Slightly different phenomena are functionally perceived as being the same type.[19] This is probably the lowest or simplest semiotic phenomenon, based on the differently shaped "active sites" on the outside of macromolecules, which may be recognized by these sites on other molecules.[20] By the same token, other molecules with the same sites may "fool" the process in question. This is the biochemical foundation of biological indeterminacy or semiotic freedom, but it requires a cyclical teleological (functional, final, purposeful, metabolic, homeostatic, or whatever predicate you prefer) process in order to display its possibilities.[21]

15) Biology is thus impossible without the Aristotelian quartet of causes.[22] Final causes should not, however, be identified with purposes (which form a special subset of them), but should be identified as all processes which are attracted by a future state.[23] Future states being general only (Peirce), final causes may make use of representation of such states by means of types.

16) As we only know rather complicated life forms (cells internally consisting of organelles which are probably formerly symbiotically living organisms), these primitive semiotic processes also characterize the cell's internal metabolism.[24]

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[18] Hoffmeyer 1999: 123–125.

[19] Stjernfelt 2001.

[20] Prodi 1988, Stjernfelt 1992.

[21] Cf. the "metabolic" tradition in biology emphasizing the importance of cyclic metabolisms, running from Kant (organisms as circles on the causal chain), via Uexküll (functional circle) to Kauffman (metabolism defined by thermodynamic work cycles).

[22] Cf. the argument for the importance of the formal cause (cyclic formal causes including final causes) in Thom 1989.

[23] The idea is Peirce's, cf. Hoffmeyer 2002.

[24] Cf. Sebeok's neologism "endosemiotics".

17) The role of the genes seems to be that of controlling epigenetic and metabolic processes in the organism (not that of creating or determining them through and through). This points to the fact that genes may be a special and successful example of a more general notion of "scaffolding",[25] that is, stabilization and channelling of (a segment of) metabolism. Other such scaffoldings could be cell architecture, organ structure, language, writing…

18) At the upper end of the natural history of meaning we find animals with central nervous systems which have taken the bases of meaning in categorical perception to form very complex semiotic abilities. The increasing indeterminacy — or, semiotic freedom[26] — can be expressed as the emergence of sign types increasingly loosened from their basis in particular sign tokens. Higher animals may not only recognize tokens as instantiation of types, they may make use of these types to symbolize, to reason, argue, use diagrams. Probably, the special human privilege is abstraction, making it possible for us to make explicit and contemplate such types, reasonings, diagrams with any particular token placed in brackets and thus facilitating control, experiment, and quick development of these signs.[27]

19) Biosemiotics thus assumes a distinction between the issue of signs and that of consciousness. Sign process are taken to be possible without consciousness, and as the existence of signs may be inferred from the external behaviour of a process, the establishment of qualia consciousness in a system has — not yet, that is — any methodology. It seems to be a tendency, though, that complex signification processes are increasingly facilitated by consciousness, maybe as a special type of neural scaffolding.

20) The interrelated web of biosemiotic concepts used here — membrane, sign, active site, function, metabolism, organism, umwelt, niche, and so on — forms a regional ontology (Husserl) of biology and semiotics,[28] and any biology, even the most would-be reductionist

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[25] Hoffmeyer's notion, cf. Hoffmeyer 2001.

[26] Hoffmeyer uses both terms, cf. 1999: 338; 1992.

[27] Deacon (1997) sees symbols as the human semiotic privilege; Stjernfelt (2001) proposes a specific subclass of symbols: abstractions.

[28] The idea of regional ontologies is first proposed by Husserl in the 3rd Logical Investigation (1980). Barry Smith has taken this as a basis for a general "fallibilistic apriorism" finding the ontological foundations in all special empirical sciences (1996), and has made explicit aspects of the ontology of umwelt and niche concepts in general (1998a; 1998b; 2001).

versions, must willy-nilly make use of some versions or other of them.[29] Such concepts provide the structural inventory called for in (3).

21) Biosemiotics does not entail vitalism, as it does not suppose the existence of *élan vital*, unknown organic force fields or the like. Neither does it entail any kind of subjectivism or relativism; even if every single organism and species has got its own point-of-view, this does not entail scepticism as those points-of-view may be compared and evaluated. Rather, biosemiotics entails *idealism* in a certain use of the word — not referring to the world being created by a subject or anything of the kind, but referring to the reality of ideal objects (like those conceptual networks of (20)). A special kind of ideal object here deserves mentioning, that of possibilities. Possibilities must assumed to possess real existence, including the idea of a fitness space of all possible genomes,[30] the idea of virtuality in nature,[31] the idea of tendencies in development and evolution, and, correlatively, the possibility for final causes to prefer one tendency over another. Thus, biosemiotics entails an ontological revolution admitting the indispensable role of ideality in this strict sense in the sciences.

22) To close the biosemiotic circle: real possibilities are also what make *signs* possible: any sufficiently complicated sign refers to a

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[29] This goes against the argument of Tønnessen (2001) which claims that universal concepts of biology is impossible, because we could imagine forms of life completely different from the ones we know. This fallacy is so widespread that it must be countered here. It has exactly the same form as the argument against cultural universals: "we could imagine cultures which were *completely* different from ours". The fault lies in the word "completely": if a thing differs completely from another, we do not know anything about it at all. Consequently, we do not know if it is a life form, a culture, or something else. The argument thus boils down to the idea that we can imagine something that we can not imagine. But this cannot form the basis of an argument. Any argument against this list must be based on empirical (actually existing life) observations or on a priori reasoning (using the concepts). Thus, any imaginable biology will use the concepts listed here. There may exist life forms very different from what we know, and they will probably enrich the list and give rise to a sophistication of it.

[30] Kauffman 2000, cf. his concept of "adjacent possible" of a system, that is, the sum of states which at any time t is at a distance of one chemical reaction from the actual state. Kauffman's adventurous idea (and candidate to a 4th law of thermodynamics) is that the biosphere invades this "adjacent possible" with maximum speed, thus at any instant covering more and more real possibilities.

[31] Hoffmeyer 2001a.

bundle of merely possible actual objects later in a functional circle,[32] that is, to a possibility, sometimes real, sometimes not.

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[32] In a broad sense, thus, any segment of a functional circle could be said to be a sign for any other segment of the same circle. What makes us speak of signs specifically, though, is probably the fact that some small segments have acquired stability so that they may repeatedly propagate the same form (René Thom: signs as propagators of form). A gene is a sign because it may repeatedly be read by the RNA; sugar is a sign for *Escherichia coli* because it repeatedly reacts in similar ways to it. The sign is thus: small (in comparison to its signification, the process which it informs), stable (in comparison to the process reading it).

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Tractatus Hoffmeyerensis: Biosemiootika väljendatuna 22 alushüpoteesi kaudu

Artikkel esitab biosemiootika põhiideed 22 hüpoteesi kaudu, tuginedes eelkõige Jesper Hoffmeyeri töödele.

Tractatus Hoffmeyerensis: Основы биосемиотики в 22 гипотезах

Статья излагает основы биосемиотики в 22 основных гипотезах, которые опираются, в основном, на работы Еспера Хоффмейера.

Sign Systems Studies 30.1, 2002

Habit formation as symmetry breaking in the early universe

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Abstract. This paper tries to combine Peirce's cosmology and metaphysics with current understanding in physics of the evolution of the universe, regarded as an ongoing semiotic process in a living cosmos. While the basic property of Life is viewed as an unexplainable Firstness inherent in the initial *iconic* state of the vacuous continuum we shall consider and exemplify two sign developing processes: (a) the transition from *icon* to *index* is considered as a symmetry breaking *emergence* of order actualising one among the possibilities of the iconic vacuum; (b) the transition from *index* to *symbol*, regarded as a habit formation — an adaptation of the surroundings to the order that has emerged. While the iconic state is characterized by *fractal* self-similarity the transitions to index and symbol are modelled by the mean field theory of second order phase transitions.

1. Prebiotic life?

Normally, in biology, the concept of life is considered a property of organisms. E.g., the recent discussion of life on Mars is based upon findings in meteorites from Mars of certain Iron compounds that are known to be formed by the metabolic activities of bacteria known from Earth. Thus, signs of life are identified with traces of organisms. It is also clear from current understanding of physical cosmology that the universe has evolved through a long period before even the presently known chemical elements were formed, — much less organisms. So, speaking of prebiotic (i.e. pre-organismic) life may seem like a contradiction in terms. However, trying to put a definite mark on the time-axis saying life begins at this point, e.g. where we find the first traces of prokaryotic cells, the basic building blocks of life, will immediately lead to conceptual difficulties. Clearly, such a cut in time can be nothing like a mathematical Dedekind-cut separating the one-dimensional continuum of time in two disjunct sets. If life starts at time *t* there must have been some sort of prebiotic life acting at time *t* minus epsilon. The first eukaryotic cell was preceded by a (in fact, very long) period of prokaryotic life. A period of trials and errors finally succeeding in making the crucial inventions leading to eukaryotic cells (such as the symbiotic inclusion of prokaryotic units like mitochondria). But the prokaryotic cells are also organisms, and, hence, living entities. So, what we have, tentatively, marked as the beginning of life turns out to be a later state in the evolution of organisms from inorganic matter. The same difficulty will turn up however we try to define the beginning, unless we push it as far back as to the initial cosmic event where matter and time is born.

In this paper I want to discuss the pre-biotic (pre-organismic) state of the universe in terms of Peircean semiotics and metaphysics. This implies that the narrow, dualistic distinction of existence vs. non-existence (of life) has to be replaced with the wider framework of Peirce's three ontological categories:

1: possibility, being
2: actuality, existence
3: generality, reality.

In this connection the first category is especially important because it allows us to consider life as an *internal quality of matte*r, endowed with *being*, although it has no external, organismic manifestations and no individual existence, like chance, that also belongs to the first category. Similarly, Edwina Taborsky (2002) considers energy as a firstness that manifests itself only when it is encoded as mass. So, the viewpoint is that *an organism is an encoded form of life, just like mass (e.g. an atom) is an encoded form of energy.*[1]

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[1] Thanks to Edwina Taborsky, who, in a private discussion, agreed with this formulation.

2. Tohu Bohu, and the continuum of possibilities

Trying to understand life as a Peircean Firstness is no explanation, for firstness is the category that cannot be explained, only explained away, i.e. as soon as we try to describe it in positive terms we are already speaking about second- and thirdnesses. We may say that life is an internal quality of matter and think, e.g., of the silent life of mitochondria in body cells, but in doing so we presume that these internal organs posses the same inner quality of "extended living feeling" (CP 6.143). The problem is, then, that although pure firstness is utterly undefineable, every account in Peircean terms of the natural history of semiosis has to depart from there. Quoting Peirce (Letter to Christine Ladd-Franklin, August 29, 1891):

> I may mention that my chief avocation in the last ten years has been to develop my cosmology.This theory is that the evolution of the world is hyperbolic, that is, proceeds from one state of things in the infinite past, to a different state of things in the infinite future. The state of things in the infinite past is chaos, tohu bohu, the nothingness of which consists in the total absence of regularity. The state of things in the infinite future is death, the nothingness of which consists in the complete triumph of law and absence of all spontaneity. Between these, we have on our side a state of things in which there is some absolute spontaneity counter to all law, and some degree of conformity to law, which is constantly on the increase owing to the growth of habit. The tendency to form habits or tendency to generalize, is something which grows by its own action, by the habit of taking habits itself growing. Its first germs arose from pure chance. There were slight tendencies to obey rules that had been followed, and these tendencies were rules which were more and more obeyed by their own action. There were also slight tendencies to do otherwise than previously, and these destroyed themselves. To be sure, they would sometimes be strengthened by the opposite tendency, but the stronger they became the more they would tend to destroy themselves. As to the part of time on the further side of eternity which leads back from the infinite future to the infinite past, it evidently proceeds by contraries. (CP 8.317)

The state of *TOHU BOHU* — (a Hebrew concept) can thus be considered as an unlimited sea of unactualized possibilities, — virtual fluctuations, or a "zero collection" of potential properties of the original vacuum. But the vacuum is not a pure firstness (not 1-1, firstness as firstness, but rather 3-1, thirdness as firstness, as Taborsky[2] puts it,

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[2] See the fn. 1; also Taborsky 2002, and Peirce (CP 1.366 and 1:473).

because it involves the continuum). A comment by the leading expert on Peirce's philosophy of continuity, Hilary Putnam, will elucidate this. Putnam wrote[3]:

> Dear Ken,
>
> Peirce's point, as I read it, is that in the continuum of pure possibilities, Secondness, that which resists — here, actuality or 'existence' as opposed to possibility — stands out as a discontinuity. If this is right, then the point is to contrast existence with the continuum of possibilities, and not Secondness with Firstness and Thirdness.
>
> (A pure unactualized possibility has no 'quality', and is thus not a First, although the continuum of possibilities is an instance of Thirdness par excellence.) If this is right, the zero collection cannot be a First, nor can it be 'Firstness' either. So the remaining interpretative problem is this: is the 'possibility' represented by the blackboard 'germinal' (the empty collection) or 'developed' (the continuum)? On the basis of my comments on the last two lectures in Reasoning and the Logic of Things, I think it has to be the latter, since the appearance of Secondness, in those lectures, seems in some sense (temporal? or is that only our mode of representing it?) to 'come out of' the continuum at a certain stage.
>
> But these are dark matters!

We can picture the "sea of possibilities" as consisting of domains or islands of different and shifting feelings.[4] Near criticality where the feelings become self-sustaining the domains will have a *fractal* shape. The Harter-Heightway twindragon (Mandelbrot 1977: 66) shown in figure 1 illustrates the *iconic semiosis* on this level. Self-similarity and other-similarity being the dominant force linking signs.

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[3] Posted by Ken Ketner to the discussion forum *peirce-l* on June 5, 2001. Cf. Putnam 1992.

[4] "Feelings", according to Peirce, are intensive qualities like temperature and pressure (firstnesses) having spatial extension (CP 6.133).

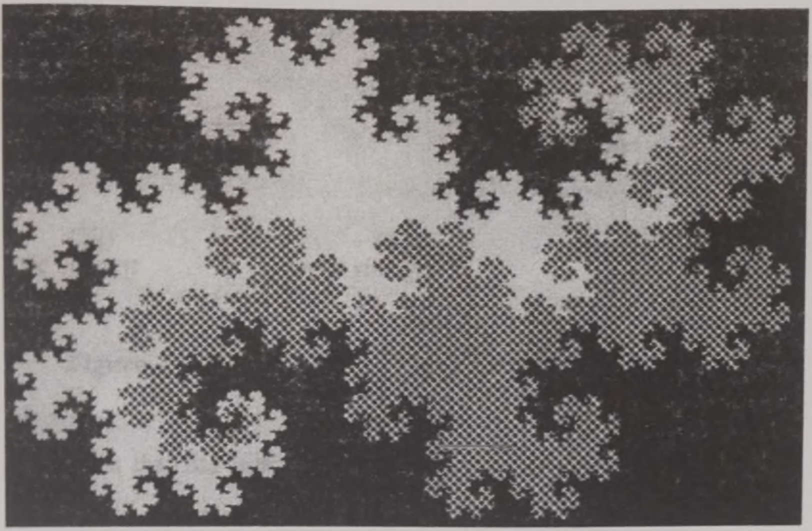

Figure 1. Twindragon made by recursive programming (level 18; P. V. C.).

3. Sign classes and emergence of order

The categories of Peirce are *inclusive* such that secondness includes firstness and thirdness includes secondness and firstness. In this way we arrive at the six classes discussed by Taborsky (Fig. 2).

We have already seen that the initial *Tohu Bohu* state can be discribed as 3-1 Thirdness as firstness. Here we have reversed the numbers to 13 — the first of third. Semiotic evolution proceeds by successive *actualizations* (1 to 2) and *generalizations* (2 to 3) starting with the qualisign (11) through (12) etc. and ending with the symbol (33) (or *mind* as Taborsky calls it). Interpreting Putnams remark such that the initial state is (13) rather than (11)[5] we only have three classes left, (13), (23) and (33), so I choose to call them simply *icon*, *index*, and *symbol*.[6]

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[5] The leftover physical theory of evolution from the qualisign (11) to the icon of the continuum (13) may be contained in the modern *M*-theory of superstrings.

[6] Instead of iconic, indexic, symbolic, *legisigns*.

We looked at the iconic state through the twindragon of figure 1 where the different domains or islands of feeling associate by similarity to self and others.

(33)
symbol

(23)
index

(13)
icon

(22)
indexic sinsign

(12)
iconic sinsign

(11)
qualisign

Figure 2. The 6 classes of signs.

The next step to consider is the transition to the indexic state when the symmetry is broken such that one particular feeling or internal order begins to monopolize the picture to the exclusion of all others. This is a critical transition well known from physics of second order phase transitions from disorder to order. The most well known example is the condensation of vapour to form droplets of liquid. The symmetry-breaking event is here the formation of a surface, i.e. a discontinuity of density separating the rarefied vapour from the denser liquid[7] This separation of the inside from the outside of a bubble is an example of *the ontological cut* discussed by Taborsky. It seems relevant to biology because it resembles the formation of a cell-membrane. When lipid molecules having a hydrophobic end and a hydrophilic end are suspended in water they will tend to reorient themselves to be parallel and form a closed membrane around a bubble of water. In both cases of droplet-formation there will be an *ordering field* — a surface tension acting to amplify the symmetry breaking operation of the surface or membrane. The idea of an *order parameter* that creates an *ordering field* which, in turn, facilitates growth of the order parameter is in physics summarized in the so called *mean field theory of (2nd order) phase transition.* An example is the Curie-Weiss theory of the

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[7] See the discussion in Christiansen 2000.

transition from paramagnetism to ferromagnetism summarized in the positive feedback loop on Figure 3.

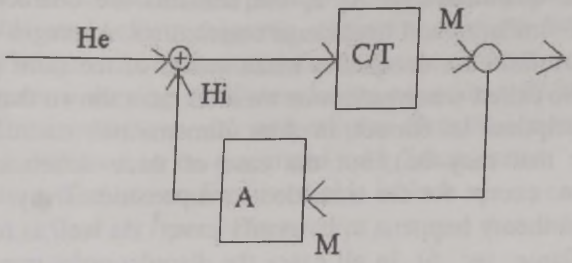

Figure 3. Positive feedback look illustrating the Curie-Weiss mean field theory of ferromagnetism.

Well above criticality the system exhibits a linear relation between the magnetization M and the magnetic field H:

$$M = \chi H$$

where χ is the paramagnetic susceptibility:

$$\chi = C/T,$$

C being the material-specific Curie-constant and *T* the absolute temperature. This describes the statistical balancing between the ordering coupling to the magnetic field (*C*) and the disordering thermal motion (*T*). The order parameter *M* is assumed to create an internal ordering field H_i that combines additively with the external field H_e. the whole diagram of figure 3 corresponds to the equation

$$M = (C / T) (H_e + AM) \qquad 1$$

Solving for *M* we get

$$M = C H_e / (T - T_c) \qquad 2$$

where $T_c = CA$ is the critical temperature.

Thus, for *T* above T_c we have paramagnetic behaviour with a slightly enhanced susceptibility. At T_c, however, it becomes possible to have a non-vanishing order parameter *M* — a spontaneous magnetization — even in the absence of an external ordering field H_e. Below T_c the linear model of figure 3 does not apply.

What really happens at and below the critical temperature is hard to describe quantitatively. At T_c the domains are characterized by fractal self-similarity and long-range correlations. Averages of powers of the mean field are unequal to mean values of the same powers of the field. So called *renormalization theories* have shown that the mean field description is correct in four dimensional euclidean space (wherever that may be), but the case of three dimensions defies description, except for the transition to superconductivity, where the mean field theory happens to be nearly exact[8] (as well as for gravitational collapse, sec. 6). In all cases the disorder-order transition is a *bifurcation*, i.e. there is more than one way in which the order parameter can be stabilized below T_c and a symmetry breaking *random choice* determines the outcome. For the ferromagnetic transition the order parameter M is a vector that can point any direction in space, but below T_c the spontaneous magnetization must point in a certain direction dependent on which domain happened to be dominating for the ordering field at the transition. The random choice made at T_c serves in this way to establish a *habit* that cannot be broken once it is formed. According to Peirce's cosmology, as outlined, e.g. in the previously quoted letter to Christine Ladd-Franklin even the fundamental laws of nature have a history of being formed in this way as habits based on an initial random choice, and the element of chance still prevails such that none of these laws are obeyed *exactly*. Habit formation is then the finishing step of natural semiosis, the step from index to symbol of figure 2. In the following section we shall briefly consider some important symmetry breaking and habit forming transitions in the prebiotic (pre-organismic) state of the physical universe.

A habit is formed as an attractor of a dynamic system, and its realization is always accompanied by energy dissipation and entropy production.

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[8] As demonstrated by the striking success of the phenomenological theory of superconductivity by the Soviet physicists L. D. Landau and V. L. Ginzburg, (Ginzburg, Landau 1950).

4. The first flash

The energy in our present universe is divided among several fields and their quanta of excitation, i.e., particles. The main division is between matter-fields and electromagnetic radiation, carried by massless photons. The quanta of the matter-fields can be divided in two main types: Fermions obeying Pauli's exclusion principle with half-integer spins, and massive bosons with integer spins. Besides, the main part of the mass is believed to be associated with "dark matter" of an unknown nature. The known Fermion fields include *six types of quarks (u, d, s, c, t, b)* and *six types of leptons (e, μ, τ*, and their neutrinos ν_e, ν_μ, ν_τ).[9]

These particles interact in four ways, *weak, strong, electromagnetic, and gravitational* carried by bosons, resp. (massive vector bosons and the scalar Higgs-particle (undetected), gluons (8 kinds), massless photons, and gravitons).

The graviton has not been detected but is known to be without charge and mass and to have spin 2. The absence of mass of the photon and the graviton explains why electromagnetism and gravitation have infinite range. On the other hand, the weak interaction is of very short range, which means that its quanta — the vector bosons (W and Z) must be rather heavy[10] (about 100 GeV, confirmed by experiments at CERN). The finite rest-mass of the vector bosons has presented a big problem for the standard model, according to which they should be massless. The problem was solved by postulating the existence of the *Higgs-boson*. These particles are assumed to form a *Bose-condensate* with a definite value of the scalar *Higgs-field, H*). Just like the condensate of electron-pairs in superconductors give the photons a finite range, the *H*-field interacts with the vector bosons and give them a finite range. In the absence of a *H*-field there would be no way to distinguish between the weak and the electromagnetic interactions, so *H* may be considered a symmetry breaking ordering field just like the mean internal field in the Curie-Weiss theory of ferromagnetism (Figure 3). According to the so-called *inflation-theory* by

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[9] It is tempting, therefore, to use the six classes of signs (Figure 2) as a key to classification of elementary particles. This line of thought will be pursued in a forthcoming paper by the author.

[10] The range of a force field mediated by boson-quanta is inversely proportional to the mass of the bosons.

Alan Guth the nucleation of H is a very violent event that creates the universe by an anormous blow-up of an initial small domain of non-vanishing H. We can picture the vacuum-energy as a function of H like shown in Figure 4.

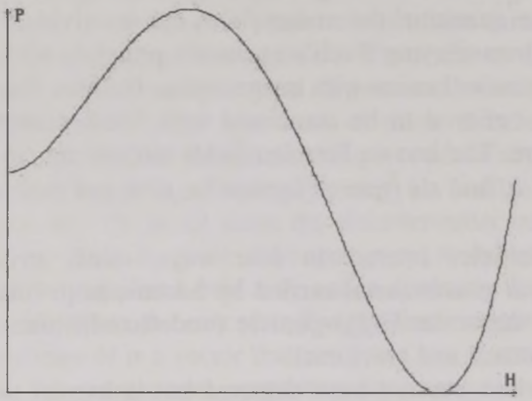

Figure 4. Vacuum potential P as function of the Higgs-field H.

The potential has a minimum for $H = 0$ corresponding to the initial vacuum state before inflation (sometimes called the *false vacuum*). However, there is a lower minimum at a finite value of H, separated from the first minimum by a potential-barrier. This barrier will prevent transition to the lower minimum until some fluctuation lifts the system over the barrier. A *thermal* fluctuation presupposes that the temperature has a finite value in the false vacuum, which may be a dubious assumption, but even at zero temperature the system may penetrate the barrier by *quantum mechanical tunnelling*. The vacuum potential P is an even function of H, so there is a symmetry breaking in the choice between a positive or a negative value of H. As soon as a domain of the system penetrates the barrier there will be enough energy released to help the transition spread as an avalanche to the whole potential universe like the growth of crystallization spreading in a super-saturated solution or a supercooled liquid from a single crystal germ. The transition creates a lot of entropy, the universe blows up by more than fifty orders of magnitude and is born in a very hot state after about 10^{-33}s. This state after inflation is then the starting point (time zero) of the standard "big bang" model of evolution.

5. Subsequent symmetry breakings

Just after the inflation period the universe is a very hot fireball with all kinds of particles and a temperature of more than 10^{15} K sufficient to produce free vector bosons and Higgs particles. But the state is cooling rapidly under adiabatic expansion, and as soon as the Higgs field settles down the previous symmetry between electromagnetic and weak interactions is broken to the habit of the force-laws known today. Another symmetry that is rapidly broken is the symmetry between particles and antiparticles. In the initial fireball there must have been a small random surplus of particles over antiparticles, and this difference will prevail after the pairwise annihilation processes, such that all antimatter has disappeared, except for anti-quarks in compounds like mesons and hadrons. Most quarks are soon bound in stable triplets to form hadrons, i.e. protons and neutrons. These two nucleons, the building blocks of all the nuclei of chemical elements are balanced by the β-process

$$n\_e +p +\nu \tag{3}$$

whereby a neutron *n* decays to a proton *p*, an electron *e*, and a neutrino *ν*, and the reverse process. The neutrinos only interact weakly, through this process, with other particles, and, as they are nearly massless[11] and, therefore moving with near-light-speed they disappear from every finite part of the universe after a couple of minutes, so that the balance of the reactions (3) gets frozen and the *n/p*-ratio becomes fixed — another habit-forming symmetry-break has occurred.

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[11] Recent experiments in Japan have shown that at least one of the three kinds of neutrinos (ν_e, ν_μ, and ν_τ) have restmasses about 10 eV, 0.002% of the electron's mass.

6. Entropy and gravity in the ageing universe

The expansion of the initial fireball is in the standard *Big Bang* model described as *nearly adiabatic*, i.e. without entropy production. According to thermodynamics, however, no habit formation (i.e. no evolution at all) can take place without entropy production, so the use of the word *adiabatic* just means that the entropy produced after inflation is very small compared to the entropy produced in the first flash of inflation. While Boltzmann and other pioneers saw the concept of entropy as signifying the *heat death* of the universe the current view is closer to Peirce's vision of a *heat birth* and a *cold death*. The expansion may be described by an *increasing scale factor* $\xi(t)$ *that stretches everything proportional to the distance* from every arbitrary chosen "centre". During inflation $\xi(t)$ had an exponential increase, but afterwards it is replaced with a much slower power-law increase. The wavelenghts of the photons in the radiation field are stretched in the same proportion as all other distances, so the temperature of the background radiation decreases inversely proportional to $\xi(t)$.

In the beginning phase when the radiation is still hot enough to ionize hydrogen the matter will exist as a *plasma* with the charged particles, electrons and protons uniformly dispersed in electromagnetic radiation. The photons cannot reach far before they are absorbed by the charged particles, so the universe is opaque. The matter particles (*e* and *p*) cannot clump together because they are continually scattered by photons. *Gravitation* is in a slumbering state of Peircean firstness, because the uniformity of matter distribution makes it pull equally in all directions, cancelling itself out in every point. The next significant symmetry breaking occurs after about 300,000 years when the temperatur drops below the ionization point of hydrogen. When the matter gets bound to the atoms of electrically neutral atoms of hydrogen and helium it ceases to interact with the photons, and the universe becomes transparent. A homogeneous distribution of neutral matter is unstable under gravitational collapse, so a randomly formed lump of greater density will attract surrounding matter and create an increasing ordering field of gravity, enhancing the lumping tendency as described by the mean field theory of figure 3. Thus, the symmetry breaking gravitational collapse leads to the formation of galaxies and stars. The concentration of matter creates entropy and rises the temperature of matter compared to the continually expanding and cooling radiation field. With light emitting stars on a dark background the universe is beginning to look familiar and the stage is set for a biochemical and organismic evolution. However, the biosemiotic perspective of symmetry breaking and habit formation still applies.

7. Concluding remarks

The point of view in this paper is that modern theories of the physics of the early universe fits together with Peirce's cosmology to contribute to the biosemiotic natural history of signification. This should not be regarded as a reductionistic attempt to place physics as a basis for biosemiotics but rather as an elaboration of the idea that physical cosmology needs a semiotic perspective in order to enter a fruitful dialogue with biology and other sciences. In accordance with scientists like Manfred Eigen and Ilya Prigogine I believe that evolution of living signs is *indeterminate but inevitable* and if it seems too radical to regard life as a first, an internal quality of matter, I ask for a better view that doesn't make it seem utterly strange that the universe has evolved to produce humans and other sign using creatures.

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Привыкание как ломка симметрии в раннем универсуме

В статье делается попытка связать космологию и метафизику Пирса с распространенным в современной физике пониманием эволюции универсума, рассматривая ее как семиотический процесс в живом универсуме. Если считать главным свойством жизни необъяснимую Первичность, которая исходит из первичного иконического состояния в пустом универсуме, то можно выделить два процесса развития знака: а) переход от икона к индексу как возникновение упорядоченности посредством ломки симметрии (которая актуализирует одну из возможностей иконического вакуума); б) переход от индекса к символу, что являет собой привыкание (habit) — адаптацию окружения к появившемуся порядку. Если иконическое состояние характеризуется *фрактальным* самоподобием, то переходы к индексу и символу моделируются теорией фазовых переходов второго порядка.

Habitueerumine kui sümmeetria murdumine varases universumis

Artiklis püütakse seostada Peirce'i kosmoloogiat ja metafüüsikat praeguse füüsikalise arusaamaga universumi evolutsioonist, vaadeldes seda kui semiootilist protsessi elavas universumis. Kui pidada elu peamiseks omaduseks seletamatut Esmasust, mis pärineb algsest ikoonilisest seisundist tühjas kontiinuumis, saab vaadelda kahte märgi arenguprotsessi: (a) üleminek ikoonilt indeksile kui sümmeetria murdumisega korrastatuse teke, mis aktualiseerib ühe ikoonilise vaakuumi võimalustest; (b) üleminek indeksilt sümbolile, mis on habitueerumine — ümbruse adapteerumine ilmunud korrale. Kui ikooniline seisund on iseloomustuv fraktaalse enesesarnasusega, siis üleminekud indeksile ja sümbolile on modelleeritavad teist järku faasiüleminekutena.

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Energy and evolutionary semiosis

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Abstract. This paper sets up a thought-experiment that examines the transformation of energy into codified mass. This transformation is understood as a semiosic action of interpretation. The semiosic action is analyzed within five "predicate" or "verbal modes" which establish different processes of transformation or interpretation. These "predicate modes", which are sign processes, take place in different areas of reality, the external realm and the internal realm. The external realm is composed of discrete objects and their interactions. Its processes are examined within classical mechanics and this paper posits a semiosic codification that is unique to these external processes. The internal realm is a holistic endoperspective with no recognition of discrete objects. Its processes are examined within quantum and field processes and this paper posits a semiosic codification that is unique to the internal processes. However, rather than promoting one or the other realm as a valid interpretation of reality, this paper suggests that both the external and internal energy-mass processes are necessary components of our universe.

Introduction

I begin with a hypothesis, a speculation, a *phantasia*, for it is "thought and ideas, not formulae, [that] are the beginning of every physical theory" (Einstein, Infeld 1961: 277). This paper outlines a "thought-experiment" on the semiosic nature of energy and mass.

I begin with a hypothesis that the basic reality of our universe is its nature as a dyadic spiral of energy and mass. The famous theory of relativity informs us of the transformative identity of mass and energy but it is a postulate of this paper that energy does not exist in our universe 'per se' but only in its nature as mass, which is to say, within the restrictions and constraints of codification. Energy can be understood as a force of pure potentiality for the actualization of itself as mass. It is difficult to initially describe energy in any more detail than that, because as pointed out, energy in our universe, due to the asymmetrical force of the Big Bang, cannot exist by itself as that pure potentiality. It is doomed, in a sense, to an infinite process of constant transformation of itself as mass. But we must acknowledge this primal dyad because the transformative motion between the potential and the actual is the basis of all abiotic and biotic processes in our universe. Aristotle pointed out that our sensual experience provides us with one account of nature that focuses on the "immediate material substratum of things which have in themselves a principle of motion or change" (*Physics* Bk II, Ch. I. 193a30) and it is our analytic capacities that provide us with knowledge of this "principle of motion or change", which is the other part of the dyad, the abstract "shape or form" of these material things, which "has not yet its own 'nature', for no universal attribute is a substance" (*Metaphysics* Bk VII, Ch. 13, 1038b35).

It is a further postulate of this paper that the architecture of this transformation is semiosis or codification, which operates within a series of ontological and epistemological cuts that initiate and increase asymmetrical gaps between energy/mass which are then mediated by increasingly complex semiosic relations or codifications. Codes, which are actions of measurement, organize energy into mass. They do this by establishing patterns of relations for that mass/energy, with the result that one encoded or actualized mass/energy is differentiated from other encodements of mass/energy. We can understand these processes of measurement as processes of interpretation. Therefore, energy that is codified should be understood in this constrained state not simply as "matter" which by itself is a meaningless term but more accurately as "information" because this energy is then capable of informing on and about other forms of energy-as-matter, by relating its codes, its organizational properties, to these other forms of coded energy. These processes of associative measurement do not necessarily involve a deliberative or conscious interaction. Mind, the logical and communal action of measurement, operates to transform energy to mass or information but it is not essential that Mind is human or conscious. There is a need "for mentality to be 'ontologically fundamental'" (Penrose 1997: 176). This process of the codification of energy to informed mass is known as semiosis. Semiosis is not confined within language or human or biological consciousness but begins at the primal level of energy

Codification and the asymmetrical cuts

What is codification? It is a referential system that measures energy. In this action of measurement, it organizes energy within patterns that enable that energy to exist as mass, as existential "stuff" within particular times and spaces, which means that this mass is both differentiated from and related to, other mass. The energy of a hydrogen atom is organized differently from that of an oxygen atom. Is the organizational pattern ontologically separate from the energy? This question has been debated for centuries. Platonism views the organizational code as a Form and sets it apart as an ideal memory. The materialized version of this pure Form can be a mimetic clone, a dialectical analogy, or even, a crafted symbol. But, the original Formal Cause, as ideal memory, remains separate from the Material Cause; the code is separate from matter. However, in disagreement, Aristotle said that "to reduce all things thus to Forms and to eliminate the matter is useless" (*Metaphysics* 1036b20). The Aristotelian concept of codes and energy merges them, for "matter [...] is something that can never exist without quality and without form" (*De gen.* 320b15). To again quote Aristotle, "what desires the form is the matter" (*Physics* 192a20). This is not merely a classical conclusion. Modern researchers concur that "the cohesion between the measuring and the measured energy flows thus turns out to be a principal characteristic of energy dissipation and conservation" (Matsuno 1998: 67). However, the debate is by no means complete for there is still strong support for the Form, the primal code, to be considered as ontologically separate from mass. It is an axiom of this paper, that the Aristotelian relational architecture is more robust than the Platonic and that codification can never be separate from matter, and therefore, that mass can never exist as pure energy. Therefore, energy, as potentiality, can be understood to have "intentionality", it desires and requires measurement so that it can be actual. How does codification operate in such an architecture?

Information or “mass” is a codified microstate of energy; it is energy in a state of “informing” by means of measurement, which is to say, by means of a referential system (the Form) whose logical properties of ordering energy provides for the establishment of other relations with other forms of matter. Measurement or referential relations organizes energy such that it operates within systemic relations with other orders of energy/mass. This means that the transformation of energy into mass or information requires separate levels for processing. This does not mean that each level can exist ‘per se’ as in a Platonic architecture but that these levels (form and energy) filiated as they are, must be differentiated. Free energy, which is to say, energy with limited relations, must somehow be differentiated from the referential codes, which is to say, the habitual relations, in order for the two to even interact with each other. That is, metalevels are a basic necessity for coupling or relations of referentiality to occur, such that energy can exist as mass, as information. This requires a series of ontological and epistemological differential cuts that act to increase asymmetry of energy which is then mediated by semiosic relations. A “cut” is a process that, by virtue of measurement, separates energy/mass into different zones of relational capacities.

The first cut sets up an ontological reality of internal and external zones. This means that there is a “mass” that is differentiated in time and space from another mass. This sets up an external realm and an internal realm. These two realms, the external and the internal, operate within different modes of codification. Second, within both these internal and external areas, there will also be an epistemological codal cut that sets up formal laws, i.e., synchronic memory, which is differentiated from the short term singularities, the actualizations of this memory, which emerge within local or initial conditions. These differentiations of energy/mass into distinct zones of operations (internal and external; memory and instantiations) will also produce energy/mass whose interactions will evolve in hierarchical complexity. This is achieved by increasing the asymmetry of those cuts. The subsequent codal relations required to mediate the cuts will increase in complexity. The physico-chemical realm of basic semiosic codification is found within atomic and chemical processes; the biological is more complex and is found within organic processes; and the conceptual, the most complex, is found within human symbolic processes. Measurement or codification of energy to mass occurs in all three realms and therefore, it is an axiom of this paper that semiosic processes are operative in all three realms (Taborsky 1999).

Semiosic zones of codification

Codification into discrete particles and their relations operates within a complex architecture that generates a series of increasingly complex cuts of energy/mass into asymmetrical sections. The most basic cut is ontological, the distinction between an instantiation and its environment. This cut measures mass into zones of the *external* and the *internal*. This has been defined as "the Heisenberg cut" (Matsuno 1999, Primas 1993, Atmanspacher 1994, 1999). This cut, with its distinction between an object and its environment, sets up a dualism that sees both the internal and the external as separate domains of codification.

Codification in the external zone ignores what is going on inside an object and considers that entity only from the ontological separation of an observer or other's stance. Measurements and interactions of mass in this zone refer only to these externally measured units as modular and impenetrable except by division into discrete parts. This sets up a basic mechanism "with matter and force as our fundamental concepts" (Einstein, Infeld 1961: 53). This is the familiar Newtonian mechanical exoperspective and it enables a world operating within interactions of electromagnetic attraction and repulsion. The internal codification, on the other hand, operates completely internally, with no recognition of otherness. This permits a holistic endoperspective, a state "prior to object-subject bifurcation, in which the so-called external world becomes totally deprived of its ontological solidity" (Atmanspacher, Dalenoort 1994: 1). Internal measurement and interactions of mass are uncertain and amorphous because they lack reference to a distinct "other" reality with the result that discrete descriptions and therefore avoidance, are impossible (see Matsuno, Paton 2000; Matsuno 2001, Atmanspacher 1999). Measurements within the internal zone permit non-local correlations, i.e., the non-local EPR interaction, while measurements within the external zone lose that holism "and objects and disentangled observers can be distinguished" (Atmanspacher 1999: 129). It is an error, I feel, to define these two zones as simply objective and subjective, for the latter term introduces a conscious and personal, individual intentionality that my analysis rejects. Measurements within the external zone are made within classical mechanics and measurements within the internal zone are made within quantum field mechanics irrespective of the size of the system and the state of consciousness.[1] My point is that classical and quantum mechanics are not ideological and oppositional perspectives about our universe, with ourselves choosing between them, but are real processes of measurement of energy/mass and both are required within the ontological nature of a complete energy/mass codification.

A second cut, the epistemological, divides both the external/ internal, or classical/quantum measurements into "both *facts* and *models*" (Atmanspacher 1994: 15, emphasis in original). Using other terms, this is the familiar mind/body distinction and has been described as "the Cartesian cut" (Matsuno 1999, Atmanspacher 1994, 1999, Primas 1993) although we remember its identity from the Platonic/ Aristotelian arguments on Form and Matter. These measurements establish material singularities and a formal or mental model of cohesive identity. That is, "the elements of *res cogitans* are non-material entities like ideas, models, or concepts [and] the elements of *res extensa* are material facts, events or data" (Atmanspacher 1999: 128). The formal model, as a mental (again, not necessarily human) process, is encoded digitally while the informal singularity is encoded analogically. Mental computation provides holonomic or synchronic constraints of communal norms that resist the dissipative forces of the non-holonomic atomistic expressions which confront this synchronic resilience.

What we have set up is an architecture for a dynamical measurement operating within a series of ontological and epistemological cuts. If we postulate a universe that began in a pure symmetry of mass/ energy and moved into asymmetrical gaps between mass and energy, then, what are the interactions that are made possible by the concomitant requirement for mediation of these cuts? In order of extremes, a

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[1] This zone should be more accurately understood to operate within aspects of relativity or field theory rather than totally within quantum mechanics. My model does not use Bohr's concept of the elementary particle as measured by a macroobserver on micromatter but uses the concept of the elementary nature of the relational interaction. However, it denies the relativity view that matter is independent of measurement. These details will be examined in a forthcoming paper.

relational interaction will be iconic, indexical or symbolic. An iconic or mimetic relation is operative where the differentiations in codification established by the measurement cuts are slight, where there is "a mere relation between the sign and the thing signified" (Peirce 1.372). Indeed, the relation subsequent to the cut is "a mere quality" (Peirce 2.243) for the separations have been amorphous and permeable. A wider or more intense cut will enable a discrete separation and a subsequent indexical relation which must be, to acknowledge the actual physical separation, itself an "actual existent" (Peirce 2.243). In an indexical relation, the two discrete entities are linked by a "direct physical connection" (Peirce 1.372). The most asymmetrical cut will enable a symbolic relation, involving an "imputed character" (Peirce 1.558) which is a relation linking these discrete entities that requires a conscious and referential intentionality. The symbol has no links, either mimetic or physical, with its interpreted meaning, other than a consciously assigned relation. As such, the symbolic relation permits the most plastic and innovative relations for such relations exist entirely by "the fact that it is used and understood as such" (Peirce 2.307). I am postulating that symbolic semiosis is only operative within the human realm. On another point, it should be noted that asymmetry increases the reaction time to establish a relation. Iconic measurements can establish relations rapidly for there is little to differentiate and recognize; the indexical requires the establishment of a physical bond and increases the reaction time; the symbolic, which is arbitrary and learned, and implies subjective intentionality, requires the longest reaction time. These temporal discrepancies cannot be overlooked in a consideration of the entire semiosic architecture.

The semiosic categories

I will introduce the three basic modes or categories of codification. The semiosic process should be understood as a dynamic and relational rather than a nominalist action; that is, the sign should not be understood as one image substituting for another image. The sign is a relational process and acts as a full sentence. The sign, whether acting as an icon, index or symbol, is to be understood not as a "thing" or noun, but as a "thing-in-relation-to-other-things". The noun-part and the predicate-part together make up the sign (Taborsky 2001) and the sign establishes both particle-mass and relational-mass. Let us now consider the basic modal categories in which this sign, as an action of establishing relations between mass, operates. These modal categories are a Firstness of holistic possibility, a Secondness of individuality and a Thirdness of normative habits of the community. These are only the basic modes; in the interpretive actualization of energy to mass, these modes will readily combine and become more complex.

Firstness is a relation of feeling, quality, chance, immediacy, "an instance of that kind of consciousness which involves no analysis, comparison or any process whatsoever, nor consists in whole or in part of any act by which one stretch of consciousness is distinguished from another" (Peirce 1.306). Any experience that is codified within a state of Firstness is completely internal and has no capacity to refer itself to an external object/model for comparison. As an experience it is in a continuous state of emergence, lacking the capacity to move itself into discrete singularities. It should be clear that "the internal perspective is fundamentally distinction-free, i.e., no object can be distinguished from anything else" (Atmanspacher 1994: 15). Mass encoded within Firstness is obviously so elementary that it is both noun and predicate, particle and wave at the same time. Its properties are homogeneic and operative within coupling bonds that set up reversible and symmetrical links that tend to maintain an equilibrium of energy to mass transformation. This mode of codification is unable to implement recording or descriptive systems, which are referential codes that integrate random sensory-motor stimuli to provide the stability of a synchronic memory. As Gödel pointed out, a system cannot prove its own consistency but requires a formal reference. Can we imagine our early universe in such a random state? Unlike energy in a state of Secondness, if not picked up by more stable codal processes, the energy in this amorphous indeterminate state does not dissipate to a less complex mass; it simply remains in this isolate internal zone as an infinite "potential", which is continuously distributed throughout the cosmos. Without the constraints of definitive measurements and a referential memory to stabilize any relations, this mode of codification enables energy to saturate its internal phase space, which we might describe as a state of pure feeling. Therefore, Firstness, as a codal process, sets up rapid non-reflexive relations with no descriptive capacity but with a capacity for expansive exploration, i.e., a radiant energy.

Secondness is the basic mode of our sensate and conscious experience, in the sense that it describes both physical and mental awareness of evident differentiations in our external environment. Secondness is the collapse of the expansive symmetry of Firstness, it is the compression of the energy of Firstness within asymmetrical constraints which transform this energy to insert mass with observable differences. Secondness acts within the irreversible selection of a specific path, where a "choice", random or intentional is made, and that particular instantiation or fusion of mass emerges as differentiated, externally, from another mass. With its focus on proximate cause and effect, energy coded within Secondness acts as the "mutual action between two things regardless of any sort of third or medium, and in particular regardless of any law of action" (Peirce 1.322). Secondness refers to "such facts as another, relation, compulsion, effect, dependence, independence, negation, occurrence, reality, result" (Peirce 1.358). The key to mass codified within Secondness is its discrete closure, as operative within the Heisenberg cut, and this cut is ratified as a closure by a link, a predicate relation – whether it is an iconic, indexical or symbolic link — to another object. Therefore energy encoded as mass within the semiosic process of Secondness "is a real thing or fact which is a sign of its object by virtue of being connected with it as a matter of fact" (Peirce 4.447). Therefore, this mass is contextualized to its local context and we can assign a definite quantitative and qualitative description to its identity. With an obvious reference to classical physics, Peirce states that

> there has been during the nineteenth century a decided leaning of scientific opinion to discredit any other sort of action in the external world than that of dynamical force; to understand a dynamical force to be a purely brute force with no element of inherent reasonableness in it, but merely to be the only force that scientific research could discover. (Peirce 6.329)

So too, Einstein gives an example of a simple mechanical view, of "two particles with forces acting between them" (Einstein, Infeld 1961: 53). In Newtonian mechanics, the inertial mass operates in an inertial frame. This is an externalist or non-interpretive mechanical interaction and we should remember that these discrete instances are brittle, contextually bound to initial conditions and without, themselves, the stability of memory.

Thirdness is the key mode. Thirdness is a mode of mediate measurement that we have, as a result of the Cartesian and Newtonian focus on the immediate physical orientation of discrete elements ignored and indeed denied for years. However, "there is some essentially and irreducibly other element in the universe than pure dynamism or pure chance [and this is] the principle of the growth of principles, a tendency to generalization" (Peirce 6.322, 6.585). Thirdness is a process of synchronic codification, operative both externally and internally, that transforms the multiplicity of diverse sensory-motor data into cohesive "habitual" diagrammes of communal knowledge. Thirdness works to glue, to bind, to relate, to establish relationships and connected interactions. It takes descriptive codes of mass from the diverse instantiations of our internal and external experiences and "translates" them into a syncretic diagramme or Laws of relations of these descriptions such that subsequent local instantiations, within Firstness and Secondness, can emerge as versions or representations of these communal Laws. Thirdness is a "matter of law, and law is a matter of thought and meaning" (Peirce 1.345). It is therefore, a process of the mind, the other side of the Cartesian cut, *res cogitans*, it is the process of assimilating, the "power of taking habits" (Peirce 1.390). Paton calls such a process of developing this epistemological coherence "glue" (Paton, Matsuno 1998). This is a succinct image of its powers as a resilient dynamics of a force enabling evolutionary cohesion.

The Architecture

We now have the basic codal categories of Firstness, Secondness and Thirdness. However, as examined by Peirce (for example, in 1.365–367; 1/383; 1.413; 1 526–544) these basic modal categories will operate as both "genuine" or pure and as "degenerate" or mixed. This will increase the complexity of relations and therefore interpretations that the sign is able to produce. I am going to set up a dyadic architecture that incorporates both the genuine and degenerate semiosic processes. I will further differentiate these semiosic actions into those that can take place in the external realm and those that can take place in the internal realm.

The external realm operates within two semiosic realities, two different ways of measuring/codifying energy. One measurement produces the singularities; this is discrete mass in a state of inertia independent of any motion. And, there is kinetic energy, the "energy of motion" that is separate from the inert mass. The first two laws of thermodynamics, conservation of mass and conservation of energy, operate separately in this realm. Mass and motion are separate. However, if we consider the singular mass, and locate ourselves within it, then, a very different mode of energy/mass relations becomes evident. The internal semiosic processes are the inclusive mass/energy relations that take place within a singular mass. Because these processes are completely internal, we must understand them as operating not within a singular entity but within a unity. Mass operates very differently within a unity rather than as a singularity. Internally, we have, not two separate processes, that of the external rest-mass and kinetic energy, but a unity of processes within relativistic mass-energy, where energy and mass are both understood as relative to each other and are therefore, constantly transforming into each other. Therefore, the two thermodynamic laws operate together in this realm. What we must also consider is that this dyadic architecture of two realms, the external and the internal, is not adversarial and dispensable but indispensable, because the codal actions within each realm provide different properties and enables the entire system to develop a dynamic flexibility and adaptive capacity.

Based on the Peircean complexity and interdependency of genuine and degenerate modal categories, I suggest six basic codal predicate operations; that is, six different semiosic processes that encode energy to mass, within these ontological and epistemological cuts. They are:

Firstness-as-Firstness [1-1]	This develops a pure possibility.
Secondness-as-Firstness [2-1]	This develops a probable existent.
Secondness-as-Secondess [2-2]	This develops an irreversible existent.
Thirdness-as-Firstness [3-1]	This develops a law of probabilities, of possibilities.
Thirdness-as-Secondness [3-2]	This develops a law of actual existences.
Thirdness-as-Thirdness [3-3]	This develops pure massless Mind.

The point is, these six different predicate codal processes are not all found within the same zone of operations. They operate, quite exclusively, in either the external or internal realms. In the external zone, the operative codes are: Secondness-as-Secondness [2-2] and Thirdness-as-Firstness [3-1]. In the internal zone, the operative codes are: Firstness-as-Firstness [1-1], Secondness-as-Firstness [2-1] and Thirdness-as-Secondness [3-2]. The final semiosic predicate, Thirdness-as-Thirdness [3-3] is pure Mind, which is massless, and I will leave its complex examination for another paper.

A brief point that will also be glossed over in this paper, is that epistemologically, Thirdness will always be encoded within a digital measurement and Firstness/Secondness within an analog measurement. Temporally, the digital code operates in past/future time and acts as a future-oriented cohesive pattern of habitual interactions. The analog code sets up a local and irreversible once-only mass. The haecceity or contextualized "thisness" in current time is the essential demarcation of an analog code. The digital abstracts information from the local contexts and sets up an interpretation that is general enough that an analog instantiation can replicate that interpretation, as a "this", but as related to another place and another time. However, mass that is codified within a digital mode cannot, in its nature as a formal abstraction, ever be completely articulated within these analog instances. This "blind spot" provides the analog with an expansive freedom of exploration. The two sides of this epistemological cut, the digital and the analog, mind and matter, together provide important features for a complex system.

Let us now move to a closer examination of the semiosic architecture. The ontological cut has the physical consequence of differentiating mass/energy into external and internal zones.

The external zone

This is the realm of individual experiences, the world of distinct boundaries, filled with objects and the actions that go on between objects, that is, "the ideas of causation and of statical force" (Peirce 1.325). We are familiar with its classical mechanics, with the action and reaction of units whose properties are separate and independent of the properties of other systems. How can we semiotically describe this external zone? We have three categories of codification to work with: Firstness, Secondness and Thirdness. And, we have two asymmetries that must be mediated with semiosis, the asymmetries developed by the ontological and the epistemological cuts.

Ontologically, in this realm the semiosic sign process must produce a clearly differentiated noun and a predicate. In this case, in the external realm, the noun to be produced is inert mass, a "thing", and the predicate is the classic Newtonian electromagnetic force of attraction and repulsion between these noun-objects. Epistemologically, the semiosic process must provide a synchronic formal set of rules governing the operations of these objects and their interactions. There are two sign processes in this realm. These can be described, semiosically, as that of pure Secondness or "unalterable fixity" [Secondness-as-Secondness: 2-2] and the stochastic average [Thirdness-as-Firstness :3-1].

Codification of energy to mass within the category of pure Secondness produces inert mass, a mass that is differentiated into discrete closures, whether micro or macro objects, all operating within the famous law of non-contradiction, as either "similar" or "dissimilar". The differentiation is so distinct that there is no need for a "time gap" of reflexion and analysis. This is why we say that the classical realm is "mechanical", lacks emotion, subjectivity, imagination, connection, freedom; it is entirely predictable, and the universe, if understood only within this realm, concludes that "all phenomena can be explained by the action of forces representing either attraction or repulsion, depending only upon distance and acting between unchangeable particles" (Einstein, Infeld 1961: 65). Obviously, our world cannot operate only with these random objects flying around; there must be rules for their interaction and their continuity.

The epistemological cut, acknowledging a differentiation between immediate point and progressive time, must provide a set of formal measurements to act as a descriptive memory, to provide a synchronic continuity of reproduction. In the external realm, this synchronic force is provided by the statistical average, which develops as an objective abstraction from the discrete events, to provide a "habitual commonality" that enforces continuity of reproduction by its enforcement of habits, routine characteristics of interaction and organization. This Thirdness-as-Firstness process sets up a prototype model, an "association by resemblance" (Peirce 1.383) to provide a normative overview which acts to inhibit random interactions. The generation of normative habits in this zone is a features-extraction top-down process. This cohesive memory, a statistical probability, constrains instances by its exclusion of the marginal instances from its normalizing template. Essentially, this overview collapses or crumples discreteness into a flat generality. A question to answer is — does this cohesive process require a human agent as its collator and enforcer? The answer is, no, for a process such as natural selection achieves the same result, with its focus on the average and its indifference to the marginal. What is missing from this particular process of generalization, this Thirdness-as-Firstness, is the ability to insert deviations into that cohesive normative set of habitual relations; that is, deviation is not incorporated into the cohesive ontology but is entropically dissipated. A codification that acknowledges only habitual relations, that rejects divergence, is unable to evolve that blueprint and accept entirely new entities. Evolution is not possible using codal relations that are only external.

These two classical mechanical forms of measurement, however, are vital. What they provide is, first, the integrity of mass, encoded in its crisp "thisness". These instances interact without knowledge of their identities beyond a physical attraction or repulsion. The cohesion, the normative glue that sets up the laws by which these discrete entities interact is, as noted Thirdness-as-Firstness [3-1], which is to say, it is an overview, a blueprint, a statistical average which flattens differentiation and ignores deviations. Given these two codifications of mass-as-particle and mass-as-blueprint, what can we conclude about this external realm? This realm operates with a clear separation of the two thermodynamic laws, that of conservation of mass and conservation of energy. The inert mass, the discrete entities, are going to increase the asymmetry between energy and mass because of the electromagnetic frictional property of avoidance. Entropy, a dissipation of mass to energy, will increase. How can the system deal with this? Second, the external mode of cohesion acts as a "negative habit" (Peirce 1.390), where the law, that statistical average, will forget and flatten (by ignoring its relevance) peripheral behaviour. These two negative relations increase the asymmetry of the energy-to-mass ratio and the system will struggle to rehabilitate itself, it will dissipate as much energy as it can to decrease this asymmetry, reduce uncertainty and attempt to increase its mass. The escalating entropic release of energy by the external zone could be called "the principle of forgetfulness" (Peirce 1.399), for it is here that the external realm actually loses its rigidity, its closures, its self-absorbed isolation. It begins to "dissolve in doubt" and works rapidly to resolve this fuzziness by, as noted, increased reproduction of its mass-to-mass by rapid regeneration and an increase in diversity of mass forms. It's a relentless battle. However, the external realm's battle between the two laws of thermodynamics is assisted by the internal realm.

The internal zone

Internal measurements, which take place within a unity, cannot use the same semiosic measurements that are used by the external realm, for those measurements refer to singularities and pluralities, which are collections of singulars. Internal measurements operate within the processes of quantum theory.[2] This zone is richer in relations than the external zone for, as noted, an identifying factor of the internal realm is the lack of singularities, of mass encoded as inert in Secondness-as-Secondness [2-2]. Energy is operating, in the internal realm, within a complex entanglement of relations rather than the Newtonian electromagnetic attrraction-repulsion between discrete particles of mass. There are three types of measurement and therefore, three types of relations: two are analog, Firstness-as-Firstness [1-1], Secondness-as-Firstness [2-1] and the digital is Thirdness-as-Secondness [3-2].

The first action of codification is an inclusive sweeping "take-all" gathering of energy, a relation that establishes this internal unity, within the code of pure Firstness-as-Firstness [1-1] as a state, "not an event, a happening, a coming to pass" (Peirce 1.307) but a pure state "which is in its entirety in every moment of time as long as it endures" (Peirce 1.307). This sets up an iconic codification of inclusion that accepts as simultaneous in space and time all forms of mass/energy. As noted, in the internal realm, energy and mass are not distinct, but are transformative versions of each other. Mass could, theoretically, stay this way in an eternal mist of cosmic energy/mass potentiality. The reason it does not do so is because the first ontological cut has established an asymmetry of energy properties in our universe, an asymmetry between mass and energy, and this has resulted in a dyadic reality of external and internal realms. Because of this complementary

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[2] This includes quantum field theory and quantum mechanics.

co-existence of energy/mass as both external and internal, the internal energy/mass will be contextualized, its properties will "be conceived in a relational way as they depend on a changing material context" (Kampis 1994: 103). That is, the internal energy/mass *must* be moved into an external existence as inert mass, distinct from kinetic energy, because of the co-existence of the external realm. How do the two realms meet?[3] The second codification in the internal zone is a borderline, a membrane codification, one that operates as the mediation between the internal and external zones. This borderline measurement, an absolutely vital process, has properties that are external, i.e., Secondness, and properties that are internal, i.e., Firstness. It is an action of Secondness-as-Firstness [2-1] and operates as a mode of prescission, a highly charged force of attraction, which focuses "attention to one element and neglect of another" (Peirce 1.549). It operates as an attractor funnel, ready to attract, bond and confine itself within the precise existent codes of the external realm and yet also exploratory due to its internal vagueness. We can certainly say, because of this indexical link with the external realm, that this borderline codal process will also be affected, in some way, by the external cohesive central tendency of Thirdness-as-Firstness [3-1] as well the internal cohesive codal properties of Thirdness-as Secondess [3-2]. It is probably one of the key codal relations.

As for the internal synchronic code, we find that it operates by a process very different from the external cohesive process. Mass, in both its vague amorphous forms of 1-1 and 2-1 is not stabilized by being transformed to inert mass, with crisp forms referenced to that "higher-being" representational codal system as found within classical mechanical codification, but is stabilized by being actually physically linked, as mass/energy, as a network of plastic relations encoded as Thirdness-as-Secondness [3-2]. These relations operate as an indexical rather than a metastatistical intentionality of synchronicity. Internal synchronic continuity sets up a network of physical relations that link each mass-energy interaction to another mass-energy interaction. As we saw, within the external zone, Thirdness acts as a normalizing memory, a judgmental descriptive agent, rejecting and effectively starving deviants into dissipation. Internally, Thirdness is holistically

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[3] A key means of enabling internal and external co-existence is by means of temporal disparities; that is, the codifications take place in different modes of time (See Matsuno 1998).

inclusive, physically linking without discrimination or judgment all and every action of codification. In this internal zone there is no such thing as the peripheral and the irrelevant, no such thing as true or false. They are all "part of the operative community". Unlike the external, it cannot dissipate energy outside its boundaries. Internal wave/particle processes may reduce to less complex forms but they remain within the holistic network. Without the capacity for discrimination, it cannot select its future and therefore it too, like the external, is unable to evolve.

The complex semiosic architecture

There are therefore, two realms by means of which energy is measured as mass or what we may consider "informed mass", i.e., information. The external classical mechanics measures energy to mass within a process that views matter and energy as two realities, and references the bits of matter to an abstract template that describes and thereby constrains how these bits interact. The functional units are the singular unit (along with kinetic force) and a developed blueprint of the "most common" of these collective instances. The capacity of this external zone of measurement to provide a predictive stability, to "describe all natural phenomena in terms of simple forces between unalterable objects" (Einstein, Infeld 1961: 54) is unparalleled. However, we are well aware that the mechanical view is incomplete. The internal quantum process sets up an inclusive network of emotive ties but is incapable of providing analysis or reflexion on these processes. The functional units are amorphous excitations and a spatial pattern of the actions of these excitations that spreads across a field, i.e., the functional units are a spatially distributed activity pattern, not the individual instance or the number of instances. The capacity of the internal zone of measurement for inclusive acceptance of all variations is equally unparalleled.

These two realities, the external and internal zones, are antithetical to each other. How does one deal with contradictory worlds? Some have rejected the one in favour of the other. One level is real and the other a figment of our imagination — and which is the real and which the fictive has been a matter of intense debate, whether between the symbolists and connectionists in artificial intelligence or the modernists and postmodernists in social theory. What if, rather than the one or the other of these zones, we postulate that our world necessarily requires both? How can we have one world operating with processes that are contradictory to each other?

The solution to the "problem" of the two worlds may be an endorsement of both their differential separation along with their associative filiation. Together and only together, they provide the capacities for a generative and exploratory transformation of energy to mass, creating closures as actual "bits" of informed, i.e., contextualized mass, dissolving these closures and generating new closures, not haphazardly, but within the workings of an exploratory and evolutionary logic and pragmaticism. If we accept that "the emergence process is itself the result of the binding of two dynamical regimes, the endo-regime which is synergetic in nature, and the exo-regime of complex interactions" (Farre 1998: 685), then, we must both insist on and aggressively research the nature of this binding. What new understandings would be required to break with the established view which sees these two worlds as separate and non-dialogical? We advocate an architecture somewhat like a Möbius strip, where the boundaries of these two realities or worlds are filiated, as in a double-helix, without denigrating the integrity of each string. The external provides relations that generate discrete entities and a cohesive metareference that focuses on the strengths of the majority and dissipates the nonessential. The internal provides relations that promote expansion and exploration and a cohesive network that enables an unrestricted inclusion of all variations. What is of interest is that the external becomes another system's internal; the internal becomes another system's external. This means that the external and internal, the classical and quantum, are not exclusionary but are co-existent.

Additionally, this architecture operates within a world made up of three different semiotic realms, the physico-chemical, the biological and the socioconceptual (Taborsky 1999). Each realm operates within both ontological and epistemological cuts and, at the least, five different modes of codification operate within each realm within a constant dialogical discourse. This means that, in total, we will have a complex "buzz" of semiotic complexity within the cosmos. In the physico-chemical realm, the codal relations are primarily iconic and therefore encodements are unable to clearly differentiate type from token, or template from instance. The physico-chemical realm operates smoothly, with limited temporal or spatial gaps. This enables a universal spread of these physico-chemical properties but prevents variation and evolution. In the biological realm, the codal relations are predominantly indexical, and therefore, tokens are variations of types. Temporal and spatial gaps appear. This enables the biological realm to produce diversity and variations according to the local ecology and evolution, as historic irreversibility, appears. In the socioconceptual realm, the relations are symbolic and the tokens are metaphors of the types. This enables the social realm to create its own types and tokens, its own relations, and permits an explosion of innovation, while at the same time, it inserts the requirement of conscious and ethical choice.

There is one further mode of codification that we have so far neglected, and that is pure Thirdness, genuine Thirdness-as-Thirdness [3-3]. Does it exist? “There is no absolute third, for the third is of its own nature relative” (Peirce 1.362). I see this as pure mind, without mass. However, pure mind does not exist per se but as a cohesive logic of relations, a force of mediative attraction focused on the future and on final causality. Pure Thirdness is Final Cause, a “sense of learning” (Peirce 1.387). The community of users will acknowledge that its analog instances will of necessity “be pragmatic”; that is, they will be “ethical”, they will be “right” over time. This also means that the community acknowledges that there is no final state for the world is constantly collaboratively both “flexing its muscles” and interpreting the ethical feasibility of its actions.

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Энергия и эволюционный семиозис

В статье ставится гипотеза о массе как о кодированной энергии. Соответствующий процесс превращения рассматривается как семиозисное действие интерпретации. Семозисное влияние анализируется в пяти “предикатах” или “вербальных типах”, которые создают разные процессы превращения или интерпретации. Эти являющиеся знаковыми процессами “типы предикатов” имеют место в разных ареалах реальности, как во внешнем, так и во внутренном. Внешний ареал состоит из дискретных объектов и связях между ними. Происходящие там процессы изучает классическая механика, и в данной статье отмечается их уникальная семиозисная кодифицированность. Внутреннее пространство является холистической внутренной перспективой, в которой не различаются дискретные объекты. Эти процессы изучаются в рамках понятий кванта и поля, и в этих процессах также отмечается их уникальная семиозисная кодифицированность. Вместо предпочтения одной части другой в качестве единственной интерпретации реальности, в данной статье советуют рассматривать как внешние так и внутренние процессы энерги/массы в качестве необходимых составных универсума.

Energia ja evolutsiooniline semioos

Artiklis püstitatakse mõtteeksperiment, mis vaatleb massi kui kodeeritud energiat. Vastavat muundumisprotsessi käsitletakse kui semioosilist mõju — interpretatsiooni. Semioosilist mõju analüüsitakse viies “predikaadis” või “verbaalses tüübis”, mis loovad erinevaid muundumisprotsesse või interpretatsioone. Need märgiprotsessideks olevad “predikaadi tüübid” leiavad aset reaalsuse erinevatel aladel, nii sisemises kui välimises alas. Väline ala koosneb diskreetsetest objektidest ja nendevahelisest seostest. Sealseid protsesse uurib klassikaline mehhaanika, millele käesolev artikkel omistab neile omase unikaalse semioosilise kodeerituse. Sisemine ruum on holistlik siseperspektiiv, milles diskreetseid objekte ei eristata. Neid protsesse uuritakse kvandi ja välja mõistete raames ja käesolev artikkel näeb ka neis unikaalset semioosilist kodeeritust. Selle asemel, et eelistada üht või teist ala kui reaalsuse ainukehtivat interpretatsiooni, soovitab käesolev artikkel nii väliseid kui sisemisi energia-massi protsesse käsitleda universumi vajalike koostisosadena.

Sign Systems Studies 30.1, 2002

Obituary: Thomas A. Sebeok

November 9, 1920 – December 21, 2001

Jesper Hoffmeyer[1]

Thomas Albert Sebeok, Distinguished Professor Emeritus of Anthropology, of Linguistics, of Semiotics, and of Central Asian Studies at Indiana University, Bloomington, was born on November 9, 1920, in Budapest, Hungary, and died peacefully at his home in Bloomington, Indiana, on December 21. The *oeuvre* of Sebeok comprises more than 600 articles and books[2] and reaches far outside the core discipline of general semiotics, which he himself pioneered.

In the context of the present volume the most overwhelming and epoch-making achievement of Sebeok's work was his creation of the new field of biosemiotics. And, at least according to George Vlahakis, Sebeok was also himself "most proud to having brought into being a group of theoretical biologists and semioticians to pursue this field of investigation [biosemiotics]".[3]

Sebeok's life was decisively influenced by the second world war. He left Hungary in 1936 to study at Magdalene College, Cambridge University, and his father advised him not to return to Budapest. Instead he immigrated to USA in 1937 and only after the war he learned that his whole family had been destroyed. Sebeok became a citizen of the US in 1944. He earned a bachelor's degree at the University of Chicago in 1941 and a master's degree in 1943 and doctorate in 1945 at Princeton University.

Sebeok's connection to Indiana University started in 1943 when he began work in the Army Specialized Training Program in foreign languages, which after a while he directed himself. He then created Indiana University's renowned Department of Uralic and Altaic Studies. He was offered the

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[2] Sebeok's bibliography has been published in Deely 1995.

[3] In the Obituary, distributed by Indiana University, Bloomington, Dec. 21, 2001.

directorship of the *Research Center for Anthropology, Folklore, and Linguistics*, which would later (in 1956) be transformed into the famous *Research Center for Language and Semiotic Studies* (RCLSS). For 35 years RCLSS remained one of the most influential academic institutions in the world of semiotics, with Thomas A. Sebeok as its Director.

All of this was little known to me when I first met Sebeok at a meeting on psycho-neuro-immunology in 1990 in the little village Tutzing in the neighbourhood of München. As I would later learn Sebeok nourished a lifelong interest in biology, and kept a huge library on subjects related to animal communication. As early as 1963 he had coined the term zoosemiotics signifying that semiotic branch concerned with the study of animal sign use, and in 1976 he observed that ethology is "hardly more than a special case of diachronic semiotics" (Sebeok 1985 [1976]): 156). This interest in life science also brought him to the work of Jakob von Uexküll, whom, as he often told, he had first read in an awful English translation. His suspicion that the translator rather than the author was to blame was confirmed as soon as he got his hands on J. v. Uexküll's own writings in German language. Sebeok successively spent much effort to reintroduce this "neglected figure in the history of semiotics" (Sebeok 1979: 187) and to produce better English versions of Uexküll's work (Uexküll 1982, 1992). This also brought him his friendship with Jakob von Uexküll's son, Thure von Uexküll, then still a professor in medicine at Ulm University.

Shortly before the day I met these two, each in his own way, stately men for the first time, I had managed to start the publication of a new magazine in Danish language by the name *OMverden*, which is a literal translation of the German term Umwelt, meaning simply surroundings. Obviously, this name was meant to allude to the particular sense given to the term Umwelt by Jakob von Uexküll, and I had sent a copy of the first issue of the magazine to T. v. Uexküll. Now, among the hundreds of participants arriving at the reception for the psycho-neuro-immunology conference in Tutzing I easily spotted Sebeok in the company of Uexküll who carried the title page of *OMverden* very visible in his jacket.

I think this meeting signalled the beginning of a new phase in the creation of biosemiotics as a scientific field. And again, as in several other cross-disciplinary endeavours, Sebeok's skills not only as a creative originator but also as the natural centre for a wide communicative network of people with very different backgrounds, was absolutely essential for the development which followed from this event. Although the meeting in Tutzing was of course in itself very interesting from a semiotic point of view, I guess it was perhaps more or less a pretext for bringing us all to southern Germany. The real formative event for the biosemiotics field was rather the meeting organized by Jörg Hermann in Glotterbad, a psycho-somatic clinic situated in the northern fringes of the Schwartzwald mountains, which took place immediately after the Tutzing meeting. Present at this occasion was a number of medical doctors, biologists and semioticians. A new meeting was summoned the next year and I think these early Glotterbad meetings were perhaps especially important because they left an impression on everybody that biosemiotics was now for real.

Still, the rapid growth of the biosemiotics field throughout the next decade would not have been possible without Sebeok's relentless support and engagement. As the co-editor (with his wife Jean Umiker-Sebeok) of the yearbook *The Semiotic Web* he was responsible for the first volume dedicated solely to biosemiotics, and as the editor in chief of *Semiotica* he not only was able to assure the publication of high quality biosemiotics papers but he also made it possible to publish a special issue (actually a whole volume) on biosemiotics followed by a volume on the legacy from Jakob von Uexküll (Hoffmeyer, Emmeche 1999; Kull 2001; Sebeok, Umiker-Sebeok 1992). 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 mechanism released more or less automatically in academia whenever somebody attempts crossing the Cartesian divide.

But perhaps Sebeok's importance for the development of modern biosemiotics was played out most significantly behind the scene. At the occasion of the American Semiotic Society's 25th annual meeting at Purdue University October 2000, titled *Sebeok's Century*, John Deely held the inaugural speech in which he put it very precisely when he said: "Sebeok not only uses the internet, he *is* the internet" (quoted by memory). Sebeok would answer your e-mails, often within a few minutes, and at nearly all times day or night. I remember sending him an e-mail at 10 a.m. in Denmark, which was answered half an hour later, i.e. 3.30 Indiana time. Since everybody I have talked to tell similar stories, the burden of his communicative effort must have been enormous. It's hard to imagine anybody to take over this essential component of Sebeok's heritage, and I am afraid the only thing one can suggest is that we all try to seriously upgrade our communicative efforts.

One could not stay close to Sebeok without becoming impressed by the remarkable force of his intellect, the intensity of his commitment, and his all-embracing knowledge and humour. The spring of anecdotes which spiced his talks seemed inexhaustible. But perhaps most impressive of all was the glimpses of warmth which were never far away. To have known his friendship is one of the dearest thing in my life.

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