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What Does it Take to Produce Interpretation? Informational, Peircean and Code-Semiotic Views on Biosemiotics

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Abstract This paper presents a critical analysis of code-semiotics, which we see as the latest attempt to create paradigmatic foundation for solving the question of the emergence of life and consciousness. We view code semiotics as a an attempt to revise the empirical scientific Darwinian paradigm, and to go beyond the complex systems, emergence, self-organization, and informational paradigms, and also the selfish gene theory of Dawkins and the Peircean pragmaticist semiotic theory built on the simultaneous types of evolution. As such it is a new and bold attempt to use semiotics to solve the problems created by the evolutionary paradigm's commitment to produce a theory of how to connect the two sides of the Cartesian dualistic view of physical reality and consciousness in a consistent way.

Keywords Information · Codes · Interpretation · Emergence · Complex systems · Evolution · Consciousness · Peirce semiotics · Biosemiotics

Introduction

As biosemiotics is trying to finish building its disciplinary matrix, it becomes clear that there are not only disagreements about what are the basic demands for a system to produce signification, but there are also disagreements about what living systems'

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ontological positions in the world are, especially if you view biosemiotics as a step in the formulation of a general theory of life, consciousness and culture. There seems to be differences in philosophical frameworks especially in the stipulation of ontology and epistemology of mind and meaning and their relational interdependence in an evolutionary framework. This is not surprising because since Descartes made a dualistic foundation for science, the problem of animal mind has been crucial. The acceptance of evolutionary theory has only accentuated the problem, as we now see our own mind and culture as a product of nature.

It has therefore become a crucial question as to whether it is possible to develop a transdisciplinary framework where a scientific theory of nature and a phenomenological-hermeneutic theory of interpretation and meaning can be integrated with an evolutionary theory of levels of semiosis. The major scientific trend is to develop monistic theories of evolution and emergence either of complex self organizing material systems, or to shift to an all-encompassing "information science" as the ontological basis. The latter has been the foundation for the development of nearly all encompassing cognitive sciences, including brain and behavioral sciences. Attempts to get contact with the experiential level of consciousness through some kind of naturalization of phenomenology still leaves us not ready to take the full paradigmatic consequences of such a move. The result is a rather inconsistent paradigm.

The biosemioticians who hope that Peircean pragmatic semiotics can act as a new and sufficient paradigmatic framework have to face his three categories and "phaneroscopic"[1]ontology of emptiness, combined with his hylozoist view of matter and mind and his Agapistic integrative view of science and religion. A major problem for many scientists is that Peirce brings mind and consciousness into his basic metaphysics as the pure feeling of Firstness. This leads to serious clashes with the received view of science based either on an energetic, a materialistic, or an informational ontology, which in turn all have the problem of making the subject a mystery. A combination of the paradigm of emergent organicism (Emmeche 2001) and theories of complex adaptive systems has been attempted by some to be integrated into a modern substitute for Peirce's ontology. The problem is that first person consciousness does not seem possible to explain from these non-Peircean paradigms other than an emergent phenomenon in a material-energetic-informational world. Thus the question is raised again: what can an ontology that supports the development of consciousness, signification, and communication be like?

Others want to stay clear of interpretation as a necessary condition for any kind of semiotics in the stages of life before the developments of central nervous systems.

[1] Phaneroscophy is Peirce's version of phenomenology and is different from Husserl's and result in that different paradigms of semiotics are built on them. Randsdell (1989/1997), Hauser (2010), Brier (2011a, b), Spiegelberg (1965, pp.18-19). The phaneron is defined in Peirce's 'Adirondack Lectures' of 1905 in the following way:

> Phaneroscopy is the description of the phaneron; and by the phaneron I mean the collective total of all that is in any way or in any sense present to the mind, quite regardless of whether it corresponds to any real thing or not. If you ask present when, and to whose mind, I reply that I leave these questions unanswered, never having entertained a doubt that those features of the phaneron that I have found in my mind are present at all times and to all minds. So far as I have developed this science of phaneroscopy, it is occupied with the formal elements of the phaneron. *(Peirce CP 1.284)*

They claim that information and meaning exists independent of interpretation on the level of cells and organs as well as organisms on that level of complexity. A new paradigm by the name of "code-semiotics" has been proposed from the level of the free-living cells up to brain level leading up to conscious embodied psyches.

Our interpretation is that the code model develops a non-Peircean functionalistic process concept of meaning, avoiding the concept of interpretation at the cellular level and in all systems that do not build representations of the world through a nervous system producing awareness and intentionality. Code biosemiotics is a school of thought where meaning is defined by coding, which is neither interpretation itself, nor implies the presence of interpretation or interpreters. On this view, semiosis came into existence with the genetic code, at the very origin of life. But beyond semiosis, interpretation further requires internal representations of the world, and is present probably only in animals with a central nervous system with the ability to build them. In a recent paper Barbieri (2011) explains consciousness as a result of the nervous system's new codes making it possible to create the Peircean concept of semiosis from that level and up. But Peircean semiotics is a total transdisciplinary paradigm of cognition and communication with a special ontology that makes the triadic semiosis possible. Can that really be done on an ontology that combines a physicochemical ontology with code-semiotics? The question is not only one of consistency and the demands of what an explanation is, but also what kind of Wissenschaft[2] is, can, or should biosemiotics be?

The Paradigm of Code-Semiotics

Code-semiotic's first level, has been proposed for the free-living cells, and in particular for the cells that appeared in the first three billion years of evolution. According to the two most prominent other paradigms of semiotics (the Saussurian and the Peircean), there cannot be signification without interpretation. But according to the Code model, system in the history of life was the apparatus of protein synthesis (the ribotype), and that apparatus does not need interpretation or interpreters.

More precisely, a semiotic system is defined as a set of signs and meanings linked by the conventions of a code. Signs, meanings and conventions, however, do not come into existence of their own. There is always an "agent" that produces them, and that agent can be referred to as a "codemaker" because it is always an act of coding that gives origin to semiosis. The first agents of life (the first codemakers) were independent of mind and subjectivity, but were nevertheless "creative", because they created a world of proteins that could not exist without a genetic code.

The Code model states that the necessary and sufficient conditions for semiosis is that A provides a conventional association between B and C, where A is a set of adaptors and B and C are the objects of two independent worlds. Thus a semiotic system is a triad of signs, meanings and code that are all produced by the same agent, i.e., by the same codemaker.

[2] We employ the concept of Wissenschaft here instead of science, as the German concept encompasses natural as well as social science and the humanities.

On this view, codes work in delimited environments in opposition to universal natural laws. The first semiotic system in the history of the evolution of life was thus the apparatus of protein synthesis (the ribotype). The interplay between DNA, RNA, enzymes, and amino acids does not need interpretation: the argument is that since the rules of the genetic code are virtually the same in all living systems, there is no room for the interpretation of code tokens in different contexts.

A semiotic system is here defined as a triadic set of processes and objects linked by a code. But this is not triadic in the Peircean sense, since the metaphysics does not entail his three categories a phaneroscopic view plus synechism and hylozoism. But the necessary environment and connections only exist inside membranes and context of the cell. Through the coding process amino acids are combined inside the cell in ways that never happen outside the cell (Barbieri 2009).

Semiosis appeared therefore at the origin of life, whereas mind and interpretation came much later. The Code model starts with a definition of semiosis that does not require interpreting minds, but describes an evolution of semiosis that eventually gave rise to mind and interpretation. The emergence of mind was associated with the origin of a third type of semiosis which is called "interpretive" semiosis (like the Peircean type), but remained also dependent on the first two types (manufacturing and signalling semiosis). Thus mind did first emerge at a very high hierarchical level, in sharp contrast with the hylozoic ontology of Peirce's semiotics. Interpretation is regarded as a process that depends primarily on representations, in addition to memory and learning, and its origin is linked to the origin of perceptions and feelings, i.e., to the origin of subjectivity and mind.

A major point of this view of life is that the living cells are built out of proteins that in a certain way are "artificial" (Barbieri 2011). Coding creates new molecular "artifacts" that are special for cells and create the material basis for the living processes. It is important to realize that in Barbieri's view, code-semiosis precedes sign semiosis in the Peircean sense, because it is based on an empirical materialist monistic and maybe even dualistic view of science[3] opposed to the phenomenological or rather phaneroscopic non-dualistic view of Peircean semiotics.

In Peirce's phaneroscopic point of view an entity is regarded as a (triadic) sign, and therefore not falling into this or that metaphysical category of dualism, where anything sense-perceived must be regarded as either "physical" or "mental". Since anything can be a sign, the sign category is prior to any categorization into physical or mental, and signs are differentiations of sense. As all signs are triadic, there is no need of other kinds of categorization prior to the recognition or interpretation of a sign (Randsdell 1998). One of the main difficulties that the development of semiotics as the foundation of a general theory of knowledge is still facing is the resistance within the natural as well as the social sciences (Bertilsson 2009) and the humanities (Deely 2011) of a paradigm that goes beyond the traditional "two cultures", the nomothetic and the ideographic as well as the empirical quantitative versus the qualitative interpretative sciences.

Thus as Deely (2011, and many other places) argues, biosemiotics inspired by Jacob von Uexküll establishes a difference between the *Umwelt* and the *physical*

[3] We infer this, since this aspect is not clearly developed explicitly in Barbieri's paradigm yet.

world. It claims that we do not perceive *things* directly but always as an *object*, which is one of many sorts of signs. Thus we primarily live in an objective world, but not in a material thing-world or physical world. It is in the interpretation of the signs that we learn to distinguish between *things* and *objects*. Our *Umwelt* of *objects* thus constitutes a link between the physical world of *things* and what Uexküll called the *Innenwelt* of sensation and perception. Thus to Deely in his interpretation of Peirce and Sebeok *pure objectivity* is only obtained by working primarily with the signs, before analyzing the "outer" objects and the "inner" feelings and sensations. Thus the objective world is not to be identified with the physical world as such; it also includes the subjective and social or intersubjective. This paradigm is fundamentally different from the code-semiotics Barbieri works to establish.

The "Grand Story" of Code-Semiotics

The *interpretive semiosis* of code semiotics looks a bit Peircean, but it is not built on his basic categories of hylozoism, tychism, synechism[4] and Agapism. It does take a long time to flesh out the Peircean ontology, which seems to defy the classifications we have developed so far, despite the fact that many researchers consider it a form of objective idealism. So it is not a surprise that Barbieri's ontology is difficult to estimate from his writings so far. But in his article in the present issue, he clearly declares that his ontology is not informational, neither computational, nor cybernetic or even systemic**.** It is a new paradigm in it's own right.

In code-semiotics interpretation is regarded as a process that requires representations, memory and learning, and its origin is linked to the origin of perceptions, feelings, consciousness and qualia. In code-semiotics a subject is an interpreter, not an interpretant. In contrast, in Peirce's semiotics *objectively* seen, the subject is a symbol and the universe a large argument, which we are still working on our interpretation of. But the

[4] Tychism and synechism are two fundamental paradigmatic concepts in Peirce's semiotics. He writes most basically that tycishm is "… absolute chance – pure tychism …" (CP 6.322, c. 1909). So Tychism is connected to firstnes as real object chance in the universe: "… Tychism, or the doctrine that absolute chance is a factor of the universe." (CP 6.201, 1898). But that has to be integrated with the Secondness of resistance, facts and individuality to create Thirdness to mediate connections between the two in synechism. This is connected to his pragmatism; "It is that synthesis of tychism and of pragmatism for which I long ago proposed the name, Synechism." (CP 4.584, 1906). He explains synechism as a basic philosophical principle the following way" …that tendency of philosophical thought which insists upon the idea of continuity as of prime importance in philosophy and, in particular, upon the necessity of hypotheses involving true continuity." (CP 6.169, 1902) This deep connection between everything, including mind and matter he calls synechism. He sums it up in the following quote: "Permit me further to say that I object to having my metaphysical system as a whole called Tychism. For although tychism does enter into it, it only enters as subsidiary to that which is really, as I regard it, the characteristic of my doctrine, namely, that I chiefly insist upon continuity, or Thirdness, and, in order to secure to thirdness its really commanding function, I find it indispensable fully [to] recognize that it is a third, and that Firstness, or chance, and Secondness, or Brute reaction, are other elements, without the independence of which Thirdness would not have anything upon which to operate. Accordingly, I like to call my theory Synechism, because it rests on the study of continuity." (CP 6.202, 1898)

objective universe is bigger than the physical universe, because it includes our inner experiental world and the social intersubjective world. Peirce writes:

> ..that Universe being precisely an argument. In the little bit that you or I can make out of this huge demonstration, our perceptual judgments are the premises for us and these perceptual judgments have icons as their predicates, in which icons Qualities are immediately presented. But what is first for us is not first in nature. The premises of Nature's own process are all the independent uncaused elements of facts that go to make up the variety of nature which the necessitarian supposes to have been all in existence from the foundation of the world, but which the Tychist supposes are continually receiving new accretions. These premises of nature, however, though they are not the perceptual facts that are premises to us, nevertheless must resemble them in being premises. We can only imagine what they are by comparing them with the premises for us. As premises they must involve Qualities.
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> Peirce: CP 5.315-317.

In Barbieri's theory the connections between sensory inputs and motor outputs in the first animals were probably simple nerve-reflex arcs, but these could not evolve much because complex hard-wired circuits were necessarily slow and cumbersome. Thus, to progress beyond this towards greater flexibility and ability to understand immediate contexts the animals had to "invent" a new solution of *signal-processing*. Barbieri is here using informational and computational concepts for the pre-conscious brain's processes. His theoretical explanation of the evolutionary leap of life towards consciousness is that the only way to get above this situation is similar to that from matter to life, that is to manufacture new objects by the way of a new code. Thus he avoids the muddled concept of emergence and substitutes it with the production of new artificial entities, new artefacts. This time the entities are not new code *molecules* that are the basis for life in his theory, but rather feelings and awareness. His theory is that this was possible because the neurons of the intermediate brain are natural "adaptors" (they perform two independent recognition processes), so they were already suited to generate a code. The new "objects" that central nervous systems were able to produce were representations and feelings, and subjectivity was the overall result of this process, because one is a "subject" only when it has access to an internal world of its own making. This will also according to Barbieri show the way to the understanding of the origin of language in the brain. In the abstract of Barbieri (2010) he sums the idea up nicely:

> Thomas Sebeok and Noam Chomsky are the acknowledged founding fathers of two research fields which are known respectively as Biosemiotics and Biolinguistics and which have been developed in parallel during the past 50 years. Both fields claim that language has biological roots and must be studied as a natural phenomenon, thus bringing to an end the old divide between nature and culture. …They both regard language as a faculty, or a modelling system, that appeared rapidly in the history of life and probably evolved as an exaptation from previous animal systems. Both accept that the fundamental characteristic of language is recursion, the ability to generate an unlimited number of structures from a finite set of elements…). Both accept that human beings are born with a predisposition

> to acquire language in a few years and without apparent efforts ….. A convergence of the two fields does require a few basic readjustments in each of them, but leads to a unified framework that keeps the best of both disciplines and is in agreement with the experimental evidence. … such a framework suggests immediately a new approach to the origin of language… it suggests that the brain wiring processes that take place in all phases of human ontogenesis … are based on organic codes, and it is the step-by-step appearance of these brain-wiring codes, in a condition that is referred to as cerebra bifida, that holds the key to the origin of language.

So what is explained here in the code-semiotic paradigm is the production of the "innenwelt" with Uexküll's terms as the basis of the development of language, but not the *Umwelt* or the life world with Husserlian terms, because the life world is the objective worlds of signs (Deely 2009), before they are assigned to belong to an inner or an outer world. The objective world of Peircean semiotics is pre-dualistic. But we now have the interesting situation that a dualistic or materialistic monistic theory claims to have produced a theory that explains how Umwelts (or, as Uexküll did not have a Peircean evolutionary foundation, we call them *signification spheres*) are possible. This is of course done from the researcher's own Umwelt, and his sharing of that with other researchers through language and interpretation of the results of the measurement of instruments. So there is a seeming paradox here in making a scientific theory to explain how we can produce scientific knowledge including language!

What is Language?

Now we have the problem that there are many views on what language is. There are at least three main angles on language:

1. The first definition sees language as a mental faculty allowing humans to undertake linguistic behaviour. This stresses the universality of language to all humans and the biological basis of the human capacity for language as a unique development of the human brain. Thus language is understood mostly to be innate, for example as in Chomsky's theory of Universal Grammar or Jerry Fodor's (1981) extreme innatist language of mind theory. These kinds of definitions are often used within cognitive science frameworks and in neuro-linguistics.
2. The second view sees language as a formal system of symbols governed by grammatical rules combining particular signs with particular meanings. This definition stresses the fact that human languages can be described as closed structural systems consisting of rules that relate particular signs to particular meanings, without addressing any truth claims about the empirical world. Such a structuralist view of language was first introduced by the father of semiology, namely Ferdinand de Saussure. The structuralist viewpoint is commonly used in formal logic, semiotics, and in formal and structural theories of grammar, the most commonly used theoretical frameworks in linguistic description. In the philosophy of language these views are associated with philosophers such as Bertrand Russell, early Wittgenstein, Alfred Tarski and Gottlob Frege.

3. The third view sees language as a system of communication that enables humans to cooperate. It stresses the social functions of language and the fact that humans use it to express themselves and to manipulate objects in their environment. This view of language is associated with the study of language in a functional or pragmatic framework, as well as in socio-linguistics and linguistic anthropology. In the philosophy of language these views are often associated with Wittgenstein's later works and with ordinary language philosophers such as G. E. Moore, Paul Grice (1957), John Searle (1970) and J. L. Austin.

Barbieri is basing his theory on a blend of the first and second view and thereby avoiding that pragmatic discourse view, which grounds Peirce's phaneroscopic pragmaticist view of meaning.

What is a Code?

Our general project in this issue is how to understand the interaction of information theoretical and semiotic concepts in the context of the foundations of biosemiotics. Thus understanding the primary concepts around coding and interpretation in information systems is essential. So let us ask, how are we best to understand the interacting issues of codes and interpretation in a broader scientific context? And what will the implications then be for our understanding of Code Semiotics?

Let us first consider the general properties of codes as generally understood. When definitions of "code" are sought, we find results from scientific disciplines like information theory, electrical engineering, digital communication, and mathematics, as well as computer science. Here a code is a set of symbols for representing something. For example, most computers use ASCII codes to represent characters. The code that a programmer writes is called source code. After it has been compiled, it is called object code. Code that is ready to run is called executable code or machine code. Codes are sets of specific rules or transformations where messages, signals or states of the world are converted from one sort or form of representation to another, including sometimes one medium of energy to another, or one physical state to another. But overall, coding refers to the conversion of one type of information to another. A code is thereby an organized system of signs. Codes are the rules and conventions about how those signs are combined, and how they relate to each other.

So we can take a "code" to be a mapping from one set of phenomena (which we can (perhaps provocatively) call signs) to another (called meanings): a particular codon is mapped to a particular amino acid; a '1' bit moves the switch to the "up" position; "Barack" is mapped to the current president of the US; an organism is drawn to the smell of food. But what is essential about codes, indeed, what distinguishes them from other kinds of regularities, is that codes are *conventional*. This means arbitrary or contingent, or just generally not necessary, at some level of analysis (some scalar level). In other words, the regularities, the mappings, embodied in a particular coding relation *could have been otherwise:* the President's mother could have named him Edgar. But, on the other hand, once selected, the fact that a code is a conventional *mapping* means that there is also determinism, and thus necessity, although at another level of analysis (a finer-grained level). Thus, it doesn't matter *which* codons are mapped to *which*

amino acids, or bit values to switch positions, or names to people, or smells to attraction or repulsion, or signs to meanings; but *once* selected, then *when the code is being followed* (which it may not always be), then *necessarily* the sign must be *taken* as its meaning.[5]

This is the inherent duality of semiotic systems, which we can map to Pattee's epistemic cut (see this issue): from the *outside*, the code is arbitrary; but from the *inside* (that is, when it is being followed), it is necessary. This is what makes a code a code, and distinguishes it from other regularities found in the world, which are necessary, and not contingent, mappings among phenomena. Indeed, this is what distinguishes *natural* meaning (as for Grice (1957), "smoke means fire"), from *semiotic* meaning ("red means stop").

So in communications, a code is a rule for converting a piece of information into another form or representation, which is not necessarily of the same type. Moreover, *encoding* is the process by which information from a source is converted into symbols to be communicated, while *decoding* is the reverse process, converting these code symbols back into information understandable by a receiver. Encoding (in cognition) is a basic perceptual process of interpreting incoming stimuli. Information science and cognitive science attempts to start from a place other than semiotics, in that it postulates that information and coding is independent of life and semiosis, that it works on an objective materialistic ontology without presuming mind or consciousness.

Some codes, like names and computer switches, are something a conscious intelligent being with agency designs with a purpose. Other codes, like natural languages, are constructed by communities over historical time. But some codes, like neural processes, cell-signaling hormones, and the genetic code, are constructed by evolutionary processes. Not only are these codes not consciously constructed, they can work on the physio-chemical level without conscious interpretation and implementation from an ontologically higher level of complexity and organization, which would otherwise normally require a central nervous system. But in code semiotics, molecules are the code makers and therefore some kind of agency is transferred to them. But this is a non-mental functional agency. So what kind of theory is this then? Or what is its paradigmatic background?

We know that Barbieri claims that his paradigm is not cybernetically founded. First order Cybernetic information science works with differences and codes in a dualistic system outside the observer, without a triadic concept of signification. Maturana and Varela's (1980) and Maturana's (1983; 1988a; b) theory of autopoiesis and structural couplings is also an alternative to Peircean semiotics. But Barbieri does not use their paradigms and/or its development in a paradigm for both natural, psychological and social sciences as we see it in Luhmann (Brier 2008a) and in Peircean semiotics (Apel 1981) and Peircean biosemiotics (Brier 2008b) or in Cybersemiotics (Brier 2008a, 2011a,b,c; Brier 2001d).

The main idea in "code-semiotics" is that codes are simpler than signs and therefore can be said to be prior to signs evolutionarily. Signs demand representation as a prerequisite to function and the main theory is that this demands a nervous system, because interpretation demands an intentionality to interpret one sign in one way and

[5] For a more detailed discussion, see (Joslyn 2001).

another in another, and we have no minds without nervous systems. This is also the reason why Göran Sonnesson in his cognitive semiotics does not use a Peircean foundation. Sonnesson (2009) does not accept the use of Peirce's sign concept in pre-conscious or sub-conscious processes of direct perception of things and processes. Thus he bases the development of his semiotic conception, not on a Saussurian semiology, but on a European phenomenological foundation. Thus Code-semiotics may provide an evolutionary basis for Sonnesson's project, because in both biosemiotics and cognitive semiotics we are interested in how code emerges through evolution, exactly because they are as important for life as Barbieri describes.

What are Interpretation and Code-following?

As with codes in general, it is crucial that we explicate our sense of interpretation, since it is so significant to the foundations of all our argumentation, and indeed to the foundations of semiotics in general. The reflexive nature of this discourse is ironic, as semioticians argue, effectively, about the meaning of meaning. Also as semioticians, we aspire to both *abstraction* of symbols systems, meaning that we don't care what we call something (what symbol we attach to which meaning); and to *rigor*, meaning that we do need to define it, and then use it consistently thereafter. This is *itself* reflexively to act as a code-making semiotician, as we've seen above.

Above we also established that semiotics requires codes. The question is whether codes, in turn, require interpretation and interpreters.

We begin by considering more deeply the nature of the determinism present in coding systems, which we have established so far only to a first approximation. There are at least two objections to this view. First, it may be possible to establish a code as a stochastic mapping, where each sign could map to either of two meanings with a coin flip. But, as long as the distribution is stationary (constant in time), then the distribution of outcomes itself reflects the determinism of the coding relation, albeit over a higher-level state space. In the same way, Schrodinger's equation is actually a deterministic operator, it deterministically maps one wave function to another. While each wave function is itself a probability distribution, nonetheless the mapping is a deterministic one within the set of all probability distributions.

Second, it may be possible for a semiotic system to involve multiple codes, which can be selected by some agency. In other words, sometimes x means y_1, and sometimes x means y_2, depending on other factors present. But that doesn't make any individual code any less deterministic, only that there is some broader process or decision system in which these multiple codes are embedded, but which brings each individual code to bear as normal, based on the observation of either external observables ("red means stop when it's a stop light") or internal states ("red means go after stop because I'll be turning right").

Note that neither stochastic mappings nor decision systems imply neural or cognitive mechanisms. Indeed, the current wave of systems biology is exporting much of the switching machinery of cybernetics into the molecular mechanics of sub-cellular pathways (Hunter 2009).

So we have a machinery of signs and meanings, and a conventional code which we (for now) say establishes a deterministic mapping between them. There is a serious

problem of code creation, which, as we've noted above, code semiotics refers to some code-creating agent. But we also have other machinery, machinery which *manifests* or *actualizes* or *operationalizes* the code mapping. As examples, these can be molecular processes, which encounter a codon and append an amino acid; mechanical processes which read a register and throw a switch; neuro-motor processes which smell food and move towards it; neuro-cognitive processes which hear "cat" and create a mental image of one's pet.

We call this second batch of machinery "code following", and note that it necessarily occurs at a faster time-scale than code creation. Since the code is a (contingent) functional mapping, therefore code following manifests a deterministic relation in the world. One can think of a cognitive agent performing this function, as with the pet cat. But surely code following does not require a cognitive agent, since e.g. ribosomes (and not just ribosomes, but whole giant sequoia trees) follow the genetic code non-cognitively.

We can then crisply ask the questions: (1) what can "interpretation" mean, if it is not code following? And (2) what do code-semioticians call code following, since it's clearly not "interpretation"? We infer that the sense of interpretation intended by code semiotics, if it is not to be observed at the sub-neural level, must involve some form of *discrimination*, such that an interpreting system would examine a sign, and *decide* what it means. Or, it engages in some other form of cognition or computation in order to arrive at a meaning.

Let us call this sense of interpretation "discriminative interpretation", and ask how discriminative interpretation is functionally different from code following? As indicated above in the discussion of decision systems embodying multiple codes, unless such interpretation is truly random in some deep way (and thus, significantly, meaningless!), the fact that some additional information and some additional machinery may be necessary to resolve the deterministic meaning of a sign, makes it no less determined, albeit within this broader universe of observables.

This is easily understood formally. We can represent our code as a function $f : X \rightarrow Y$, mapping signs $x \in X$ to meanings $y \in Y$. If there is additional information Z needed to resolve a particular sign $x \in X$ to its meaning $y=f(x) \in Y$, then f is simply replaced with a new function $f' : X \times Z \rightarrow Y$, such that x means y_1 under condition $z_1 \in Z$, but could mean y_2 under condition $z_2 \in Z$. That is, $f(x,z_1)=y_1$, and $f'(x,z_2)=y_2$. Thus all we've done is created a collection of functions $f_z : X \rightarrow Y$, one for each $z \in Z$, with the role of a discriminating "interpreter" being to manifest the selection of a particular f_z function based on the observation of some $z \in Z$.

Effectively, we've created a more complex code, but nonetheless still a deterministic system of coding. Begging questions of free will or randomness, we can easily embed discriminative interpretation within processes of meta-code following. Such processes of embedding coding relations in higher order spaces involving Z, *W, Q*, etc., and building up additional complex semiotic machinery, are, of course, exactly the process of the evolution of semiotic systems seen in biological and cultural evolution. Building up such deep hierarchically embedded levels of interpretation is the nature and hallmark of complex semiotic systems, building on a foundation of simple (code-following!) interpreting systems founded in biosemiotics.

This simple distinction between code-following and code-making may be all that's at stake in code-semiotics' desire to relegate interpretation to cognitive systems, as distinct

from identifying interpretation as any form of code-following. It is hard to understand what could be at stake for the issue of explaining code-making or code-following in non-cognitive systems. Indeed, on strictly rhetorical grounds, the sense of interpretation as code following seems preferable, since it's actually what "interpretation" itself means to a first understanding, to follow a code or to take something for something else in virtue of such a coding.

We can certainly identify cases of discriminative interpretation, like cognitive interpretation in neural organisms, or language translation, or hermeneutics, or literary criticism, or semiotic philosophy papers. But we can also identify interpretation in general as any process which encounters a sign and takes it for its meaning in virtue of some code. Moreover, interpretation in this sense of code-following requires a mechanism to physically detect the sign and manifest the corresponding meaning. And in seeking to merely identify this mechanism, it is natural to call that no less than an "interpreter". Thus a ribosome is an interpreter. And the right amino acid is its interpretation of some codon.

What follows from this code-following sense of interpretation is that information is not meaningful in the absolute, but only relative to a code; that is, only *within* a system of interpretation; that is, only *in virtue of* a mechanism of interpretation; that is, only to an embodiment of that mechanism within some form of an interpreter. Thus meaning follows from a code, in fact, meaning follows from a code *being followed*, implying a process by which a code *is* followed. More broadly, meaning is the phenomena resulting from the interpretation of a code creating molecules, organelles, organs, emotions, consciousness and thought. So semiotics and biosemiotics is necessarily the science of interpretation, and of interpreters.

What is gained by asserting that interpretation must be discriminative, that is, cognitive? It doesn't export the concept of code to anywhere else in the evolutionary hierarchy than before, since code making and code following must still be present sub-cognitively: it retains code at the level of the origin of life. It is hard to understand how it changes the code-semiotics argument, and to the extent that they beg agency to the codemaker, that's simply the recognition of the problem of the origin of any coding relation in the first place.

But this is not to say that the mysteries have been resolved. For example, how can we correlate the ideas that, on the one hand, both code-following (that is, interpretation) and *control* relations (that is, the *actions* of semiotic systems) must both be identified with the origins of life; and on the other hand that both code-following and control relations involve the presence of contingent regularities (Joslyn 2000)? As we've seen, in the case of code-following, the contingent regularity is the code itself, which "could have been otherwise". But in the case of control relations, the contingent regularity is the maintenance of a dynamic equilibrium state far from a (usually thermodynamically understood) static equilibrium, which would otherwise be predicted by models based on physical law alone. In fact, we understand that the ability of organisms to generate negentropy by maintaining themselves through metabolic processes in homeostasis far from thermodynamic equilibrium is exactly in virtue of their ability to follow their genetic codes, that is, to interpret their genetic legacies. This brings the *energetic* side of biology to bear on the semiotic, which appears to be a necessary feature of any whole biology.

Is Code-Semiotics an Evolutionary Theory?

Barbieri is highly critical of emergentist attempts to explain evolution, including Eigen's (1992) hyper-cycles, Kauffmann's (1993) self-organized auto-catalytic loops as well as Varela and Maturana's (1974) and Maturana and Varela (1980 and 1986) autopoiesis. Maturana establishes his own vocabulary like Peirce to make clear that he does not fit into any of the existing paradigms. Barbieri claims to solve the problem of the production of artificial entities before and by the living systems *giving the molecular code makers agency***.** But, at the same time he is claiming a type of agency that is devoid of any form of mind-representation and interpretation. He thus takes upon himself the burden of producing a theory for the origin of such agency, without which he has just described the problem, but not contributed to solve it.

That living systems are not machines created by a more conscious and intelligent being is fundamental in the paradigm of natural sciences. Life has evolved out of a world which—we so far think—can be described sufficiently by physics and chemistry, and without the life that biology was invented to describe (before it was reduced to only molecular chemistry and genetics). Furthermore from the evolution of life consciousness is seen to emerge. Few would deny this description of the world. The problem is that many mistake the description of evolution for a theory of how life and consciousness arose in the world and what these phenomena are. Both systems theory and dialectical materialism have in the outskirts of the accepted view of the natural sciences attempted to produce explanatory theories. Von Bertalanffy's general system theory (Bertalanffy 1976/68) of holism and self-organization plus later developments such as cybernetic information theory and Niklas Luhmann's (1995) autopoietic system theory have already been mentioned. Von Bertalanffy's (1976/68) general system is based on a sort of organicism and dialectical materialism, combining natural and historical materialism. For Friedrich Engels the development of a dialectics of nature was then a theory of the evolution of life and mind. It was further developed through Leontiev's (2009) development of *activity theory*. Manfred Eigen (1992) with his hyper-cycles and Stuart Kauffmann (1993) with his self-organized auto-catalytic loops have both with marginal success attempted to explain how agency could develop from the interaction between molecules that did not have any agency themselves whatsoever. But Barbieri is (as mentioned) highly critical towards these attempts, and claims to solve the problem by the molecular code-maker agency in his new daring code-semiotics.

As far as we can see he reasons as such: codes are important in life; codes needs a maker; the macro-molecules involved in such codes must then be the code-makers; therefore they must have agency; and an agency that is devoid of any form of mind-representation and interpretation. But what kind of agency *is* that? Another of the developers of biosemiotics, Alexei Sharov, has developed (2010) an agency-theory which has life as a prerequisite, but he does not attempt to explain how it emerged either, as far as we can understand.

Defined from a Peircean biosemiotics, codes and informational signals are quasi-signs as they are dualistic phenomena, whereas signs demand all three categories working together. Peirce's theory does not work without his paradigmatic framework of the three categories and the ontology those imply, but this is exactly what Barbieri

want to avoid in order to make biosemiotics scientific. We think that we have to settle for Wissenschaftlig instead of scientific.

Thus we see the remaining problem in the paradigm to be to offer us a deeper theoretical explanation, not an addition to the received view's description of evolution, because that has so far not produced a theory of experiental life and mind that can explain how signification arise in certain systems in our universe.

A crucial problem is thus whether life as well as mind is a natural and perhaps necessary outgrowth of first principles in physics and chemistry, or instead we need to add informational or even code-semiotic or phaneroscopic semiotic principles and laws to explain life and later the consciousness it produces. Or is the semiotic view a foundational change in our whole outlook on the world, as John Deely (2001) pledges in *Four Ages of Understanding* and many books and papers since.

The cybernetic computational informational view is based on universal and abstract (un-embodied) conceptions of information and computation that is the foundation of "the information processing paradigm", which is foundational for much cognitive science and its latest developments into brain function and linguistics comprising also a philosophy of science. It is claiming that "information" is an objective form in the world, that it can be objectively parted into pieces of "data", and that humans, brains, computers and organizations process them in the basic same way. This is called "computation", and is a primitive (not really well-defined) concept of information processing that goes beyond the Turing computer definition. This is a "software", as opposed to a "hardware" definition.

All these concepts attempt to extend our knowledge of how computers function through a general science of computation into a general paradigm of knowledge and knowing. This is of course not possible to do without also stipulating an ontology (a world view and an anthropology). The world view sees the universe as a computer. The anthropological view sees humans as dynamic systems producing and guided by a computationally functioning brain, and language as a sort of culturally developed program for social information processing.

But this is too narrow a view to give a full understanding of human knowledge interacting. What is lacking is knowledge of the role of first person experience, qualia, meaning and signification and their evolutionary and historical development in human society and culture. Further, a Turing machine is only an abstract program or machine without a particular embodiment. But another important aspect which remains to be solved is the troublesome problem that we are *not* our brains. Rather, our brains are ours, although in ways we do not understand. At least we cannot be separated from our brains and still be us—as far as we know. Researchers, therefore, are now trying to broaden the concepts of computation and information into a theory of natural info-computation into what you can call a pan-informationalism combined with a pan-computationalism (Dodig-Crnkovic 2010; Dodig-Crnkovic and Müller 2011) partly based on the visions of Gregory Chaitin's (2005) meta-mathematics, where he attempts to view mathematics as a biological process.

Consequences of Code Semiotics

Code semiotics argues that the emergence of meaningful, semiotic observables from informational processes is neither mysterious nor obscure, and that biological processes

deserve full standing on their own right in the phenomena of nature. It focuses on *nominable* entities, that is, entities which can be distinguished by their identity, and are thus candidates to serve as signs in coding systems. The paradigmatic cases for these in biosemiotics are, of course, the a-periodic polymers which are biological macromolecules, while for non-physical systems these are our semiotic constructs, our symbol strings.

This echoes the sense of component system of Kampis (1991), which are *combinatorial* physical structures characterized by high-dimensional strings of nominable entities, rather than low-dimensional manifolds of physical objects and processes (fluids, solids, membranes, etc.) more typically seen in physics-based biological models. This explains the straightforward way in which chemical "species" are constructed through the combinatorial processes of the specificity of chemical bonding, and the corresponding quite different world views of physicists and chemists. It is the digital, “random access” nature of these discrete, combinatorial entities which gives them their identity, their nominability. Seen in this light, the “levels” of emergence in the natural world from physics through chemistry to biology and sociology/psychology are gracefully recovered.

The code semiotics perspective extends the concept of artifact and mechanism “down” to the biomolecular layer. One implication is to consider, perhaps just for parsimony, what the consequence would be of rather extending biological concepts up to the mechanical level proper? Echoing Rashevsky (1938) and Rosen (1991), it is not that organisms are meaningful machines, but rather that all of the higher-order artifacts, machines, codes, models, and semiotic constructs of humans including mathematics and language are organic processes. Perhaps these perspectives will end up producing equivalent results, but it is interesting to consider the duality of the argument.

We offer the perhaps obvious suggestion that the “null hypothesis” of “first order biosemiotics” is that semiotics and life are not just co-extensive, but at least also “co-explanatory”, if not “co-causal”. But this is an hypothesis, which should be (somehow) testable. The point is that this co-extensivity is necessary, but not sufficient, for subsumption (all life is semiotic), implication (we can infer semiotics from the presence of life, or vice versa), or causation (semiotics causes life, or vice versa). Referring to our argument about coding systems above, and in particular the fact that any particular coding system is a *contingent* regularity, the question is whether such an observed co-extensivity is itself necessary or contingent; that is, must it have been thus, or might it have been otherwise?

In this case, the question isn't just whether a different instantiation of a genetic code might have survived, or even that life may not have evolved *at all*, but rather might there have arisen, or could there even ever exist, semiotic systems which are neither living themselves, nor depend on living systems as our mechanical systems do? One might respond that any such systems would surely have to *be* organisms, forcing us to demonstrate that the essential aspects of life are, in fact, semiotic. Or we might respond more weakly by simply calling any such systems organisms, forcing the extension of the definition of life to be just whatever semiotic systems are. But in either case, we are called on as scientists to attempt to explore this possibility, perhaps to approach refutation by attempting to develop models of non-living semiotic systems (of course excluding human-created artifactual semiotic systems which exist in the broader noosphere, itself contained within the broadly-construed biosphere).

Finally, Barbieri claims that it is not possible to imagine how molecules can become symbols in a Peircean sense. This may depend on what kind of ontology and epistemology you have, because it is truly not possible from a classical deterministic materialist mechanical view. But we agree that science has left that view centuries ago. The problem of how to characterize the alternative then becomes interesting. It seems that Barbieri on one level shares Peirce's synechism and Tychism as he chose monism and distanced himself from material mechanicism; and furthermore he has an kind of emergentist evolutionary world view not based on system theory's informational view, but instead on a code-semiotic one.[6] But we cannot see Barbieri dealing with the epistemological phenomenological point of view that all knowledge starts with a combination of subjective and intersubjectivr experience as Peirce, Husserl, Heidegger and Merleau-Ponty do. Peirce calls his version phaneroscopy. Barbieri seem to start with the concepts of environment understood in a physicalistic way. But from a phaneroscopic point of view it is the distinction, or a Pattee's "epistemic cut", that creates the difference between consciousness and environment, or as Spencer-Brown (1972) and Luhmann (1990; Luhmann 1995) would say, between "system and environment".

This means that physics or any kind of "external" empirical science never can be the foundation for a knowledge system from which all knowledge of the world and ourselves as emerged systems from evolution, can be built up from. This is because it forgets its own basis in lived experience and language. Although we must respect the science of physics, chemistry, molecular biology, genetics, and so on, we should not make it alone foundational to our world view. The phenomenological (Speigelberg 1965) and the biological knowing as well as the social and linguistic knowing is equally as foundational in our reflection of the nature of the scope of the production of scientific knowledge.

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[6] Maybe in the form of a Supervenience theory? But that in our view is a sort of physicalism combined with a pseudo-emergentism that does not solve the problem of life and consciousness, qualia etc.

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