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Protosemiotics and physicosemiosis

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Abstract. Protosemiotics is the study of the rudiments of semiosis, primarily in nature. The extension of the semiotic field from culture to nature is both necessary and possible in the framework of Peirce's semiotic theory. Against this extension, the critique of pansemiotism has been raised. However, Peirce's semiotics is not pansemiotic since it is based on the criterion of thirdness, which is not ubiquitous in nature. The paper examines the criteria of protosemiosis in the domain of physical and mechanical processes.

1. Protosemiotics

Protosemiotics is the study of protosemiosis, i.e., of protosemiotic processes. What is protosemiosis? The Greek form *proto-* means "first", but in modern scientific terminology, several more specific meanings are associated with the prefix *proto-*. Linguists, e.g., define the common ancestor of the languages of a family as a *protolanguage*. Biologists use the prefix in the sense of "archetypal", as in *protomorph*, and in chemistry, *proto-* designates "the first or lowest of a series, [i.e.,] one having [...] the smallest relative amount of the element indicated in the name to which it is prefixed", as in *protochloride* (*Webster's IIIrd New Int. Dict.*). Along these lines, we can define protosemiosis as the most rudimentary process of semiosis, a process that barely fulfils the minimum requirements of semiosis and is hence just above the semiotic threshold between the semiotic and the non-semiotic world, if such a threshold exists at all.

Although, as far as I see, the term *protosemiosis* has not yet found its way into any encyclopedia of semiotics, it has occasionally been

used in semiotic theory, albeit without precise definitions. Irmengard Rauch (1999), in her recent book entitled *Semiotic Insights*, has two chapters on "Protosemiotic" and on "Protosemiotists" in which she discusses medical semiotics as *protosemiotic*, and classics of modern semiotics such as Peirce or Saussure as protosemioticians.

Closer to our definition of *protosemiotics* is the way Giorgio Prodi (1983) discusses "protosemiotic interactions in nature". Protosemiosis, according to Prodi, is essentially a synonym of biosemiosis" (Cimatti 2000: 362–64). The central argument of Prodi's protosemiotic theory is that life is "natural semiosis". Prodi first elaborated this thesis in his study *Le basi materiali della significazione* of 1977, unaware of Charles Sanders Peirce's much earlier contributions to his field of research.

2. Protosemiosis and the semiotic thresholds

In the context of Italian semiotics of the 1970s, however, Prodi's protosemiotics was a bold extension of the semiotic field whose delimitation had been laid down within much narrower confines by Umberto Eco's authority. Eco defends the thesis of a relatively high semiotic threshold. Eco's semiotic threshold between the semiotic and the non-semiotic field is the dividing line between culture and nature. His criteria of separating the two worlds are essentially the arbitrariness of the sign and the possibility of using it for the purpose of lying (cf. Nöth 2000b). Others who have been in favor of a high semiotic threshold are the semioticians in the tradition of Husserl's phenomenology. According to this tradition, human intentionality and "meaning endowing acts" are the criteria of sign use (cf. Nöth 2000a: 36).

The history of semiotics since the 1960s, partly under the influence of Thomas A. Sebeok, has seen a lowering of the semiotic threshold in several stages (Nöth 2000a). From its earlier restrictions to the study of human language and culture in the domain of *anthroposemiotics*, it advanced with *zoosemiotics* to the study of animal communication, with *phytosemiotics* to the study of sign processing in plants, and with *biosemiotics* to the study of semiosis in microbiological processes. Notice that this lowering of the semiotic threshold since the 1960s actually means only an extension of the research field of a semiotics in the tradition of structuralism. It is not an extension of the field outlined by Peirce, whose semiotic philosophy covered the study of

semiosis in nature, culture, logic, and language. The lowering of the semiotic threshold in semiotics during the last decades hence went parallel with the rediscovery of Peirce's broad concept of semiosis.

Today, even the possibility of semiosis in the prebiological world is a topic on the semiotic agenda. The domain of study has been dubbed *physicosemiotics* by Walter A. Koch (1987: 67) or *physiosemiotics* by John Deely (1990: 32). Deely (2000: 3) calls research in this domain "the final frontier of semiotic inquiry", but he also admits that the adherents of this recent extension of the semiotic field are still a small "radical faction" of semioticians. There are two domains of the nonliving world in which the nature of protosemiosis may be considered, one is the field of physical or chemical processes and of cosmological evolution (Nöth 2001b), the other is the world of machines (Nöth 2001c).

3. Pansemiotics?

The larger, more conservative, faction of semioticians condemns the extensions of the semiotic field beyond human culture as "pansemiotic" (Baltzer 2000), some beginning their critique at the biosemiotic, others definitely at the physicosemiotic threshold. With the label of pansemiotism, the critics want to imply that the concept of semiosis becomes a useless theoretical tool if every process in our world is defined as a process of semiosis. However, to describe Peirce's universal semiotics as a pansemiotic theory is a gross simplification. Semiosis, in the framework of Peirce's theory, presupposes thirdness, but the world does not only consist of phenomena of thirdness, but also of phenomena of firstness and of secondness, which are not yet semiotic phenomena, although they may have "quasi-semiotic" characteristics, since Peirce's theory of continuity does not establish a mere dichotomy between semiosis and nonsemiosis, but distinguishes many transitions between genuine and degenerate or quasi-semiosis.

Physicosemiotics is the scandal of conservative semioticians. The idea that semiosis should be possible in the inorganic world is a contradiction in terms to all those who postulate that human intentionality or at least life is the essential semiotic threshold. There are not many semioticians who subscribe to the allegedly pansemiotic theory that there might be semiosis as a genuinely triadic process in nature before life is there to interpret signs (see above, 3.).

Nevertheless, Charles Sanders Peirce is the crown witness of both the advocates and the opponents of this theory: Thomas Short (1998: 49), the renowned specialist in Peircean semiotics, affirms that semiosis, according to Peirce, can only be anthropo- or zoosemiosis, because there is "no basis for the assertion that semiosis occurs outside of living things". On the other hand, no less renowned Peircean scholars, such as Helmut Pape (1989), Klaus Oehler (1993), and Lucia Santaella Braga (1994, 1996, 1999a), affirm that the origins of semiosis, according to Peirce, begin before life. Between the two camps we find Felicia Kruse (1990: 220). She gives evidence of many instances of Peirce's extension of the theory of semiosis from living nature to the physical universe, but believes that it remains unclear whether Peirce actually wants to extend the theory of semiosis from the living to the material world or whether he merely wants to point out analogies between processes in the organic and the inorganic world.

4. Protosemiosis in organisms

No doubt, Peirce was a biosemiotician (cf. Nöth 2001a: § 3). Peirce's semiosphere certainly includes the whole biosphere, and his idea that biological protosemiosis begins with the *purpose* of a microorganism in its selective reaction to its environment has been the guideline of biosemioticians in the extension of their semiotic field from perception and cognition to processes of cell biology, metabolism, genetics, or immunology. Conservative biosemioticians establish a semiotic threshold at this point. Without life there can be no semiosis, they argue. Some of them suggest that there is a domain of presemiotic transition between the physical and the biological world, which they call *information*. "Before semiosis there was information", was, e.g., Thomas Sebeok's argument in 1986 (Sebeok 1986: 15; cf. von Uexküll 1997: 449, who refers to this domain of protosemiosis by the term *semiotics of information*), although, a year earlier, the same author had still considered the possibility of a semiotic dimension of physics when he wrote under the influence of Archibald Wheeler's theory of the participatory universe: "Possibilities for aligning physics and semiotics are slowly beginning to swim into focus, and by this I mean to forecast that the means of entry to the universe will be found in the classical adage, *Nosce te ipsum*: the key is concealed within ourselves" (Sebeok 1985: 20).

The premises of the view that protosemiosis takes place in an organism that "reads" its environment is not in essential disagreement with radical constructivism and its theory of the subject that constructs its own environment (cf. Uexküll et al. 1993). However, when it comes to consider the role of the environment in this process, the radical contructivists are less radical than Peircean semioticist, who are willing to face the no less radical question whether final causality exists only in the purpose of the sign interpreter or whether it also exists in the sign before it is interpreted or even in the object of the sign.

5. Is there final causality in objects that serve as a potential sign?

The question whether there is final causality also outside of the mind of an interpreting subject is of relevance to the interpretation of natural signs which have no sender like the smoke that indicates fire. Do natural signs have a purpose?

It has been argued that every natural object is a *potential* sign since there is always the possibility that some interpreter may take some object as a sign of something else. Does this mean that every object in nature is endowed with a semiosic teleology? Is there a protosemiotic final causality inherent in the potential of all natural objects to serve as signs?

Based on the semiotics of the late Scholastic semiotician Poinsot, Deely (1990: 90–91; 1994: 198) develops the thesis that physicosemiosis is the potential of natural objects to be taken as signs. One of Poinsot's semiotic maxims was: "It suffices to be a sign virtually in order to signify in act". From this principle, Deely derives the argument that not only the interpreted, but also the uninterpreted nature is endowed with semioticity and that this semioticity is a virtual one. Semiosis in the physical world is hence a "virtual semiosis". The "action" of the virtual sign is directed towards its interpretation somewhere in the future, but its effect, namely an actual interpretation, depends largely on chance (Deely 1994: 199–200). A still undiscovered fossilization of a dinosaur bone in my garden would be such a virtual sign, says Deely. It is, so to speak, dormant until it comes to life in an actual instance of sign interpretation, but it is nevertheless a sign. Deely (1994: 174) even attests a triadic nature to this natural sign: *A*, the sign, is the bone of the dinosaur. *B*, its object, is the once living

dinosaur to which it once belonged. *C*, its interpretant, is the present geological stone formation which was once a real bone.

However, if semiosis exists already in a natural phenomenon *before* it is interpreted as a natural sign, such a virtual sign is really defined independently of its actualization in a future interpretation, and in fact, Deely (1994: 174) goes so far as to argue that the undiscovered fossil in my garden already constitutes a semiotic triad before and independently of its future interpretation: this triad consists of the ancient bone as a sign, the dinosaur as its object, and its present state of fossilization as its interpretant. It is hard to see in how far this triad is more than a concatenation of two dyads of a very different kind, namely a cause-effect relationship which connects the present fossil with the bone seventy million years ago (see also Short 1998: 48) and part-whole relationship between the bone and the animal, whose bone was later fossilized.

The actualization of this potential of natural objects to be interpreted as signs depends on chance, since the number of natural objects with a potential semioticity to some interpreter is infinite, and the chances of these objects to be interpreted as signs depend on the interpreters' fortuitous encounter with these objects. Chance, however, belongs to the category of secondness. It can only be the source of efficient causality, which is dyadic, not of final causality, which is triadic. Hence the so-called potential sign as such is not a sign endowed with teleology.

In this context it is interesting to note that today research in autocatalytic shows that biosemiosis cannot have its roots in chance. Stuart Kauffman (1995), e.g., gives evidence from mathematics, where the improbability of the chance encounter of elements of matter to create life can been demonstrated by probability calculus. If life did not originate from chance, it cannot be expected that protosemiosis in general can have its origins in chance.

6. Teleology in natural signs

But how can final causality, "the purpose of a sign", be at work in a natural sign which does not have a sender? One of the effects of teleology in any semiosis, according to Peirce, is the control that the object of the sign exerts on the outcome of its interpretation, i.e., the interpretant. The natural object imposes, so to speak, cognitive constraints

on the interpreter, and such restraints cause a restriction of the possibilities of its interpretation. Ransdell (1977: 173) illustrates such an effect of protosemiotic teleology in the interpretation of a natural sign with the example of traces on the ground which indicate the former presence of a tiger. According to Ransdell, the (dynamical) natural object in this situation exerts a kind of control on the interpreter by means of "further signs whose unquestioned interpretation can go towards determining the correctness or incorrectness of the interpretation in question. Such further signs might be, for example visual percepts of the animal, its smell, its roar [...] and so on". Hence, it is not the subject that constructs its environment, but subject and object presuppose each other like lock and key. The dynamical force of semiosis has its source both in the interpreter and in the object of the natural sign. Semiosis does not originate in an autonomous interpreting subject, but both in the so-called subject and the object with which it is confronted.

With different arguments, Prodi's (1988) in his account of biological protosemiosis equally ascribes semiotic autonomy to the object of the sign in relation to its interpreter. Protosemiosis, according to this model, is based on the logic of the complementarity between a selecting A, the interpreter, and a selected B, the sign:

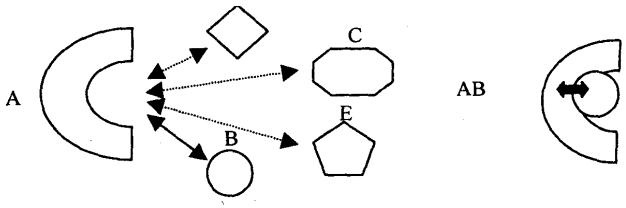

Figure 1. Protosemiosis according to Prodi (from Cimatti 2000: 363).

Cimatti (2000: 363–364) summarizes Prodi's ideas on this protosemiotic constellation as follows: "At the beginning neither *A* is a subject nor is *B* an object, since the subject is such only in respect to something which counters it (an object), just as an object needs […] a subject in order to define itself as such".

7. Protosemiosis in complex physical systems

Dynamic systems theory and the theory of complex systems have shown that teleology also exists in physical and chemical processes. Spontaneous self-organization occurs in dissipitative structures. *Order out of Chaos* is physically possible, as Prigogine & Stengers (1984) have shown. Other evidence of the possibility of growth of complexity in physical nature, which was previously thought to be a characteristic of life only, has been provided by Stuart Kauffman's (1995) above-mentioned research in autocatalytic processes. According to Bruce Weber & Terry Deacon (2000), there is even evidence of *memory* in physically chaotic systems (see also Weber & Depew 1999: 56), and memory is, of course, an eminently semiotic process.

Peirce was himself involved in biophysical research of teleological processes in which he saw proof of a "tendency toward bringing about an ultimate state of things" (CP 7.471) and the possibility of "chance begetting order" (CP 6.279; cf. Santaella Braga 1999b). He did not use the term physicosemiosis to describe these processes, but one of his conclusions was that "mind acts on matter" (CP 7.370, 8.259; Santaella Braga 1999a: 513).

Short (1998: 45) underlines that teleology is not a sufficient, but only a necessary criterion of semiosis, but more important than this difference between the processes in the inorganic and the organic world is what they have in common: a tendency towards self-control, self-reference, growth towards future states independent of initial states, but with a telos from the beginning on.

In spite of their common foundation in teleology, there are, of course, also differences between anthroposemiosis and physicosemiosis (or -quasisemiosis), but these differences are only a matter of degree. As Oehler (1995: 26) points out: "Human acts of cognition differ from other self-referential and self-correcting processes by virtue of their greater degree of self-reference and self-correction. Human beings achieve this superiority through the creation of symbols, which represent and control our habits of action".

8. Protosemiosis in machines

Is there protosemiosis in nonliving systems, in machines, computers, artificial intelligence, or at least in artificial life? There is no doubt that computer semiotics is a branch of cultural semiotics insofar as it is concerned with the interface between humans and computers, but is information processing *within* "intelligent" machines also sign processing, or is it merely signal processing? Are machines becoming *autonomous* agents in processes of semiosis?

Peirce had some radical ideas on machine semiosis (Nöth 2001c). He who often used the term "logic" as a synonym of "semiotic", developed a theory of "logical machines" in 1887, based on machines invented by Jevons and Marquand. His conclusion was that these devices as well as the calculating machines of his times were "reasoning machines" (Ketner 1988; Skagestad 1993, 1999; Tiercelin 1993). Since reasoning seems to be a process of semiosis, we might conclude that these machines were semiotic machines. However, Peirce suggests that they are not, although he goes so far as to conclude that "*every* machine is a reasoning machine" (*ibid.*: 168). Is reasoning then possible without semiosis? Elsewhere Peirce gives the answer: a machine, such as the Jacquard loom, although capable of reasoning and calculating like humans, is not capable of "the triadic production of the interpretant" and operates hence only as a *quasi-sign* (CP 5.473). The machines that Peirce discussed in 1887 were *deterministic*, or as Heinz von Foerster (1993) calls them, *trivial machines*, whose output is completely determined by their input. Such machines are only capable of *quasi-semiosis* and not of genuine semiosis.

In the age of Artificial Intelligence and Artificial Life, we have *nontrivial machines*, which are capable of learning, and whose output is no longer completely determined by their input. I cannot deal much further with the semiotics of machines here (but see Nöth 2001c) and must restrict myself to pointing out one of the radical conclusions at which Peirce arrives in this context. Instead of only asking whether machines can think like humans, he raises the question of whether humans are not also like machines in certain protosemiotic respects. Restricting himself to the human faculty of calculating and of solving syllogisms, of which machines of his time were already capable, his answer was: "A man may be regarded as a machine which turns out, let us say, a written sentence expressing a conclusion, the man-

machine having been fed with a written statement of fact, as premiss. Since this performance is no more than a machine might go through, it has no essential relation to the circumstance that the machine happens to work by geared wheels, while a man happens to work by an ill-understood arrangement of brain-cells" (CP 2.59).

In accordance with his synechistic theory of the gradual evolutionary transition between mind and matter, Peirce does not only conclude that the human mind, when solving a mathematical or logical problem, works like a mind machine, but also that the calculating and the logical machines of his time were "reasoning machines". This similarity between human thought and the merely mechanical "reasoning", according to Peirce, can be explained by the common evolutionary heritage of biological and physical nature: both the human brain and the physical laws of mechanics have evolved under the same cosmological constraints so that a certain degree of similarity between the operation of both can be assumed (cf. Nöth 2001c). The mode of sign processing common to humans and machines is diagrammatic iconicity: "The secret of all reasoning machines is after all very simple. It is that whatever relation among the objects reasoned about is destined to be the hinge of a ratiocination, that same general relation must be capable of being introduced between certain parts of the machine" (Peirce 1887: 168).

In this respect, however, not only a logical machine, but "every machine is a reasoning machine, in so much as there are certain relations between its parts, which relations involve other relations that were not expressly intended. A piece of apparatus for performing a physical or chemical experiment is also a reasoning machine, with this difference that it does not depend on the laws of the human mind, but on the objective reason embodied in the laws of nature. Accordingly, it is no figure of speech to say that the alembics and cucurbits of the chemist are instruments of thought, or logical machines" (*ibid.*).

Peirce did not believe in the dualism between mind and matter. He defended the general principle of continuity between both, called *synechism*. Instead of a spontaneous origin of semiosis, there must have been continuity between mind and matter. However, in spite of his vision of a "universe perfused with signs", Peirce also postulated many subtle differentiations between processes of *genuine* semiosis, *quasi-semiosis* and "degenerated" semiosis. In this perspective, the semiotic threshold is not a question of a dualism between two worlds, but one of the many stages and steps of transition from one to the other.

9. Metaphysical protosemiosis and the continuity from mind to matter

Mind, thought, and genuine semiosis are basically synonyms to Peirce (Santaella Braga 1994). Protosemiosis hence has its origin in the origin of mind. But where does mind begin? Did it not evolve from matter? Peirce defends the general principle of continuity between both, which he called *synechism*. He did not believe in any dualism between mind and matter. Consequently, instead of a spontaneous origin of mind there must have been continuity between mind and matter, but which came first in cosmic evolution?

Peirce's answer to the riddle of evolutionary primacy is a metaphysical one: mind comes first, matter last. Semiosis is hence the origin, matter the end of cosmic evolution. The logic behind this metaphysical cosmology derives from the order of the three universal categories. Mind, considered as the pure possibility of thought (Potter 1967: 17, 135), not yet as a real event of thinking or even reasoning in a human being, must come first because it belongs to the category of firstness, of possibility, and spontaneity. Matter can only come last because it belongs to the category of thirdness, which is the one of habit and necessity.

Peirce's metaphysical account of evolution describes the beginning as a *chaos*, a state of qualitative continuities still without regularity (CP 1.412, 6.215). This state of pure continuous *firstness* was then interrupted by discontinuities. These discontinuities entered the scene as instances of secondness like "flashes" (CP 1.412). The ensuing repetition of such singular occurrences of chance lead to habits, regularity, order, hence to thirdness (CP 1.414). Some irregularities were eliminated in evolution, others became more and more regular.

This is why Peirce can say that *matter* is *mind* frozen "to regular routine" (CP 6.277). His logic of evolutionary cosmology urges the conclusion that the end of the universe is reached at a point where matter is completely bound in regularity, resisting any spontaneous variation and influence by chance. This end state of order is by necessity the end of evolution, the death of the universe.

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Протосемиотика и физикосемиозис

Протосемиотикой называется наука о началах семиозиса в природе. В рамках пирсовской семиотической теории расширение семиотического поля из культуры в природу необходимо и возможно. Такое расширение подвергалось критике как пансемиотизм, но семиотика Пирса не пансемиотична, так как опирается на критерий *thirdness*, не обнаруживае-

мый везде в природе. В статье рассматриваются критерии протосемиозиса в физических и механических процессах.

Protosemiootika ja füsikosemioosis

Protosemiootika on teadus semioosise algetest, seda eeskätt looduses. Peirce'i semiootikateooria raames on semiootilise ala laiendamine kultuurist loodusesse ühtviisi vajalik ja võimalik. Sellist laiendamist on kritiseeritud kui pansemiotismi. Peirce'i semiootika ei ole siiski pansemiootiline, kuna põhineb *kolmasuse* kriteeriumil, mida kõikjal looduses ei leidu. Artiklis uuritakse protosemioosise kriteeriume füüsikalistes ja mehhaanilistes protsessides.