



The Sign Science and the Life Science *

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In the celebrated passage in which Saussure referred to *une science qui étudie la vie des signes au sein de la vie sociale*, the term science is, as a rule, loosely, arguably, and, in my view, misleadingly rendered by the English quasi-cognate “science” (for example, by Harris, in Saussure 1983:15). Saussure went on to say that this science – that is, semiotics (alias semiology) – “does not yet exist,” nor can one “say for certain that it will exist.” If so, the status of semiotics as a science (in the strict sense, rather than meaning simply savoir) would be comparable with that of, say, exobiology, a sanguine term coined by Joshua Ledeborg at a meeting in Nice in 1957 for the study of extraterrestrial life (Ponnamperuma 1972: viii); but this “science” of exobiology remains, to this day, devoid of a palpable subject matter.

Such is not, however, the case if semiotics is defined – as all of us echo here, after the variegated usage of the Schoolmen, the Latin expression *doctrina signorum* – according to Locke in 1690, Berkeley in 1732, Peirce in c. 1897, and others, as a “doctrine” (cf., generally, “On the Notion ‘Doctrine of Signs’” Deely, 1982:127-130). When viewed as a “teaching manœuvre combined with a learning stratagem” (Sebeok 1986d), semiotics is found to be at least as richly infused with content as what is today practised under the label “cognitive sciences,” the domain of which is in fact essentially conterminous in gist and problematic, if not necessarily in methodology, with that of semiotics.

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In this essay, I juxtapose, as a framing and heuristic device, “sign science” with “life science.” The latter is a general phrase “comprehending all the Sciences ... that have to do with the structures, performances and interactions of living things.” These are enumerable as the conventional biological sciences but additionally subsume several “interfacial” sciences, such as biochemistry, biophysics, and bioengineering, the last of which, Medawar and Medawar (1977: 7), claim, “also establishes a common frontier between biology and communications theory.”

Ten years ago, I noted a libration in the annals of semiotic inquiry between two seemingly antithetical tendencies: a major tradition, in which semiosis is taken to be a steadfast, indeed bedrock, hallmark of life; and a minor, predominantly glottocentric trend, in which semiosis is tied to human existence alone. As a matter of personal conviction, I then declared myself in the former camp, stating that “the scope of semiotics encompasses the whole of the oikoumene, the entirety of our planetary biosphere,” adding that semiosis “must be recognized as a pervasive fact of nature as well as of culture” (Sebeok 1977:180-183). In what follows, I propose to explore this claim further.

I begin with two interlinked queries: what is semiosis (or, as Peirce sometimes put it [5-4731], *semeiosis*); and what is life?

Peirce adapted the designation “semiosis” (in a variant transcription) from Philodemus’s fragmentary Herculanean papyrus *On Signs*, where the Greek equivalent occurs at least thirty times (1978:140, to represent a type of reasoning or inference from signs. He endowed the term with a definition of his own as an action, or influence, “which is, or involves, a cooperation of three subjects, such as sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs” (1935-1966:5.484). The “action of a sign” is the semiotic function that sets an inferential process in motion.

Morris gave a somewhat different definition of semiosis, as a sign process, “that is, a process in which something is a sign to some organism (1971:366). His precept gives ample scope for pinpointing the locus where the process takes place, to wit, in anything alive. It follows that the notion of semiosis is yoked to the notion of animate existence and, as a corollary, that there could have been no semiosis before the appearance of life in the universe (or, for all practical purposes, the emergence of terrestrial life).

This leads to the second query, cogently formulated and addressed in Schroedinger’s path-breaking book (1946), *What Is Life?* Elsewhere (see

above, Ch. 10) I had occasion to raise this same question, taking Schroedinger's discussion as my lodestar, but also taking duly into account Pirie's strictures (1937), according to which – especially considering borderline phenomena between the inanimate and the animate – such an inquiry may not even serve a useful purpose. The crux of Schrodinger's classic formulation has to do with the Second Law of Thermodynamics, particularly with the principle of negative entropy, which is often, if hitherto far from satisfactorily, coupled with a notion of information (more accurately, the lack of it) about the statistical structure of a semiotic system (cf., for example, Brillouin 1950). In any event, Schrodinger's discussion points to the salience of semiotics in the understanding of life processes; or, as Wiener put it (1950:21) – keeping the common opinion in mind that the subject matter of semiotics is the exchange of messages (that is, time series) – the amount of information is a measure “of the degree of order which is peculiarly associated with those patterns which are distributed as messages in time.”

There are several additional noteworthy properties of life. One of these is its hierarchical organization, “a universal characteristic which life shares with the rest of the cosmos and which defines, in the overall architecture of the universe, its position on the genealogical tree.” The hierarchy of nature appears as an ontological interpretation of data from the “real world,” a pattern of relations which obviously extends up through semiotic systems, including particularly the verbal (cf. Jakobson 1963). This problem usually appears in the guise of messages in the superimposed context, where the terminal noun is to be read as the equivalent of Leibnitz's metaphysical concept of a monad, involving an indefinite series of perceptive acts coordinated by a unique point of view; or of Jakob von Uexküll's (1982:3) semiotically more patently pertinent biological concept of *Umwelt*.

Another conspicuous property emerges from the interplay between the fundamental invariance in life's subjacent biochemistry and the prodigal variability of singular realizations thereof, paralleling the conjugate ideas of global semiotic universals and local, or so-called cultural, variables.

“Meaning,” the cosmologist Wheeler argues (1986a:vii) – or, better, “significance” (Saussure's *significativité*, or *pouvoir de signifier*, as in Goedel 1957:276; cf. Peirce 1935-1966:8.314) – “is important, is even central”; and “meaning itself powers creation” (Wheeler 1986b:372; Wheeler 1984 develops this productive idea further). In semiotics, then, a fortiori, significance is at once the cardinal and the most haunting of concepts, yet the significance circuit must, in turn, be based on construction by the observer participancy of some carbon-based life.

The first traces of life detected so far date from the so-called Archaean Aeon, which began 3,900 million years ago; the progress of the animation of inert matter is expertly portrayed by Marguhs and Sagan (1986:47-57). In the course of evolution, according to the convincing, if speculative, metaphor of Dawkins (1976, Ch. 2), DNA replicators—a replicator being anything in the universe of which copies are made, thus any portion of chromosome, as well as a sign-and-its-interpretant, or, for that matter, a printed page and a facsimile thereof—cocoon themselves in “survival machines.” These comprehend all prokaryotes, that is, cells, such as bacteria, in which the genes are not packaged into a membrane-bound nucleus; and the four eukaryotic super-kingdoms, unicellular and multicellular organisms, such as plants, animals and fungi, in which they are. Such molecular replicators behave as non-verbal signs, which constrain and command the behavior of all living organisms, including ourselves (Sebeok 1979b:xiii), who are members of one genus, *Homo*, only a sole species of which, *homo sapiens sapiens* survives, endowed with the unique propensity to call additionally into action, when needed, an interwoven repertoire of verbal signs. Bodies, Dawkins’s survival machines, were in due course equipped by evolution with on-board computers called brains, the function of which is to facilitate message exchanges with comparable equipment in other bodies. (Dawkins also coined the word “meme” [1976:296] to designate non-genetic replicators, capable of flourishing only in environments provided by communicating brains.) Although this hypothesis is not yet proven, the brain does appear to be a highly complex amalgam of microscopic spirochetes, densely packed together in a symbiotic existence, a colony which itself feeds and thrives on a ceaseless traffic of sign input and sign output.

The universal RNA/DNA-based genetic code is commonly referred to as a “language,” as, for instance, by Beadle and Beadle (1967:216): “the deciphering of the DNA code has revealed our possession of a language much older than hieroglyphics, a language as old as life itself, a language that is the most living language of all—even if its letters are invisible and its words are buried deep in the cells of our bodies.” But this figurative equation is unfortunate, for it would be more accurate to call both the molecular code and the verbal code semiotic systems or, in Jakobson’s parlance [1974:501, “two informational systems”), explicitly recognizing that they radically differ from one another on, to use Hjelmslev’s terminology, the expression plane: the former is an object of study in chemistry, the latter in phonology.

The genetic code is but one of several endosemiotic systems. Bodies are made up of semiotically intertwined subsystems, such as cellular organelles,

cells, tissue, organs, organ assemblages. Endosemiotic sign processes, Thure von Uexküll (1986: 204) amplifies,

use chemical, thermal, mechanical and electrical processes as sign carriers. They make up an incredible number. If one reflects upon the fact that the human body consists of 25 trillion cells, which is more than 2000 times the number of people living on earth, and that these cells have direct or indirect contact with each other through sign processes, one gets an impression of the amount. Only a fraction are known to us. Yet this fraction is hardly comprehensible.... The messages that are transmitted include information about the meaning of processes in one system of the body ... for other systems as well as for the integrative regulation systems (especially the brain) and the control systems (such as the immune system).

Semiosis is the fulcrum around which another emerging interfacial discipline—recently dubbed “semio-immunology” or “immunosemiotics” turns. The central problem immunologists keep struggling with is how the healthy immune system manages to recognize and respond to an almost infinite number of alien organisms and yet fails to assail components of self. What has become reasonably clear is that a single line of defense against potential pathogens is not enough and that there are dissimilarities between antigen recognition by T cells and that by B cells. Jerne has proposed (1985:1058) a model of particular interest to semioticians, including especially linguists, with his claim that the immense repertoire of the vertebrate immune system functions as an open-ended generative grammar, “a vocabulary comprised not of words but of sentences that is capable of responding to any sentence expressed by the multitude of antigens which the immune system may encounter.” The human immune system consists of about 1 000 000 000 000 cells, dissipated over the entire body, excepting only the brain, but the former and the nervous system are known to exercise pervasive mutual sway one over the other by means of two-way electrochemical messages.

The metabolic code constitutes still another fascinating set of endosemiotic properties, because, as Tomkins (1975) showed in his brilliant article completed just prior to his death, complex regulation is characterized by two entities not operating in simple mechanisms: these are metabolic symbols and their domains, where the former “refers to a specific intracellular effector molecule which accumulates when a cell is exposed to a particular environment” (ibid.:761). For example, cyclic adenosine monophosphate (cAMP) acts, in most micro-organisms, as a symbol for carbon-source starvation, or ppGpp acts as a symbol for nitrogen or amino acid deficiency. Without going into details, the conspicuous point to note here is that, while

a simple regulatory mode, that is, a direct chemical relationship between regulatory molecules and their effects, is a clear instance of Peirce's "secondness, or dependence," the complex mode is an instance of "thirdness, or mediation" (3-422). This insight was foreshadowed by Peirce himself in his observation that a "rhema is somewhat closely analogous to a chemical atom" (3-421). Tomkins's reasoning (1975: 761) is highly semiotized: "Metabolic symbols need bear no structural relationship to the molecules which promote their accumulation," and, since a particular environmental (or contextual) condition is correlated with a corresponding intracellular symbol, the imputed "relationship between the extra- and intracellular events may be considered as a 'metabolic code' in which a specific symbol represents a unique state of environment."

The endocrine and the nervous systems, as noted above, are intimately fastened together via signs. As for the neural code itself, semiosis is what neurobiology is all about. "The modes of communication include membrane conductances, patterns of neural spikes and graded potentials, electric coupling between cells, electrical and chemical transmission at synapses, secretion, and modification of neural function" (Prosser 1985: 118). The basic principle for understanding most sign use by neurons comes down to the selective permeability of their plasma membrane to ions (charged atoms), which seem to penetrate through specific pores, or channels, in the membrane. Another newly labeled interfacial field of research is "neuro-communications," which aims to portray in a current jargon the (human) mind, or "software level," and brain, or "hardware level," as a pair of semiotic coupled engines, namely, computational devices for verbal – nonverbal sign processing.

Beyond endosemiotics, the literature of biosemiotics distinguishes among phyto-, cyto-, and zoosemiotics, the latter comprising a specially marked branch, anthroposemiotics, to reflect its predominantly glottocentric emphasis, amounting at times to an obsession. These distinctions correspond exactly to the standard classification of eukaryotic multicellular organisms into the plant, fungus, and animal super-kingdoms, the last including the *animal loquens*. The minor tradition I cited above concentrates on anthroposemiotics to the exclusion of all the other divisions; it excludes, that is, almost all of the rest of nature.

The plant-animal-fungus trichotomy (see also other chapters this book) is based on the manifold but complementary nutritional pattern of each group, which is to say on the manner in which information, or negentropy, is maintained by extracting order from the environment. It is therefore at

bottom a semiotic taxonomy. Plants, deriving their food from inorganic sources by means of photosynthesis, are *producers*. Animals, ingesting their food-performed organic compounds-from other organisms, are transformers. Fungi, breaking their food down externally and then absorbing the resulting small molecules from solution, are *decomposers*. On this macroscopic scale, plants and fungi are two polar-opposite life forms: the composers, or organisms that build up, and the *decomposers*, or the organisms that break down. Animals are the mediators between the other two. By reason of their go-between status, animals have become incomparable virtuosi at semiosis, and that on several levels: in the interactions among their multitudinous cells; among members of their own species; and with members of all other life forms extant within their *Umwelten*. It is even possible to postulate provisionally a fruitful analogy between the systematists' P-A-F model and the classic semioticians' O-S-I model: according to this, in general, a fungus/interpretant is mediately determined by an animal/sign, which is determined by a plant/object (but plant/fungus are likewise variant life forms, of course, just as object/interpretant are both sign variants; cf. Peirce to Welby, in Hardwick 1977:31, 81).

As one would expect, the literature of zoosemiotics (a surprisingly productive term coined in 1963), dealing with both semiosis in the speechless animals and nonverbal semiosis in *Homo*, is immense. (Two encyclopedic overviews are to be found in Sebeok 1968 and Sebeok 1979b.) Many investigators consider separately aspects of intra-specific animal communication (see, for example, Lewis and Gower 1980; and Bright 1984) and aspects of interspecific communication, which are further partitioned into communication with members of other animal species and, as a specially elaborate case thereof, two-way communication between animals and men; the latter further impinges on a host of problems of animal taming, training, and domestication. One particular subtopic which, abetted by much media brouhaha, continues to excite the public, but also on which work has now reached a perhaps unsurmountable impasse, has focused on a search for language propensity in three African and one Asian species of apes, and/or also in certain pelagic mammals (for critical reviews, see Sebeok and Umiker-Sebeok 1980; Umiker-Sebeok and Sebeok 1981a; and Sebeok 1986b.)

Semiosis in the vegetative world has been accorded much less discussion, but the principles underlying phyto- semiotics are thoughtfully assessed by Krampen (1981; cf. also the remarks of Thure von Uexküll 1986: 211-212). Krampen (*ibid.*:203) argues that their code differs from those of zoosemiotics "in that the absence of effectors and receptors does not allow

for the constitution of [Jakob von Uexküll's] functional cycles, of object signs and sign objects, or of an *Umwelt*," yet that the world of plants "is nevertheless structured according to a base semiotics which cuts across all living beings, plants, animals, and humans alike." For instance, plants, though brainless and solipsistic systems they may be, are capable of distinguishing self/non-self. Plant semiosis incorporates the ancient microcosmos, a circumstance that accounts for botanical success, and they do have significant interactions with both animals and fungi.

Semiosis in fungi, or cytosemiosis, is not yet well understood, although their modes of interaction with other life forms specially algae, green plants, insects, and warm-blooded animals (to which they are pathogenic)-by such means as secretion, leakage, and other methods are basically known. One of the most fascinating forms of semiosis has been described in the cellular slime mold, where the sign carrier turns out to be the ubiquitous molecule cAMP, mentioned above.

There exists a massive and very ramified literature, though shockingly uneven in quality, on the biological bases of human nonverbal semiosis; for two excellent general accounts, see Guthrie (1976) and Morris (1977). By contrast, since Lenneberg's masterful (though sadly neglected) 1967 synthesis, there has been no similarly comprehensive discussion of the biological foundations of language. For a recent discussion of the main issues relating to the origin of language, see Sebeok (1986c). That article argues that language emerged as an evolutionary adaptation over two million years ago, in the guise of a mute semiotic modeling system-briefly, a tool wherewith hominids analyze their surroundings-and was thus present in *Homo habilis* and all successor species. Speech, the paramount linear display of language in the vocal-auditory mode, appeared as a secondary exaptation probably less than 100,000 years ago, the minimum time required to adjust a species-specific mechanism for encoding sentences with a matching mechanism for decoding and interpreting them in another brain. The fine-tuning process continues. The overall scenario sketched out in that article is in good conformity with Thom's (1975:309-311) judgment about the double origin of language, in response to two needs, one personal-"aiming to realize the permanence of the ego"-and the other social-"expressing the main regulating mechanisms of the social group." And it is likewise so with Geschwind's equivalent view (1980:313) "that the forerunners of language were functions whose social advantages [that is, communicative function] were secondary but conferred an advantage for survival [that is, the modeling function]."

The Stoics were well aware that “animals ... communicate with each other by means of signs” (Sebeok 1977: 182). By the thirteenth century, Thomas Aquinas had concluded that animals make use of signs, both natural and those founded on second nature, or custom. Virtually every major thinker about semiotic issues since, from Peirce to Morris to Thom, and, above all, Jakob von Uexkull, have reaffirmed and generalized this fact to encompass the totality of life. Only a stubborn but declining minority still believes that the province of semiotics is coextensive with the semantic universe known as human culture; but this is not, of course, to deny Eco’s dictum (1976: 22) that “the whole of culture should be studied as a communicative phenomenon based on signification systems.”

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