Biolinguistics and Biosemiotics

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Abstract The paper surveys the fields of biolinguistics and biosemiotics, outlines their domains of common interest, and discusses the differences between their research programs. It shows that the two interdisciplines have developed in parallel, carry a similar academic prestige, overlap in their scope of topics of inquiry, and have common roots in the history of evolutionary and genetic biology. Whereas biolinguists restrict themselves to the study of language, biosemioticians are interested in the study of organisms in general, wherefore the biosemiotic research program is closely associated with theoretical biology. The differences are not only differences between the general and the specific but also between theoretical foundations. Biolinguistics has its foundation in Chomsky's linguistics, in particular in his "Minimalist Program", and it has a high interdisciplinary interest in neurolinguistics, genetics and the behavioral and brain sciences. Biosemiotics, by contrast, is founded on a research program that extends semiotics to a theory of sign processes in culture and nature. The paper concludes with considerations about the influence of Peirce's semiotics on Chomsky's biology of language.

Keywords Biolinguistics • Biosemiotics • Biology • Language • Semiotics • N. Chomsky • Ch.S. Peirce

Biolinguistics and biosemiotics are two sister sciences of common lineage, which overlap in their domains of research. Nevertheless, it seems as if the two siblings have taken little notice of each other until very recently.[1] Were they separated at birth or have they become alienated since then? What do they have in common? The present paper can only suggest a few answers to such questions, which are worth a research project of its own.

[1] Augustyn 2009 and 2013; Barbieri 2010; Swan 2011.

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E. Velmezova et al. (eds.), *Biosemiotic Perspectives on Language and Linguistics*, Biosemiotics 13, DOI 10.1007/978-3-319-20663-9_8

What Biosemiotics and Biolinguistics Have in Common

Biolinguistics and biosemiotics show remarkable parallels in their history and prehistory. They have common roots and many common research interests.

Parallels: Beginnings, Development, and the State of the Art

Biolinguistics and biosemiotics are about the same age, have partly the same origins and they have gone through parallel developments. Both interdisciplines enjoy international prestige and have succeeded in securing a firm place among the academic disciplines at the crossroads of life sciences and humanities within a few decades.

Neither biolinguistics nor biosemiotics were heard of in the current sense before the 1960s or 1970s, respectively, although the research topics of the two interdisciplines had been studied earlier under other designations. The editors of *Biolinguistics* give the following information about the genealogy of the designation of their interdiscipline in the first issue of their journal:

> The term "biolinguistics" first appears, to our knowledge, as part of a book title, the *Handbook of Biolinguistics*, published nearly 60 years ago (Meader and Muyskens 1950). The book advocates (as the authors put it) a modern science of biolinguistics, whose practitioners "look upon language study […] as a natural science, and hence regard language as an integrated group of biological processes […]. This group seeks an explanation of all language phenomena in the functional integration of tissue and environment" (Meader and Muyskens 1950, p. 9). The term "biolinguistics" resurfaces in 1974 as part of a report on an interdisciplinary meeting on language and biology (Piattelli-Palmarini 1974), attended by Salvador Luria and Noam Chomsky, and organized by Massimo Piattelli-Palmarini, under the sponsorship of the Royaumont center for a Science of Man.[2]

Without any apparent connection to these two terminological precursors, the term *biolinguistics* also appeared in East Germany, in its German variant *Biolinguistik*, in the title of a paper by Joachim-Hermann Scharf in 1975. However, before the turn of the century, the term was rarely used, if at all. In French its first occurrence seems to be in the title of a paper by Jacques Ninio, in 1990. The term *biosemiotics* first appears in sporadic usages employed by Friedrich S. Rothschild (in 1962 and 1968), Juri Stepanov (in 1971), Marcel Florkin (in 1974), Walter A. Koch (in 1974),[3] and Rudolf Jander (in 1981) before it became the name of a research field of its own from the late 1980s onwards.[4]

The topics of both interdisciplines were first studied under other names, usually expressions with *biology* as one of their constituents and *language*, *communication*, or *semiotics* as the other. The immediate precursors of modern biolinguistics can be found in studies carried out under the designation of *biology of language*. Widely

[2] Boeckx and Grohmann 2007, p. 2.

[3] Cf. Koch 1974, p. 318.

[4] Cf. Nöth 2000, p. 254; Kull 1999.

acknowledged as a classic of modern biolinguistics are two books with titles of this kind: Eric Heinz Lenneberg's book on *The Biological Foundations of Language* of 1967, and Philip Lieberman's *Biology and Evolution of Language* of 1984. There are good reasons to consider the date of Lenneberg's book's publication, 1967, as the birth date of modern biolinguistics.[5] In fact, the term *biology of language* remained a synonym of *biolinguistics* for many years. In the immediate succession of Lenneberg and Lieberman, early studies in biolinguistics continued to be published under titles such as *The Biology of Language*[6] or *Biological Foundations of Language.*[7]

Among the immediate precursors of the term *biosemiotics* is *biocommunication*, used in the title of Günter Tembrock's remarkable book of 1971 on animal communication.[8] This is the field of research for which Thomas A. Sebeok had earlier introduced the designation of *zoosemiotics.*[9] Zoosemiotics and biosemiotics are not always sharply distinguished from one another. Logically, the former can be conceived as a branch of the latter since the study of biological sign processes evidently includes the study of animal communication. However, there is also a tendency to define biosemiotics more narrowly in contrast to zoosemiotics as the study of microbiological sign processes.[10] Nevertheless, if we take the two volumes issued under the titles of *Biosemiotica I* and *II* as paradigmatic of its scope,[11] the research field of biosemiotics comprises a very broad spectrum of topics ranging from cellular sign processes and genetic codes to the evolution of human sign use up to the emergence of verbal language.

There are also remarkable parallels between the two disciplines as to their development since their beginnings and their current state of the art. In both fields of research, we now find programmatic surveys and in depth studies of the respective research fields. In biolinguistics, the current state of the art is covered comprehensively by Lyle Jenkins, Talmy Givón, W. Tecumseh Fitch, Anna Maria Di Sciullo and Cedrik Boeckx, C. Boeckx and Kleanthes K. Grohmann.[12]

The state of the art in biosemiotics is well documented in the *Introduction to Biosemiotics* edited by Marcello Barbieri,[13] the collective volumes *Biosemiotics*,[14] *Biosemiotica I* and *II*,[15] in the works by Joachim Schult,[16] Jesper Hoffmeyer,[17] in the

[5] Jenkins 2000, p. 3; Fitch 2009, p. 284.

[6] Walker 1978; Puppel 1995.

[7] Ballmer 1982; Suchsland 1992.

[8] Tembrock 1971; cf. Sebeok 1968b.

[9] Sebeok 1968a and 1972.

[10] Cf. Nöth 2000, p. 254.

[11] Sebeok 1999; Hoffmeyer and Emmeche 1999.

[12] Cf. Jenkins 2000; Givón 2002; Fitch 2009; Di Sciullo and Boeckx 2011; Di Sciullo 2012; Boeckx and Grohmann 2013, correspondingly.

[13] Barbieri 2007a.

[14] Sebeok and Umiker-Sebeok (eds.), 1992.

[15] Sebeok 1999; Hoffmeyer and Emmeche 1999.

[16] Schult 2004.

[17] Hoffmeyer 1993 [1996] and 2008.

survey articles by Kalevi Kull[18] and M. Barbieri, and in the *Essential Readings in Biosemiotics* edited by Don Favareau.[19]

Last but not least, both interdisciplines have managed to establish themselves in academia by means of periodicals. Since 2007, *Biolinguistics* is an open access internet journal which serves as a forum for "the exploration of issues related to theory formation within the biolinguistic program of generative grammar as well as results drawn from experimental studies in psycho- and neurolinguistics or cognition at large",[20] and since 2005 biosemioticians have had their own periodical, first, the *Journal of Biosemiotics* and since 2008, *Biosemiotics*.

What is the scope of biolinguistics and of biosemiotics, respectively? Let us first consider the recurrent topics of research and the interdisciplinary connections of the two research fields (in sections "Parallels: Beginnings, Development, and the State of the Art" and "The Scope of Biosemiotics"). Both research fields are evidently concerned with biological foundations, determinants, or roots of their respective domains, one domain being language, the other consisting of sign processes and sign systems in general. Since language is a sign system and semiotics is the study of signs and systems of signs, biolinguistics should be a branch of biosemiotics. In reality, however, there is only an overlap between the two research fields and most publications in biolinguistics are not based on biosemiotic premises.[21] The two research fields are not **a priori** rigidly defined in their extent, but the topics subsumed under each of them in the publications that carry the names of the respective disciplines permit the following outline of the two research fields.

The Scope of Biosemiotics

Recurrent topics of biosemiotics, as it presents itself in the papers of *Biosemiotica I* and *II*, *Biosemiotics*, the *Introduction to Biosemiotics* edited by Barbieri, Favareau's *Essential Readings*, and elsewhere, deal with

- microbiological and molecular sign processes,[22]
- cellular semiosis (sign processes within and between cells[23]),
- processes of immunological semiosis,[24]

[18] Kull 1999.

[19] Favareau 2010.

[20] As formulated online in the journal's "Editorial Policies" (http://tinyurl.com/k47h8gw; website consulted in September 2014).

[21] Sebeok 1999.

[22] Kawade 1996.

[23] Florkin 1974; Sercarz et al. 1988; Barbieri 2003 and 2007; Bruni 2007.

[24] Eco 1988; Prodi 1988a, b; Sercarz et al. 1988.

– endosemiosis vs exosemiosis, i.e., sign processes that take place within organisms and between organisms,[25]
– genetics, "the grammar of genes", in particular "how the genetic code resembles the linguistic code",[26]
– neurosemiotics,[27]
– phytosemiosis (sign processing by and in plants[28]) and semiosis in symbiosis, parasitism, and mimicry,[29]
– the semiotics of nature in general[30] and ecological aspects of biosemiosis in particular,[31]
– physical bases of biosemiotic processes[32] and the role of semiosis in the emergence of life from lifeless matter,[33]
– biological evolution,[34] communication,[35] and the origins of semiosis in general,[36]
– evolutionary roots of language,[37] biosemiotics and biolinguistics,[38] language and life,[39]
– evolutionary roots of culture, literature, and the arts[40] and the "poetics of nature",[41]
– artificial life,[42]
– transdisciplinary connections with cybernetics,[43] information theory,[44] and the theory of self-organizing systems,[45]

[25] This is a distinction first drawn by Th.A. Sebeok (1972, p. 163), Uexküll et al. (1993), J. Hoffmeyer (2008, pp. 213–264).

[26] As the subtitle of López-Garcia 2005 puts it; Pollack 1994; Barbieri 2003.

[27] Nöth 2000, p. 259; Roepstorff 2004; Kull et al. 2008, p. 50.

[28] Krampen 1981 and 1992; Witzany and Baluška 2012.

[29] Nöth 2012b.

[30] Nöth and Kull 2001; Hoffmeyer 2005 and 2010; Nöth 2008.

[31] Nöth 1998; Nielsen 2007.

[32] Pattee 1997 and 2001.

[33] Hoffmeyer 1993 [1996] and 2008; Weber 2009.

[34] Kull 1992; Andrade 1999; Hoffmeyer 1993 [1996] and 2008.

[35] Sonea 1992.

[36] Nöth 1994.

[37] Koch 1991; Deacon 1997; Hoffmeyer 1993 [1996, pp. 97–112] and 2008, pp. 265–314; Katz 2008; Barbieri 2007b.

[38] Augustyn 2009; Barbieri 2010.

[39] Emmeche and Hoffmeyer 1991.

[40] Koch 1983, 1986a, b, 1989 and 1993; Coletta 1999.

[41] Weber 2011.

[42] Emmeche 1992; Etxeberria and Ibañez 1999.

[43] Brier 1999.

[44] Nöth 2012a.

[45] Vijver 1999.

– basic concepts of semiotics, such as sign, semiosis, cognition, intelligence,[46] signal, symptom,[47] meaning,[48] signification,[49] self-reference,[50] information,[51] or intentionality,[52] in light of biosemiotics.

The Scope of Biolinguistics

An authoritative definition of biolinguistics has been proposed by Noam Chomsky. Biolinguistics studies internal languages ("I-languages") in the following way: "The biolinguistic perspective regards the language faculty as an 'organ of the body', along with other cognitive systems. Adopting it, we expect to find three factors that interact to determine I-languages attained: genetic endowment (the topic of Universal Grammar), experience, and principles that are language- or even organism-independent. Research has naturally focused on I-languages and UG, the problems of descriptive and explanatory adequacy."[53]

With its programmatic restriction to how knowledge is encoded by a language organ, the scope of biolinguistics is narrower than that of biosemiotics. Which aspects of language are in its focus, and what is the interdisciplinary scope of biolinguistics? Answers to these questions can be found in Jenkins's study entitled *Biolinguistics: Exploring the Biology of Language*: "Evidence has been drawn from studies of: universal and comparative grammar (syntax, semantics, morphology, lexicon, phonetics, phonology), acquisition in children, psycholinguistic tests, perceptual studies, articulatory and acoustic phonetics, brain injuries and diseases (aphasias, aprosodias, etc.), split brains, language-isolated children (Genie), developmental disorders (Laura), electrical activity (e.g., ERPs), imaging (PET, MRI, etc.), genetic disorders (sporadic and familiar), twin studies, language in the deaf (sign language), language in the blind, linguistic savants, pidgin and creole languages".[54]

Besides linguistics proper, neurophysiology and neurolinguistics,[55] on this account, genetics and the behavioral and brain sciences are close to biolinguistics. However, Jenkins's list of the interdisciplinary connections of biolinguistics is by no means complete. Among the disciplines whose research results other biolinguists have consulted are evolutionary and comparative historical linguistics,[56]

[46] Hoffmeyer 2008.

[47] Staiano-Ross 2012.

[48] Cowley 2008.

[49] Hoffmeyer 1993 [1996, pp. 1–10] and 2000.

[50] Hoffmeyer 1993 [1996, pp. 39–51]; Goudsmit 2009.

[51] Salthe 2007; Barbieri 2012.

[52] Schult 1992; Deely 2007.

[53] Chomsky 2005, p. 1.

[54] Jenkins 2000, pp. 228–229.

[55] Ahlsén 2006.

[56] Scharf 1975; Bichakjian 1995; Hauser 1996; Larson et al. 2010; Di Sciullo and Boeckx 2011.

paleoanthropology and comparative anatomy,[57] sign language studies,[58] ethology and animal communication studies,[59] especially in apes and various bird species, cultural anthropology, cognitive science, as well as cell and molecular biology.[60] The *Cambridge Handbook of Biolinguistics* outlines the interdisciplinary scope of biolinguistics by dividing the research field into three domains, (1) language development (psycholinguistics of language acquisition and bilingualism), (2) mind, brain, behavior (cognitive and brain sciences, neurosciences, aphasiology, genetics), and (3) language evolution (including biological and human evolution in general as well as evidence from primatology and bird song studies).[61]

Overlap, Differences, and Common Ground

Although the survey of the topics and affiliations of biolinguistics and biosemiotics presented above testifies to common interests and some overlap between the two fields, differences must not be ignored. Such differences are apparent in the relevant definitions of the two interdisciplines and the premises of the research programs by the founders and leading representatives of the two interdisciplines.

The Biolinguistic Research Program

There is little disagreement about the basic assumptions and premises of the biolinguistic research program. The core belief of biolinguists, according to Fitch, is "that the human capacity to acquire and use language is an aspect of human biology, and that it can thus be profitably studied from a biological perspective".[62] His résumé that "the central research topic in biolinguistics is a characterization and explanation of the human capacity to acquire and use language"[63] is in full accordance with the much earlier outline of the goals of the same research program, which Barbara von Eckardt formulated in the form of the following questions: "What is the genetic program underlying the uniformity in human language capacity, the course of language acquisition in children, and the apparent diversity of natural languages?"[64]

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[57] Lieberman 1984.

[58] Armstrong et al. 1995.

[59] Suchsland 1992, pp. 103–142; Győri 1995.

[60] Fitch 2009.

[61] Boeckx and Grohmann 2013.

[62] Fitch 2009, pp. 283–284.

[63] *Ibid.*, p. 287.

[64] Eckardt Klein 1978, p. 3.

Manfred Bierwisch specifies the biolinguistic program by substantiating the claim for the biological nature of the human language faculty with three arguments: (1) The human language faculty is species-specific, it has genetic roots, and it develops in critical phases. (2) Evidence for the biological nature of language comes from language disturbances caused by brain lesions, which is proof that the human language faculty is due to certain cerebral mechanisms. (3) Language is acquired with a remarkably incomplete, heterogeneous, and sometimes even mistaken verbal input.[65]

The founding father of the biolinguistic research program is Chomsky, whose programmatic manifestos of the biolinguistics research program are his treatises *Cartesian Linguistics* (1966) and *Language and Mind* (1968). According to Jenkins, Chomsky's guidelines for biolinguistic research can be summarized in five programmatic questions: "(1) What constitutes knowledge of language? (2) How is this knowledge acquired? (3) How is this knowledge put to use? (4) What are the relevant brain mechanisms? (5) How does this knowledge evolve (in the species)?"[66]

The Biosemiotic Research Program

"Biosemiotics can be defined as the science of signs in living systems", states K. Kull[67] succinctly, while Claus Emmeche presents the following outline of a more comprehensive research field: "*Biosemiotics* proper deals with sign processes in nature in all dimensions, including (1) the emergence of semiosis in nature, which may coincide with or anticipate the emergence of living cells; (2) the natural history of signs; (3) the 'horizontal' aspects of semiosis in the ontogeny of organisms, in plant and animal communication, and in inner sign functions in the immune and nervous systems; and (4) the semiotics of cognition and language. […] Biosemiotics can be seen as a contribution to a general theory of evolution".[68]

In contrast to N. Chomsky, who conceives of "the study of language as part of biology",[69] and C. Boeckx and Massimo Piatelli-Palmarini, who propose that biolinguistics and linguistics be seen as two "natural sciences",[70] biosemiotics is not a branch of biology for C. Emmeche, but "it is a branch of general semiotics".[71] J. Hoffmeyer, too, rejects the view of biosemiotics as a natural science. In his opinion, biosemiotics is more closely related to a "process philosophy, which considers substance (matter) not as life's fundamental entity but rather as an intermediate stage of an emergent *process*" and which is "principally anchored in the evolutionary philosophy of Charles S. Peirce".[72]

[65] Bierwisch 1992, pp. 8–11.

[66] Jenkins 2000, pp. 1, 228.

[67] Kull 1999, p. 386.

[68] Emmeche 1992, p. 78.

[69] Chomsky 2007, p. 14.

[70] Boeckx and Piatelli-Palmarini 2005.

[71] Emmeche 1992, p. 78.

[72] Hoffmeyer 2008, p. 4.

The undisputed founder of the biosemiotic research program is Th.A. Sebeok (1920–2001), although he himself reminds us that it was Charles Morris (1901–1979), who, in his book *Signs, Language and Behavior* of 1946, had already postulated that progress in semiotics "rests finally upon the development of a genuine science of signs, and that this development can be most profitably carried on by a biological orientation".[73]

Like Chomsky, Sebeok has his background in linguistics, and like Chomsky, Sebeok is in favor of a "biological approach" to the study of signs.[74] However, Sebeok cannot subscribe to the view that biosemiotics is a branch of biology because the spheres of life and signs, Juri Lotman's biosphere and semiosphere,[75] are coextensive: "The criterial mark of all life is semiosis; and […] semiosis presupposes life. Accordingly, the bailiwick of biology may be viewed as equivalent to 'natural semiotics' […] or biosemiotics".[76]

Sebeok's biosemiotics is not directed towards affirming the uniqueness of the human language faculty. In the debate between the essentialists and the evolutionists, in which we find biolinguists generally taking the essentialist side, biosemioticians are usually found on the evolutionist side. The former argue that language is essentially "different from other forms of communication and that language separates humans from other species",[77] whereas the latter postulate continuity in the growth of sign processes and systems.[78] Furthermore, whereas biolinguistic research begins with the origins of language, the biosemiotic research program begins with the origins of life.[79]

The current biosemiotic view about the relation between biology and semiotics, documented in the first of eight theses of a joint manifesto of the biosemioticians K. Kull, Terrence W. Deacon, C. Emmeche, J. Hoffmeyer, and Frederik Stjernfelt, can be read as a homage to Sebeok, when its very first thesis states that "the semiosic-nonsemiosic distinction is coextensive with the life-nonlife distinction, i.e., with the domain of general biology".[80] For Sebeok, the semiotic threshold between the non-semiotic and the semiotic world is the threshold between life and lifeless things.[81] For him, this is a threshold between information and semiosis. In evolution before the origins of life we only find information (the ongoing increase of entropy), whereas semiosis begins with the origin of life.[82]

[73] Sebeok 2001, p. 3.
[74] Sebeok 1994, pp. 5–9.
[75] Sebeok 2001, p. 158.
[76] *Ibid.*, p. 10.
[77] Messer 1995, p. 174.
[78] Cf. Bichakjian 1995.
[79] Nöth 1994.
[80] Kull et al. 2009, p. 168.
[81] Sebeok 1986, p. 15.
[82] *Ibid.*

The eighth programmatic thesis on biosemiotics, which states that "organisms create their umwelten",[83] shows the hand of another precursor of modern biosemiotics, Jakob von Uexküll (1864–1944), the author of an ecological *Theory of Meaning*.[84] Environment, according to Uexküll,[85] is not a world exterior to the organism, but rather a subjective *Umwelt*, consisting of an inner world, as given by the organism's perception and specific operational world of practical interaction, with the environment. *Umwelt*, in this sense, is the way in which the environment is represented to the organism's mind, and it comprises the scope of the organism's operational interaction with its environment. Because of the species-specific differences between organisms, their different needs, capacities, and perspectives of their environment, there are as many kinds of *umwelt* as there are species (or even organisms). Every species and every organism can only perceive whatever the biological structure of its receptors, its brain, and its specific perspective of its environment allows it to perceive.

Further sources of inspiration of Sebeok's biosemiotics are Peirce's as well as Lotman's semiotics, in particular Lotman's theory of the semiosphere (cf. above) and of modeling systems.[86] Adapting Lotman's theory of culture as a secondary modeling system to the broader scope of a semiotics that begins in the organic world and with reference to Peirce's premise that "not only thought is in the organic world, but it develops there",[87] Sebeok postulates that modeling begins with mental representations in all organisms so that it "permeates the entire organic world".[88] *Modeling* and semiosis are hence practically synonyms, but humans model at three levels, whereas animals model only at one. Sebeok defines modeling in anima semiosis and in human cognition as *primary. Secondary modeling*, by contrast, begins with human language and its unique syntactic potential (an acknowledgement of Chomsky's biolinguistic claim), whereas *tertiary modeling* is the characteristic of "true culture".[89]

The seventh of the programmatic theses on biosemiotics states that "semiosis is a central concept for biology"[90] and thus reveals its foundation in the semiotics of Peirce (1839–1914). Sebeok gives with the following definition of semiosis: "In Peirce's usage, semiosis, or 'action of a sign', is an irreducible triadic process, comprising a relation between (1) a sign, (2) its object, and (3) its actual or potential interpretant.[91] Peirce particularly focuses upon the way that the interpretant is produced, and thus what is involved is understanding, or teleonomic (i.e., goal-directed) interpretation of a sign".[92] This is why semiotics cannot be a branch of biology and

[83] Kull et al. 2009, p. 172.

[84] Cf. Uexküll 1928 [1973] and 1940; Kull 2001.

[85] Uexküll 1940, pp. 158, 334.

[86] Cf. Sebeok and Danesi 2000.

[87] Peirce 1866–1913 [1931–1958], CP (= *Collected Papers*) 5.551, 1905 (=a manuscript of 1905).

[88] Sebeok 1994, pp. 126–127.

[89] *Ibid.*

[90] Kull et al. 2009, p. 171.

[91] Peirce 1866–1913 [1931–1958], CP 5.473, 1907.

[92] Sebeok2001, p. 17.

neither can biology be a branch of semiotics. Life and semiosis are intimately intertwined, so that "a full understanding of the dynamics of semiosis may, in the last analysis, turn out to be no less than the definition of life".[93]

Rudimentary Semiosis in the Realm of Plants

What Peirce means by semiosis as the action of a sign is not always well understood. Although semiosis has indeed to do with interpretation, Peirce does not define it as the agency of an *interpreter* or *code-maker*, as Barbieri[94] and others see it, who have adopted Morris's view of semiosis as the agency of a sign maker. With Peirce, the notion of the "action of the sign" has to be taken literally. The sign, and not some interpreter, is the agent in semiosis.[95] The agency of semiosis is one of mediations between the object represented by the sign and interpretant, which is the semiotic effect of the sign. Furthermore, processes of semiosis involve teleology or purpose, a mode of causality which begins at the microbiological level.[96] Peirce goes so far as to say that such processes involve *mind*, when he states: "The microscopist looks to see whether the motions of a little creature show any purpose. If so, there is mind there".[97]

Let us illustrate Peirce's theory of semiosis in nature further with an example of phytosemiosis. As early as 1865, Peirce had begun to reflect on affinities between the biological dissemination of plants and processes of semiosis and representation. However, these first associations between biological reproduction and semiotic mediation were still rather hypothetical. The argument was only that a plant propagating itself is "somewhat like" a medium standing for something: "Everything may be comprehended or more strictly translated by something; that is, has something which is capable of such a determination as to stand for something through this thing; somewhat as the pollen-grain of a flower stands to the ovule which it penetrates for [the] plant from which it came since it transmits its peculiarities of the latter".[98] Before 1900, Peirce could not yet affirm that plants are semiotic agents because his definitions of sign, representation, and the representamen still postulated the criterion of an interpreting mind. In 1873, Peirce argues that phenomena of

[93] Sebeok 1985, p. 69.

[94] Barbieri 2008a, b and 2010, p. 205. Barbieri does not quote Morris, but his definition of semiosis as "the production of signs" (Barbieri 2008a, p. 577) or as the result of the agency of a "code-maker" who "is the agent of semiosis, whereas signs and meanings are its instruments" is certainly in line with Morris's definition of semiosis "as a process in which something is a sign to some organism" (Morris 1946, p. 366) as far as the question of the agency in the process of semiosis is concerned (the question as to who is the agent in a sign process; cf. Nöth 2009).

[95] Cf. Nöth 2014a.

[96] Santaella 1999.

[97] Peirce 1866–1913 [1938–1958], Peirce 1982, CP 1.269, 1902.

[98] P. 333, (a manuscript of 1865).

an inanimate nature are signs only if understood as such by an interpreting mind. A weather-cock, for example, "is a sign of the direction of the wind", but usage of the word **sign** applied in this case "is an indirect one", for: "unless there be some way or other which shall connect words with the things they signify, and shall ensure their correspondence with them, they have no value as signs of those things". A thing "is not actually a sign unless it is used as such; that is unless it is interpreted to thought and addresses itself to some mind".[99] In 1897, the interpreting mind is a real interpreter. Here, "a sign, or representamen, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign".[100]

With his extension of the concept of representamen, a quasi-synonym of "sign", in 1902, to processes in the absence of human minds, Peirce could now affirm what he had merely hypothesized in 1873, namely that the faculty for biological self-reproduction makes a sunflower a representamen: "If a sunflower, in turning towards the sun, becomes by that very act fully capable, without further condition, of reproducing a sunflower which turns in precisely corresponding ways toward the sun, and of doing so with the same reproductive power, the sunflower would become a Representamen of the sun".[101] The process of semiosis described here characterizes the sunflower as a representamen; its object is the sun, and its interpretant is the flower's offspring. The sun is the object represented by the plant because it determines it to turn towards the sun. The flower's offspring is its interpretant because the daughter-flower stands in the same relation to the sun as its mother stood and because the daughter is determined by its mother to behave in the same way as she used to behave.

Peirce thus seems to be more specific as to the agency of plants in processes of semiosis: the sunflower exemplifies the agency of a representamen representing an object and translating its message to its offspring. Nevertheless, instead of saying that these plants *are* representamens which are not signs, Peirce restricts himself to saying that there are "possibly" representamens which are not signs, and instead of concluding that the sunflower *is* a representamen of the sun he only says, in the above quote, that it "would become a Representamen of the sun". This way of avoiding an early commitment to insights which have meanwhile been advanced in biosemiotics may be read as an exemplification of Peirce's principle of fallibilism: instead of raising the new insight immediately to the status of a certainty, he foresees the necessity of further research into the questions raised by his hypothesis.

Peirce comes to the conclusion that "possibly there may be Representamens that are not Signs", not without adding the additional reservation that "thought is the chief, if not the only, mode of representation".[102] Again, Peirce still uses the modal adverb "possibly" to express some fallibilistic uncertainty as to the possibility of semiosis in a nature without thoughts of minds. In 1906, he finally attributes even

[99] Peirce 1866–1913 [1931–1958], CP 7.356, 1873.

[100] *Ibid.*, CP 2.228, 1897.

[101] *Ibid.*, CP 2.274, circa 1902.

[102] *Ibid.*, CP 2.274, circa 1902.

thought to non-human nature,[103] when he writes that "thought is not necessarily connected with a brain. It appears in the work of bees, of crystals, and throughout the purely physical world".[104]

Chomsky, Peirce, and the Biology of Language

Prisca Augustyn argues that there are three bridges able to connect Chomsky's biolinguistic program with Sebeok's biosemiotics.[105] The first two are in Chomsky's references to two topics of equal interest to biosemiotics, ethology, and the Uexküllian notion of *umwelt*. How far these occasional references can justify a significant affinity between biolinguistics and biosemiotics must be left open here.

The third bridge is Peirce's logic of *abduction*, to which Chomsky makes several explicit references in a good number of his papers in the context of reflections on language learning.[106] Is Peirce's logic of abduction a cornerstone of Chomsky's biolinguistic program? Already Chomsky's early remarks on abduction were critical. In *Language and Mind*, Chomsky expresses his "opinion" that Peirce's arguments are "not very persuasive",[107] and his interest in the logic of abduction was apparently short. Trevor Pateman explains why and when Chomsky abandoned the model of abductive language learning.[108]

The most significant incompatibilities between Peirce's semiotics and Chomsky's biolinguistic program are probably two. First, while syntax is the most important module of the human language faculty in the narrower sense according to the biolinguists, pragmatics is in the center of the Peircean semiotic approach to language.[109] Second, while biolinguists focus on genes, the human brain, and the physiology of speech production, Peircean semiotics has its focus on the agency of the sign, to which it attributes a life of its own which is not the sign maker's life.[110] The complementarity of the scopes of the two research fields should be a challenge for more intense interdisciplinary collaboration between biolinguists and biosemioticians.

By means of a provocative thought experiment, Peirce presents the following reasons why the language competence of humans cannot only be accounted for by the way human brains have developed genetic forms that are missing in the brains of other animals: "A psychologist cuts out a lobe of my brain […] and then, when I find I cannot express myself, he says, 'You see your faculty of language was local-

[103] Cf. Santaella 1994.

[104] Peirce 1866–1913 [1931–1958], CP 6.551.

[105] Augustyn 2009 and 2013.

[106] Wirth 1993.

[107] Chomsky 1968 [2006, p. 80].

[108] Pateman 2003. For Peirce's theory of language learning, cf. Nöth 2014b.

[109] Cf. Nöth 2011.

[110] Cf. Nöth 2009 and 2014a.

ized in that lobe.' No doubt it was; and so, if he had filched my inkstand, I should not have been able to continue my discussion until I had got another. Yea, the very thoughts would not come to me. So my faculty of discussion is equally localized in my inkstand. It is localization in a sense in which a thing may be in two places at once".[111] Peirce's argument is that the human language faculty is not embodied in brains and tongues alone. The *umwelt* – here exemplified by the writer's inkstand – and external signs play an equally important role. Ideas are not produced by brains, and thought is not only limited to inner thought. It lives on in external embodiments in which it continues to act in semiosis.

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[111] Peirce 1866–1913 [1931–1958], CP 7.366, 1902.

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