ploying intelligence and imagination in paying due attention to who is speaking/writing, for what purpose and in what context or circumstances, in the light of one's prior experience, if any, of both the speaker/writer and of the language in question.

« 17 » After the passage quoted above, Barbieri continues as follows:

> "By the same token, the rule of the genetic code that a group of three nucleotides (a codon) corresponds to an amino acid is equivalent to saying that that amino acid is the organic meaning of that codon. Anywhere there is a code, be it in the mental or in the organic world, there is meaning. We can say, therefore, that *meaning is an entity which is related to another entity by a code*, and that organic meaning exists whenever an organic code exists." (Barbieri 2016: 6)

« 18 » This makes it clear that the point of Barbieri's brisk characterisation of codes is to propose a modification to what he presumably thinks of as the existing English-language code, whereby henceforth[4] "we can say," meaningfully, that because the biological world is full of codes, it follows that it is suffused with "organic meaning," regardless of the absence from most of the biological world of agents capable of meaning or understanding anything by what they do. What he says about "organic codes" amounts to stipulative (re)definition, and stipulatively defining terms (sign vehicles) is part of the process of drawing up a code, not something one can do using a code itself. To talk of "code biology" is to change the meaning of the word *code* in a way that would be impossible if *code* were a unit of a code, i.e., encoded some fixed meaning.

« 19 » Finally, K (§32) quotes Barbieri as saying that "science is made of models and models do not coincide with reality" ("the map is not the territory"), and that he (K) is wrong in assuming that code biology uses metaphors as if they were not metaphors. K then goes on to observe that when Barbieri speaks of "the discovery of the genetic code" rather than the discovery of DNA, it is precisely an example of how the map *does* become the territory, because the metaphor becomes the theory that announces that "Life is chemistry, information and codes." What is questionable here is whether we are confronted with metaphor at all. "Language is a raft" is a metaphor. No one believes that language is a physical object like a raft. "A language is a code," however, seems to be met with much less scepticism. That is not a metaphor, but a profound and pervasive mistake.

4| This is not intended to imply that this idea of Barbieri's appears for the first time in this particular publication.

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From Code Biology to Cybersemiotics: Levels of Semiosis

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> Abstract • Kravchenko suggests that to understand the nature and function of language one must approach it as species-specific semiotic activity that has a biological function. However, this approach reduces the semiotic nature of living systems to the language characteristic of the *Homo sapiens* and it remains unclear how to move from the biological domain to the social and cognitive semiotic domains. I suggest exploring the possibilities of the cybersemiotic theoretical framework, which could provide an alternative in explaining language in terms of levels of semiosis, and conclude with a call for more research into the emergence of semiosis at various levels and into the role of communication.

Handling Editor • Alexander Riegler

« 1 » Alexander Kravchenko presents a provocative and well-documented discussion on the need to introduce to language sciences a semiotic approach, interpretation processes, the interpreter (observer), and a biological account of cognition and language. He argues that "to understand the nature and function of language, the language sciences must approach it as *species-specific semiotic activity that has a biological function*" (§2, emphasis in original). However, his article still does not explain how to move from the recognition of semiotic processes in cells, all the way up to organisms, societies and human language.

« 2 » In my commentary, I explore alternative approaches that could provide a solution to this problem. I conclude with a call for more research into how semiosis and language arise at various levels and the role of communication in semiotics.

« 3 » In his pioneering work on biosemiotics, Thomas Sebeok (2001) developed the concept of "global semiotics," arguing that all human beings, or more generally, all living entities on our planet modulate

their environment by means of signs, but only humans have the capacity to reflect on them. As explained later by Susan Petrilli and Augusto Ponzio (2007: 33), such a semiotics describes the study of semiosis or the general science of signs from a specifically human perspective because it assumes that only human beings have the capacity to make signs the object of reflection (metasemiosis). However, Sebeok (2001) also proposed "levels of semiotic integration" as an attempt to understand the missing links among semiotic processes in cells, bodies, societies, and cognition. (Similar ideas were presented by Charbel Niño El-Hani, João Queiroz and Claus Emmeche 2009 in their proposal of a multi-level approach to the emergence of semiosis in semiotic systems, and by Søren Brier 2008, 2009 in his proposal of cybersemiotic levels integration.) When considering language from a semiotic perspective, Sebeok (2002: 17) saw the necessity to explain not only the emergence of life but also the emergence of semiosis in living systems, since there could not have been semiosis prior to the evolution of life. Furthermore, in the discussion of whether the genetic code is (like) a language or not, Sebeok considered questioning the analogy between (molecular) endosemiotic code and the anthroposemiotic code (which includes a verbal component) secondary, because what is of importance is that both are productive semiotic systems (ibid: 19). This is why the idea of levels of semiosis is important to understand the biological function of language and the notion of interpretation in living systems at lower levels such as cells and organs. The idea of levels is also important in Brier's work. He claims that language should not be taken as given, but rather should be understood as an emergent property of living systems that involve five cybersemiotic levels that go from the physical, chemical and biological nature in the lower levels of semiosis, to the emergence of consciousness and language at the highest levels. If language has not only a biological root but can also be considered an emergent property of living systems, the problem of considering language as a species-specific semiotic activity with a biological function is explaining how to move from semiotic processes in cells and bodies to semiotic processes in societies and human language. In other words, when explaining the emergence of semiosis in living systems it is equally important to explain the emergence of language since, from a semiotic point of view, language can be considered an emergent property of living systems. However, from the concept of levels of semiosis, it is still not clear whether semiosis and language are emergent processes with physical, biological, social and cognitive dimensions or whether they are emergent processes only at a particular level.

« 4 » The concept of levels of semiosis raises the questions about the interpretation process and the interpreter addressed by Kravchenko, since for him:

> "The key notion of *interpretation*, without which the concept of sign loses its epistemic relevance, poses a cardinal problem in accounting for sign processes in living systems at the lower level, down to the cell: what or who can be fathomed as the 'interpreter' here"? (§8)

We can also add the question about the place of the observer within the process: at which level does the observer emerge or at which level do we locate her?

« 5 » For Kravchenko (§§12f), the semiotic notion of interpretation can be resolved in two ways:

- by revising Peirce's semiotics; and
- through Marcello Barbieri's code-biology proposal in which the notion of interpretation is discarded as irrelevant for semiosis, a theoretical proposal to which Kravchenko is opposed.

However, a third way to address interpretation is through the understanding of emergence of the levels of semiosis, in which interpretation arises with the observer at the higher levels. It can also be considered as an alternative for explaining how to move from the origin of organic semiosis to the origins of animal and human semiosis in Barbieri's proposal.

« 6 » For Sebeok (2001), the first level of sign processes occurring inside individual cells is called *microsemiosis*, the second level related to information networks is called *cytosemiosis*. The third level (*semioses*) concerns the combination of cells into organs by a network of nerve cells, which is subtly intertwined by dendrites of nerve cells with a considerably slower transport system for sign vehicles, the bloodstream. Lastly, based on Thure von Uexküll and co-authors' (1993) study on how the neural and immunological counter worlds are tethered by sign processes to form a conjoined unitary inner world, Sebeok suggested that a fourth *endosemiotic* integration level emerges, which is then turned into "experienced reality" (Sebeok 2001: 13).

« 7 » El-Hani, Queiroz, and Emmeche (2009) describe semiotic processes on three concurrent levels. They claim that in order to describe the fundamental interactions of a given entity or process in a hierarchy, we need first to consider it at the level where we observe it (focal level). Next, we need to investigate it in terms of its relation with the parts described at a lower level (usually, but not necessarily always, the next lower level). And lastly, we need to consider entities or processes at a higher level (also usually but not always the next higher level), in which the entities or processes observed at the focal level are embedded. The higher and lower levels have a constraining influence over the dynamics of the entities or processes at the focal level. These constraints are crucial for explaining the emergence of entities or processes at the focal level. Emergent processes at the focal level are the product of the interaction between processes at the higher and lower levels. In summary, these authors claim that semiosis is a process that emerges at the focal level. However, the authors also recognize that the selection of the focal, the higher and the lower levels depends on the research goals and epistemological and methodological approaches on which each particular research is based.

« 8 » The proposals by Sebeok and El-Hani and his colleagues show that it is not easy to describe semiosis as an emergent process nor to explain its relation to the physical, biological, social and cognitive levels of living systems in general and to human language in particular. Brier's theoretical framework cybersemiotics (2008, 2010) offers a solution to this problem. He argues that cybersemiotics integrates cybernetic, systemic, informational, and semiotic approaches to explain self-organization, selection of differences and constructivism. On the basis of this integration, he proposes the heterarchical levels of evolutionary cybersemiotic emergence, i.e., five basic ontological

concepts that describe, in turn, the five cybersemiotic levels resulting from the integration of Peirce's semiotic philosophy.

« 9 » The first level has a physical nature and is described as quantum vacuum fields entangled by causality. However, it is not considered physically dead as in classical physics; on the contrary, from the Peircean view, it is part of Firstness, which also holds qualia and pure feeling. The second level is related to Peirce's Secondness and is of efficient causation. This level is ontologically dominated by physics (kinematics and thermodynamics), but Peirce also considers it as the willpower of mind; modern information considered it as the differences which, when interpreted, can become significant and meaningful. The third level, a protosemiotic level of objective information where the formal causation manifests itself clearly, is ontologically characterized by chemical sciences and concepts of pattern fitting. The fourth level is related to Peirce's Thirdness; it is where life is self-organized and where semiotic interactions emerge, initiating internally in multi-cellular organisms (*endosemiosis*) and between organisms. Information can help analyze life at the chemical level but, from a biosemiotic perspective, it is not sufficient to capture the communicative and dynamical organizational closure of living systems. Finally, the fifth level is where the human self-consciousness emerges through syntactic language games, bringing along rationality, logical thinking, and creative inferences (i.e., intelligence) (Brier 2009).

« 10 » According to the abovementioned, meaning and language can be considered emergent properties of the higher level's organization with a clear physical and biological basis integrated in the very nature of a living organism, which in turn, allow us to consider an observer as she recognizes something as a sign. This agrees with Kravchenko's discussion about the need to include both the interpretation process and the observer for semiosis to emerge in living organisms. It also allows us to explain the move from matter, cell, and organs to cognition and language in the particular case of the human being.

« 11 » There are two strong arguments in Kravchenko's critique on Barbieri's code biology that coincide with the arguments presented so far:

a the need to include interpretation processes and the observer to understand the emergent nature of semiosis (§9) (even in the most fundamental levels as cells or organs), and

b the need to understand language as a species-specific semiotic activity that has a biological function (§2).

« 12 » Kravchenko's critique on code biology parallels the critique of cybersemiotics on the informational view on information, signification, communication and cognition. Certain concepts compatible with cybersemiotics are already present in Kravchenko's article when he discusses signs as relational phenomena (§§23ff). However, what is missing in Kravchenko's proposal is an account of how to move from cells to language in semiotic terms. For instance, it is not clear whether semiosis is an emergent process in cells or the biological domain of cells is a pre-semiotic level needed for semiosis to emerge at a higher level. In this respect, cybesemiotics appears to be an alternative when addressing and extending the understanding of the emergence of meaning in living systems, as I argued above.

« 13 » Brier (2010) suggests that in terms of systems thinking, the contemporary vision of nature is based on multilevel, multidimensional hierarchies of inter-related clusters that form a heterarchy, i.e., a heterogeneous hierarchy of processual structures. According to Brier, levels emerge through emergent processes, when new holons (something that is simultaneously a whole and a part) appear through higher-level organization. Even though Brier is skeptical about cybersemiotics being able to account for the emergence of life, sense experience and linguistically borne self-consciousness, he nevertheless considers that

> "if this system and cybernetic view is placed into a Peircean framework, where living potentialities (Firstness) are processes manifested through constraints and forces (Secondness) into regularities and patterns (Thirdness) in a recursive manner from level to level, it makes much more sense." (Brier 2010: 254)

« 14 » The move from code biology, to biosemiotics, cybernetics, and finally to cybersemiotics could allow us to consider that cytosemiosis, endosemiosis, and microsemiosis are terms implying that we are dealing with different kinds of semiotics rather than qualitatively entirely different systems. This situation implies the need to study more specifically how semiosis arises in each instance.

« 15 » Finally, Kravchenko's critique on the cognitive inadequacy of the code metaphor and the misuse of Claude Shannon's information theory in contemporary research also suggests the need to include not only a discussion about interpretation, meaning, and information but of cognition and communication, as well. In particular, communication could be the missing link between semiosis, interpretation, meaning, and the place for the observer in this picture. Kravchenko recognizes this when he states that "[…] if all living creatures are semiotic systems, they must be capable of generating meaning as something of value to these systems. But what is meaning and how (where, by whom) is it generated and interpreted?" (§9). And when he recovers Jordan Zlatev's formula to define meaning as the relation between an organism and its physical and cultural environment determined by the value of the environment for the organism (§27), what is being described is precisely a communication process in which meaning emerges as a result since communication can be seen as a meaning-making process produced by an observer or interpreter (Vidales 2017). Exploring the inclusion of communication as a response to the informational view on contemporary research is a path that could reveal new insights on semiosis, language, and meaning in living systems. This is something that is already present in Kravchenko's target article, but which has not been fully developed yet.

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Levels of Interpretation of Signs

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> Abstract • Biosemiotics assumes multiple levels of interpretation of signs. At the lowest level is protosemiosis, which is represented by intracellular information processes, and which can be seen as a semiotic alternative to code biology. Protosemiosis includes interpretation. However, it has fewer components in comparison to mental interpretation. In particular, protosemiosis lacks references to external objects in the sense of Peirce.

Handling Editor • Alexander Riegler

« 1 » In the target article, Alexander Kravchenko argues that the concept of code biology developed by Marcello Barbieri ignores interpretation, which is the essential component of any sign processing, and that biosemiotic theory should approach it differently. I mostly agree with both arguments, and use my experience in biosemiotics, a discipline that integrates biology and semiotics, to outline theoretical developments that allow incorporation of intracellular information processes analyzed by Barbieri into the biosemiotic theory.

« 2 » Intracellular information processes such as transcription and translation are automated, nearly deterministic, and executed by machine-like molecular agents (polymerase-II protein complex and ribosome nucleoprotein, respectively). This inspired molecular biologists to use computer and machine metaphors for describing these processes. Mechanistic interpretation of molecular biology had a huge success in experimental studies of signaling pathways even though it obviously contradicts the non-mechanistic properties of life at the organism level that include freedom, adaptability, and creativity. Barbieri attempted to bridge this gap by developing the concept of code biology. His main point is that the genetic code (a mapping from the set of nucleotide triplets to the set of amino acids) is mechanistic, but its evolutionary origin is not. The evolution of the code depends on the emergence of code-maker agents, such as ribosome and a set of adaptors (tRNA-aminoacyl complexes). Barbieri (2015) attempted to extrapolate the code metaphor to all levels of hierarchical organization of life; he wrote about codes of the body plan, neural code, and the code theory of mind. Barbieri mentioned that the interpretation of signs exists in the minds of animals and humans, but his research was always focused on the code model of semiosis as opposed to interpretative semiosis (Barbieri 2009).

« 3 » Biosemiotics chooses a different path for integrating lower and higher levels of information processes in organisms by rejecting the computer metaphor, together with the notion of coding. Computation is a formalism that assumes determinism, infallibility, and pre-existence of all components; according to biosemiotics, none of these assumptions applies to living systems. In particular, what seems as determinism (e.g., driver stopping at the red light) is in fact *semiotic causality*, which is "bringing about things under guidance of interpretation in the local context" (Hoffmeyer 2008: 64). Semiotic causality includes freedom to choose between possibilities and hence is incompatible with physical determinism. Molecular processes in cells resemble computation only at short time intervals, e.g., during one round of protein synthesis on a ribosome. At longer times, the dynamics becomes increasingly context-dependent. Translation initiation can be blocked, and mRNA can degrade via multiple pathways or get stored in stress granules. Exponentially branching process trajectories are not addressed in the theory of computation. Moreover, molecular processes in cells include construction (and destruction) of agents, programs, scaffolds, and resources. In contrast, computers can only allocate externally supplied memory units to virtual agents and resources. Biosemiotics considers information as signs *interpreted* by some agents. Signs do not exist on their own, i.e., fully independently of agents. Instead they are agency-dependent relational entities because their meanings are grounded in the activity, history, and goal-directedness of agents (Sharov 2018). This approach is not compatible with Charles Sanders Peirce's hylozoism, although some elements of Peirce's semiotics are applicable in biosemiotics.