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REVIEW

Biosemiotic Achievement Award for the Year 2021

Alin Olteanu[1] · **Vinicius Romanini**[2]

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Abstract
The Annual Biosemiotic Achievement Award was established at the annual meeting of the International Society for Biosemiotic Studies (ISBS) in 2014, in conjunction with Springer and Biosemiotics. It seeks to recognize papers published in the journal that present novel and potentially important contributions to biosemiotic research, its scientific impact and its future prospects. Here the winner of the Biosemiotic Achievement Award for 2020 is announced: The award goes to Ahti-Veikko Pietarinen and Majid D. Beni for their article "Active Inference and Abduction".

We are pleased to announce that the Biosemiotic Achievement Award for 2021 goes to Ahti-Veikko Pietarinen and Majid D. Beni for their article “Active inference and abduction”. The article was published in *Biosemiotics* volume 14, issue 2 (August 2021), pages 499–517.

Pietarinen is affiliated with Tallinn University of Technology (Estonia) and the Research University Higher School of Economics (Moscow, Russia) and Beni is affiliated with Middle East Technical University (Ankara, Turkey).

Several excellent papers in the 14th *Biosemiotics* volume reveal new lines of inquiry through discussions on the methods and scope of biosemiotics, often with consideration of the Modern Synthesis. Settling on one paper was not an easy choice. However, Pietarinen and Beni’s paper is outstanding in many regards, displaying an arguably new potential for biosemiotic research and theory.

This paper originally proposes a “naturalization of abduction” (Pietarinen, Beni 2021: 513), namely a thorough grounding of this Peircean notion in biosemiotic theory, in light of the implications for theoretical biology of the recent corollary notion

✉ Alin Olteanu
alin.olteanu@rwth-aachen.de

[1] Käte Hamburger Kolleg Cultures of ResearchRWTH Aachen University, Aachen, Germany

[2] School of Communication and Arts, School of Communication and Arts, São Paulo, Brazil

of "active inference". This sheds new light on matters of endosemiosis and exosemiosis by bringing the Free Energy Principle (henceforth FEP), into the discourse of biosemiotics.

Already a commonplace in theoretical biology, the *FEP* was originally proposed by Friston (2010) as an explanation for how the properties of autopoietic systems are kept invariant in the face of continuous variations in the relations developed with their environment. Put simply, it postulates that biological systems devote a large part of their resources to garnering information that can serve as evidence for a model about the environment. Friston calls this search process *active inference*, a process by which reasoning systems are able to expect sensations and plan their future actions as a means to confirm beliefs that are part of a generative model about the hidden states of their environments. These action/perception cycles explain both the production of new beliefs and the behavior to confirm previous beliefs.

Friston bases his principle largely on the Markov blanket originally introduced by Pearl (1988). The Markov blanket expresses the minimal necessary conditions that boundary regions around an internal state (or node) of any system must have in order to preserve themselves from disruption due to the inexorable increase of entropy. Following Ramstead et al., (2020), Pietarinen and Beni accept that Markov blankets can be interpreted semantically by assuming that sensory states are meaningful representations of reality. As in Peirce's definition of the symbol, the *essere in futuro* is the essence of this process, and its interpretant is hypothetical, or abductive, as Pietarinen and Beni (2021: 503) explain:

> The boundaries of organisms characterized as Markov blankets - or rather their realist interpretation as Friston blankets - have a markedly Peircean, irreducibly triadic form. The boundary itself is a mediator between the agent's external and internal states. It provides the form of how information flows from external to internal states, with the resulting changes in the 'belief' system of the agents concerning its hypotheses, which as Peirce notes are accepted "on probation" (CP 6.525, 1913), namely on what the external changes may turn out to be in the future.

Pietarinen and Beni (2021: 509) propose the following schema for what they term "abductive active inference", as the basic inference at work in the modeling of environments:

"(1) Y, a surprisal, is experienced.

(2) If X were to be the case, then cessation of Y would be the matter of course.

(3) Therefore, let us see to it that/there is reason to suspect that X (to "believe-X" about external states) is to be part of the generative model. "

To arrive here, perceptual inference, as understood through the lens of statistical physics, is explored in reference to abduction:

"The justification of active inference is thus the justification of abduction, too: the fact that the mind of an organism is a semiotic factory of signs that has evolved in affinity with its environment sufficiently justifies a reliance on that form of inference." (Pietarinen, Beni 2021: 505).

This justification, namely, comes down to the "investigand" mood that organisms live by, as Peirce referred to it, which is also "the general insight behind FEP, namely the main tenet that organisms are in the business of finding evidence for their own existence, not necessarily *in actu* but also in terms of what could, would or might constitute such evidence in the future states of affairs." (Pietarinen, Beni 2021: 506).

This highly enriches biosemiotic theory with insights from other biological systems theories.

Biosemiotics has mostly produced qualitative research, as commonly expected for a semiotic theory, which is one of the reasons that this 14th volume of the journal produced an issue focused on quantitative research.

Pietarinen and Beni's (2021) proposal opens the possibility for a new, more encompassing biosemiotic research program that not only has a quantitative grounding, but in turn supports recent statistical explanations of environment modeling. Concretely, the paper proposes expanding the established semantic interpretation of FEP towards what can be called a proper semiotic interpretation of this statistic modelling.

This progress in the state-of-the-art of biosemiotics can make semiotic theories more attractive for the hard natural sciences. By relying on Empirical Bayes, FEP helps explain how sensory input is caused. As it explains that (active) inference puts action into perception, Pietarinen and Beni (2021) observe an important link between biosemiotics and how FEP explains mind, brain and, in general, the behavior of organisms. Their starting point is that the Sebeokian notions of endosemiosis and exosemiosis accurately fit an Empirical Bayes account of internal-external equilibrium (via Markov blankets).

It is particularly insightful that both FEP, through its Bayesian framework, and (Sebeokian) biosemiotics consider that the basic work of an organism is to model and that the process of modeling a meaningful environment is done through inferencing. FEP is the principle that this modeling process is guided by the organism's regulation of entropy as the minimization of free energy through inference. Statistically observed, this is termed "active inference" (see Friston et al., 2006; Parr et al., 2022). Through this exploration, Pietarinen and Beni (2021) bring a strong reminder of the roots of biosemiotics as a modelling theory in Peirce's semiotics and the actuality of Peirce's broadly encompassing notion of inference (with implications, for instance, in animal cognition and AI).

By going back to the Peircean principles that Sebeok set for biosemiotics, Pietarinen and Beni (2021) elegantly and innovatively avoid the objectivist and subjectivist fallacies into which representation theories often run and point to what can be a resolution to the conflict between enactivism and semiotics. The answer lies in Peirce's view on evolution:

> "The leading principles of abduction are, for Peirce, that the nature is explainable, that is, it is possible to find out what the law-like principles are that govern the behavior of the processes in the reality. The nature is explainable, in turn, because the mind has evolved in attunement with nature over the long, evolutionary and cosmological history of the development of the universe." (p. 505)

The process (evolutionary) view here, arguably, avoids giving priority either to the representation of "external" objects by a mind or to the emergence of the environment through the subject's immersion in an ocean of potential data. Moreover, the theory of mind based on active inference also supports Peirce's notion of perceptual judgment, which, arguably, has not yet been exhaustively explored in a biosemiotic concern. It is worth remarking that, only recently, Paolucci (2021) drew attention to the actuality of Peirce's theory of perception as inferential given state-of-the-art cognitive sciences. It is curious that while Pietarinen and Beni draw the parallels between active inference and abduction, they do not explicitly tackle the notion of perceptual judgment. They might see that as an aside the scope of this particular paper. Also, another research direction that this article opens up but does not tackle is paralleling active and sensory states (in active inference theory) with, respectively, *Wirkwelt* and *Merkwelt* (in Uexküll's theoretical biology, e.g. Uexküll 2010).

The framework proposes solutions for a number of dualistic dilemmas, specific to semiotics, that still pester contemporary philosophy. Of significant epistemological importance for biology, the reductivism/vitalism dualism is avoided through the (non- or anti-Cartesian) concept of mind as "semiotic factory":

> In this view, an organism is not a rule-following machine whose behavior emerged from following the instructions of its genetic blueprint. Rather, it is the error-correcting and reaching-out for some new and emergent homeostatic set-points that constitute the driving methodologies of living systems.

Seen in this way, the co-evolution of organisms and environments implies a balanced explanation for the roles of genotype and phenotype in modeling environments:

> "There has to be generalisability in its habits of action: when something goes awry, the genomic blueprint is not the primary place to look for advice or solution protocols. What organisms are particularly good at is to not only predict the states of their environment but to predict (or to 'conceive' and 'imagine', again in the appropriately downregulated sense of these terms) themselves as inhabiting those future environments: that is, to minimize the delta-error or discrepancy between what their configurations are now and what they remember them to have been or expect them to become in the future in terms of an abductively guided guesswork. " (Pietarinen, Beni 2021: 505)

Last but not least, Pietarinen and Beni (2021) unfurl Peirce's concept of abduction by paying specific attention to still unpublished manuscripts from Peirce's late period of intellectual activity, after 1903. As Peirce's logic has been recently gaining ground in the cognitive sciences while many of his texts remain in the form of unpublished manuscripts, this is a service to the entire semiotics community.

We believe that this paper will reveal new ground for theoretical inquiry in biosemiotics that will present its research program as more attractive for hard, statistical natural sciences. Also, it displays biosemiotics as a salient contemporary uptake of Peirce's logic. With this in mind, it is a pleasure for us to award the 2021 Biosemiotic Achievement Award to Pietarinen and Beni's article.

The members of the 2021 Biosemiotic Achievement Award selection panel,
Alin Olteanu.
Vinicius Romanini.

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