Why Explicit Semiotic Grounding Is Essential to Biology as a Science? The Point of View of Biosemiotics*

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ABSTRACT

A common approach in biosemiotics suggests that semiosis (any activity or process that involves signs) is a natural process embedded in evolution, which entails the production of meaningful processes. As Pattee has argued, a closer look at living systems shows that semiosis is closely related to a very specific and highly functional context of selected constraints. Symbolic control consists in 1) instituting a friction on the novelty, variability and randomness of life processes 2) allowing *survival value* at all levels of biological organization and 3) enabling self-organization. Then it would be the network of semiotic controls to actually playing a pivotal role in biological organization and evolution.

> Organisms (including individual cells) are those who interpret; the interpretation process or semiosis (in the sense of C. Peirce) is the process of life, is life itself (according to Sebeok's thesis)
>
> (Kull 2014d, p. 49)

1. Why Should we Reintroduce the Semiosis in the Events of Nature?

Along the 20th century, Darwin`s theory of evolution has been characterized as one the major trend at providing scientific explanations for the evolution of

* The title recalls the second of the eight fundamental theses of Biosemiotics established in 2008, during the Saka meeting (II thesis : "Biology is incomplete as a science without a semiotic grounding"). On this subject, please refer to Kull K., Deacon T., Emmeche C., Hoffmeyer J., Stjernfelt F. (2009) and Robinson A., Southgate C., Deacon T. 2010.

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organisms, their differentiation in species and the adaptation to their environment (Avise and Ayala 2009). Thanks to Darwin, evolutionary theory of organisms was then accepted into the physical realm of the laws of nature (Avise and Ayala 2009, p. 281), also opening up the possibility, at least in principle, of a reconciliation between the methods of the natural sciences and those of biology. From this perspective, Darwin`s theory of evolution is also crucial for unveiling the nonspecial status of humans within the *scala naturae*, whose evolution is finally attributable to the all-encompassing 'efficiency' of natural selection.

According to orthodox Darwinism, the primary cause of evolutionary change consists of the basic mechanism of random variation and natural selection. Immediately after the publication of the first edition of *On the Origin of Species* (*by means of natural selection*) in 1859, Darwin′s theory suffered numerous theoretical attacks[3], especially by those who questioned the role of natural selection as the main driver of evolutionary change and the « design » of organism. Also, among the issues that Darwin`s theory could not explain: the origin of evolutionary novelties and how natural selection would have ensured the transmission of those small changes whose functionality would have appeared favourable only *a posteriori*, i.e. at the conclusion of a gradual evolutionary process. At that time, the lack of knowledge of the mechanism of heredity made impossible the explanation of the gene frequency mutations in populations (Ayala 2009).

Even nowadays we are facing with crucial issues of that kind. Could life have been evolved otherwise? Should we consider the random mechanisms of variation and the natural selection as the only truly sources of evolution for the arrangement of adaptive functions and structures?

According to modern Biosemiotics[4], Neo-Darwinian biology is not complete and should be replaced with a semiotic conception of life, which seems to offer a much more comprehensive view of the evolution of biological systems:

[3] The debate on evolution after 1859 has been well summarized by Bernardino Fantini in Paolo Rossi (1988). *Storia della scienza*, vol. 6, Gruppo editoriale l`Espresso, Torino, pp. 137-156.

[4] Quotation from the *International society for biological studies*`s web site: "Biosemiotics is an interdisciplinary research agenda investigating the myriad forms of communication and signification found in and between living systems. It is thus the study of representation, meaning, sense, and the biological significance of codes and sign processes, from genetic code sequences to intercellular signaling processes to animal display behavior to human semiotic artifacts such as language and abstract symbolic thought." http://www.biosemiotics.org/

> Neo-Darwinian biology as practiced all over the world has prescinded (i.e., abstracted from necessary contextual support) an asemiotic conception of life as mere molecular chemistry, and yet at the same time it is dependent on unanalyzed semiotic assumptions. The reason why this is not felt as a problem is that biology compensates for the excluded semiosis by introducing a plethora of implicitly semiotic terms like "information,""adaptation," "signal," "cue," "code," "messenger," "fidelity", and "cross talk." These uses are seldom well defined and are often applied in an allegedly metaphoric way, with the implicit assumption that they can be reduced to mere chemical accounts if necessary. (Kull K., Deacon T., Emmeche C., Hoffmeyer J., Stjernfelt F.,2009,p. 169)

Over the past two decades, Biosemiotics addressed significant criticism to Neo-Darwinism, by showing the existence of a very strict kinship between genome, development of phenotype and the context of semiotic interpretation where biological processes (cellular metabolism, splicing, signal transduction, rate control, protein folding) take place. According to Biosemiotics, any activity of sign processes involves the production of meaning, which is always the result of interpretative processes (Barbieri 2007). In a very broader sense, as Hoffmeyer has pointed out, we should see biology as a science of interface between physics and semiotics, an interface "in which we study the origin and evolution of sign processes" (Hoffmeyer, 1997, p.5). It is even important to remark, as Hoffmeyer does, that semiotic interactions - the processes by which 'signs are exchanged' - have been conveyed by evolution by the inheritance of DNA (Hoffmeyer 1996; Hoffmeyer 1997; Barbieri 2003[5]).

> Cells like organisms are historical entities carrying in their cytoskeleton and in their DNA traces of their pasts going back more than three billion years. They perpetually measure present situations against this background, and make choices based on such interpretations. Thus, one might well claim that the sign rather than the molecule is the basic unit for studying life. (Hoffmeyer, 1997, p.3)[6]

Analogously - Kalevi Kull and others assert - we should not omit from considering that organisms are embedded within the environment, with respect

[5] "While morphological structures did rise and fall countless times, the "deep" organic codes have never disappeared. This tells us that they truly are the fundamentals of life, the invariants that persist while everything else is changing." Barbieri 2003, p. 234.

[6] I refer to the free version of this paper, available at the following link: http://cogweb.ucla.edu/Abstracts/Hoffmeyer_97.html

to which their actions should be "concordant or discordant with the dynamics of achieving the end" (Kull, Deacon, Emmeche et al., 2009, p. 171). As Kull has argued: ″semiosis is the process which both creates the realities and connects them″ (Kull, 2007, p. 174). According to this standpoint, he adds, ″biosemiotics means the study of living systems that interprets them as sign systems, or communicative structures" (ibid., p. 175).

'Interpretation' reminds us of what the philosopher Merleau-Ponty wrote about the differences between organisms and machines: ″definition [of a machine] is independent of content; it must not transform″ (Merleau-Ponty, 2003, p. 159); ″The machine functions, the animal lives - that is, it restructures its world and its body″ (Ibid, p. 162). Merleau-Ponty`s reconceptualization of nature has been highly influenced by Jakob von Uexküll (1864-1944)`s theory of meaning, according to which "meaning is the key concept of life" (Jämsä, 2007, p.69). Merleau-Ponty`s foremost argument in the course notes on nature at the Collège de France (1956-1960) is the need of understanding umwelt as an open field of actions, where organisms exchange meaningful and interpretative communications. In *The Structure of behavior* (1942), Merleau-Ponty also emphasizes that animal behavior reveals a certain different norm of biological organization, which plainly opposes the specificity and uniqueness of living beings to the generality and repetitiveness of physical entities, which are interchangeable and anhistorical.

Let me open a very short parenthesis on the controversial issue of formalization in biology. In the natural sciences formalization refers to the attempt to provide explanatory models or, at least, 'simulacrum-explanation' models, whereby "the objects of the model have only the form or appearance of things and, in a very strong sense, not their substance or proper qualities″(Cartwright, 1983, p. :42) [7] . The idea is to reproduce such phenomenon as much as possible in accordance with its expected evolution within the reference system. That makes it particularly difficult to achieve in biology, where specificity lies at the core of evolvability (Pattee 1996; Longo, Montévil 2014), and which, in turn, makes biological phenomena hardly reducible to generality expressed by physical laws. On this subject, Pattee affirms:

> There are fundamental reasons why physics and biology require different levels

[7] Cartwright 1983, p. 18: "...fundamental laws do not govern objects in reality; they govern only objects in models."

> of models, the most obvious one is that physical theory is described by rate-dependent dynamical laws that have no memory, while evolution depends, at least to some degree, on control of dynamics by rate-independent memory structures (Pattee, 2001, p. 4).[8]

Since its debut in the 1980s, Biosemiotics's main purpose is to apply semiotics (i.e. the science of signs systems, as generally accepted) into the interpretation of the events of nature (Jämsä, 2007, p.71. This trend was named 'semiotisation of nature' (Hoffmeyer 1997). Semiotisation of nature assumes that signs (thus, semiosis) are the basic units of life and also aims at providing no reductionist explanations of the origin of biological information involved in morphogenesis and epigenesis (of the basic constituent elements of life, as cells, tissues, organs). As Kull has argued: "organisms act on the basis of sign relations that have turned into habits, or codes'' (Kull, 2014d, p. 48). Thus, as natural laws evolved and became 'acquired habits' embedded in the inanimate physical world (Peirce 1958), in biology, phylogenetic, developmental and ecological constraints have become acquired habits (in the long run of evolution) and fixed by the inheritance of DNA.

Also according to Salthe, even if constraints are the result of historical contingency, they tend to be preserved ″by the process of preservation of genetic marks by natural selection″ (Salthe,2007, p. 135).[9]

Barbieri has proposed the idea that as well as genetic code, the other extant organic codes that have appeared in the history of life (e.g. immunological and behavioural codes) have caused a very increase of complexity in organisms` organization, that is "the most fundamental property of all living creatures, the very essence of life" (Barbieri, 2003, p.242). As Barbieri affirms, natural selection does not explain the essential property of living systems to increase their own complexity and develop from incomplete information [even single cells are "systems where the phenotype is more complex than the genotype" (Barbieri, 2003, p.244)[10]].

That amounts to say: transitions from physical and chemical interactions (inorganic matter) to life should involve a fundamental reorganization of

[8] I refer to the free version of this paper, available at the following link: http://www.informatics.indiana.edu/rocha/publications/pattee/pattee.html

[9] Salthe 2007, p. 136: ″genetic information imposes constraints on chemical dynamics."

[10] According to Barbieri 2003, epigenesis concerns with reconstruction or production of a structure from incomplete information. In this sense, evolution by natural selection does not provide a thorough theory of cell as well as of embryonic development in terms of epigenetic systems.

physical matter, especially in how physical properties were expressed and distributed (Deacon, 2012, p. 194). My thesis is that semiotic regimes controls at work in biological systems are essentially related to the activity of selected constraints, in opposition to increasing disorder and in favour of enabling self-organisation.

Debate about how semiotic control and interpretation processes may have emerged as essential characteristics for the evolution of life, has been going on for a long time. Pattee's one foremost argument is that ″the origin of life requires understanding the origin of this symbolic control and how inanimate molecules become functional messages″(Pattee, 2007, p. 115), thereby clarifying the physical conditions under which such evolvable symbolic control of matter have been raised). Despite the traditional philosophical problem of reference between symbols and the material structures they refer to, Pattee emphasizes, "I have always found the complementary question of how material structures ever came to be symbolic much more fundamental." (Pattee H.H., Rączaszek-Leonardi J., 2012, p. 213). Personally, I take this advice as a clear attempt to place Biosemiotics among the life sciences approaching the living organisms scientifically, whilst avoiding reductionism (physicalism). Hence, Biosemiotics foresees the possibility of reintroducing the semiosis in the interpretation of the events of nature, by showing how organic codes (beyond the genetic one) and memories have been slowly but surely provided with specific linguistic rules expressing functions, interpretative processes and values. Definitively: "Dependence on symbols structures and language constraint is the essence of life" – Pattee emphasizes (Pattee H.H., Rączaszek-Leonardi J., 2012, p.82). Accordingly, life has emerged by a complexification of hierarchies of local controls on material structures.

> ... the study of biology focuses on those specific events over which the organisms and observers have local control. Beginning with the organism's specific catalytic rate control by enzymes, evolution progresses by elaborating and testing many types of controls at many hierarchical levels. Over the course of evolution organisms have gradually increased their ability to control their internal and external environments on which their survival depends.(Pattee, 2007, p. 116)

2. Is There empirical Evidence for the Semiotisation of Life?

During the last sixty years, DNA transcription has been referred by molecular biology in terms of a vehicle for the transfer of genetic information package. The central dogma of molecular biology expressed genetic control as a ″single, irreversible, flow of information from nuclear DNA through intermediary RNA to proteins″ (Gould, 1980, p. 80). However, the developments of the last few decades have shown that genotype does not contained a complete description of the phenotype (Barbieri 2003; Hoffmeyer 1997; Rocha 1995) and that genetic constraints do not exert a unidirectional (linear) causal influence from DNA to RNA (West-Eberhard 1989, 2003; Benasayag 2010; Fox Keller 2000, 2015a, 2015b; Prochiantz 2012; Oyama 2000; Lewontin 2000; Griesemer 2005; Favareau, Cobley, Kull 2012; Deacon 2012). There is therefore no simple relation between genome and the construction of the organism: biological information is inseparable from its context, meaning that it needs of being interpreted (Hoffmeyer 1997). Hence, the genetic code cannot operate out of its coextensive array of cellular and molecular mechanisms, which, in turn, are determined by specific historical and functional contexts.

> DNA replication depends on an extensive array of cellular molecular mechanisms, and the influence that a given DNA base sequence has on its own probability of replication is mediated by the physiological and behavioral consequences it contributes to in a body, and most importantly how these affect how well that body reproduces in its given environmental context. DNA does not autonomously replicate itself; nor does a given DNA sequence have the intrinsic property of aiding its own replication–indeed, if it did, this would be a serious impediment to its biological usefulness. (Deacon, 2012, p.131)

Thus, the absence of physical and behavioural contextuality makes biochemical sequences and organic codes inexpressible, which means incapable of performing their proper functions. This is one priority issue identified by Biosemiotics: “in biology empirical facts are always contextually constrained” (Kull K., Deacon T., Emmeche C. et al., 2009, p.169). By the way, even cells, when cultured and removed from their environment, lose much of their functionality and sometimes their control over own internal processes (Wilson, 2005, p. 63). We must therefore notice the importance of the relational context over the processes and products of life, even at the macroscopic level, in the impact with the environment, where animals exhibit very complex social behaviors. As remarked by Hoffmeyer, we should never forget the ″reality of relative beings″ (Hoffmeyer, 2007,p. 162) such as individuals, populations and even cells are.

Accordingly, Biosemiotics suggests that the relation ′sign-object-interpretant′ should be tackled as essentially rooted in evolution and organization of living matter, even at molecular and cellular levels. The main challenge, Barbieri emphasizes, "is to introduce meaning in biology, on the grounds that organic codes and processes of interpretation are fundamental components of the living world" (Barbieri, 2007, p. xi). This a key point, I think. The problem of accounting for an evolutionary theory of semiosis meets with explanation of semiosis as a natural process, that is subject to physical laws 1) by identifying the origin and the different phases of its evolution and 2) by providing the empirical facts testifying its existence as a natural fact, i.e. as a process of life inherited by DNA.

As I will clarify in due course, semiotic processes seem to have a clear and very close connection with at least one of the following phenomenona: 1) decrease of the amount of entropy[11] 2) enablement of self-organization, and 3) "the capacity to generate end-directed behaviors" (Kull, Deacon, Emmeche et al., 2009, p. 171). Of course, the expression "end-directed behaviors" does not refer to some metaphysical shifts or revival.

Not so very long ago, the physicist Erwin Schrödinger emphasized that living matter represents an unprecedented presence in the physical universe, due to its local escape from entropy decay. "It is by avoiding the rapid decay into the inert state of equilibrium that an organism appears so enigmatic" – Schrödinger argued (Schrödinger, 1967, p. 46).

According to Hoffmeyer, the decrease of entropy at work in biological systems triggers two important reflections. One concerns the specific (semiotic) biological self-organization enabled by the appearance of internal constraints, while the second is about the central problem of observables and interpretation of such biological organization (i.e. the relation between the observer and the system). As Pattee points out, the question is: "How do we recognize such simple behavior as inherently generated by objective constraints rather than by the outside observer`s subjective classifications of the system`s behaviour?" (Pattee H.H., Rączaszek-Leonardi J., 2012, p. 88).

To put it through Hoffmeyer`s words:

[11] In opposition to physical entities, living beings construct order by absorbing energy, thus by opposing themselves to increasing decay or disorganization (Longo, Montévil 2015; Salthe 2007).

> ...according to the 2nd law of thermodynamics entropy will never decrease by itself, and thus for a decrease to occur somebody will have to do physical work upon the system. This means that the presence of a constraint potentially discloses (to an observer) that work has been done. Or, differently stated, the constraint refers to the work done - the constraint appears as a sign. But how come that an observer can make that reference?[12]

Of course, this is a crucial point: how we can detect an objective measurement of that phenomenon? How can we be sure that such observations have not been generated by a phantom observer, who is located outside the organism? (Favareau, Cobley, Kull, 2012).

Myself, what is important to remark here is that a biological system is capable of semiotic control under the aegis of specific and historically selected physical/developmental constraints. That is why, Pattee emphasizes, while physical laws "do not change in time and have no symbolic memory of past events", "observers and symbolic systems are characterized by their response to selected past events, which are recorded as memory" (Pattee H.H., Rączaszek-Leonardi J., 2012, p. 204).[13]

According to Biosemiotics, organic codes and memories are real and not semantic metaphors as advocated by physicalism (Barbieri 2007b). Contrary to a mathematical approach of information, biological information is inseparable from its historical evolutionary context. The main point is that biological information enables specific trends of rules to be expressed in specific local contexts. Biochemical processes, for example, require special molecules for different type of reactions (e.g. catalysis, coding, etc.). Even more, it is the relational-memory context that is very important in biology. Mechanisms of copying or coding of genetic codes or synthesis reactions are context-dependent and memory-dependent processes (Barbieri 2007b; Hoffmeyer 1997; Pattee 2001, 2012).

Now it is easy to notice that such investigation of semiotic systems lies at the intersection of different scientific domains (chemistry, physics, etc.), and that the unification of methods and concepts always comes with practical problems in science. This also reminds us the status of biology as a discourse ranged ″over

[12] This was stated by Jesper Hoffmeyer in our e-mail correspondence (May 20, 2015).
[13] In another paper, Pattee stresses : "...for a record to have any function or meaning requires complex coding, reading and interpreting mechanisms" (Pattee, 2007, p .118).

several levels of scale″ - from species to cells and ecosystems (Salthe, 2007, p. 133), and which is always engaged with the difficulty to provide explanatory principles at different integrative levels (Griesemer 2005). As recently remarked by Kull, natural scientific methodology seems to set certain limits to the way of acquiring knowledge of biological phenomena. Among them, the more important concerns the way the world of life evolves through qualitative and meaningful relationships.

According to Biosemiotics – indeed -what really distinguishes physical systems from biological phenomena is that these latter only exist and may act in the context of symbolic information, i.e. information that is "characterized by its meaning, value or function" (Pattee 2012, p. 205).

3. Why Biological Organizational Closure is a Semiotic Closure?

It might seem to be a tension between constraints (that are constitutive of living systems) [14] and the essential event of chance in the evolution of life, as if constraints could represent a kind of limitation of freedom at working in evolutionary change (Pattee H.H., Rączaszek-Leonardi J., 2012, p. 97: "The common language concept of a constraint is a forcible limitation of freedom"). As I will argue, this tension does not exist and organizational closure should be addressed explicitly in terms of semiotic control.

As Pattee emphasizes, in a developmental biological system, constraints deal with the internal simplification of its behaviour (Pattee, 2012, p. 88). As other authors have suggested, structural stability of biological systems arises from a closure of constraints (Mossio, Bich, Moreno, 2013; Montévil, Mossio, 2015). As recently claimed by Montévil and Mossio, for example, "one of the specificities of biological systems is the fact that the thermodynamic flow is constrained and canalized by a set of constitutive constraints in such a way as to establish a specific form of mutual dependence between those very constraints" (Montévil, Mossio, 2015, p.181). Nevertheless, whereas in physics and chemistry constraints are not dependent on "the dynamics on which they act" (Montévil, Mossio, 2015, p. 181), in biology "the conditions of existence of the constitutive constraints are, because of closure, mutually determined within the

[14] Unlike laws of nature in physics, constraints require "some distinct physical embodiment in the form of a structure (molecules, membranes)" (Pattee, Rączaszek-Leonardi 2012, p. 82). As Pattee emphasizes, it is important to realize that constraints "are made up of matter which at all times obeys the fundamental laws of nature in addition to behaving as a constraint", ibid., p. 83.

organisation itself» (ibid., p.181). As emphasized by Juarrero (1999), furthermore, constraints at work in biological systems should be understood as generative, "in the sense that they enable behaviors and outcomes that would otherwise be impossible" (Montévil, Mossio, 2015, p. 183).

Contrary to physical objects, a biolon (a cell, an individual, a species) is far from the state of equilibrium and nested within unpredictable and contingent phenomena (Gould 1989; Oyama 2000). Moreover, whereas the physical objects are characterized by the preservation of laws during transformations, the global structural stability of biological systems is associated to variability and permanent changes of symmetries. On this point, Longo and Montévil (2014) refer to self-organization of living systems in terms of ′extended criticality′:

> [...] critical transitions in physics are mathematically analyzed as isolated points. In our approach to biological processes as "extended critical transitions", "extended" means that every point of the evolution/development space is near a critical point. [...] Thus, criticality is extended to the space of all pertinent parameters and observables (or phase space), within the limits of viability (tolerated temperature, pressure and time range, or whatever other parameter, say for a given animal), [...]. In terms of symmetries, such a situation implies that biological objects (cells, multicellular organisms, species) are in a continual transition between different symmetry groups; that is, they are in transition between different phases, according to the language of condensed matter. (Longo, Montévil, 2014, p. 186)

Hence, although characterized by extended criticality, organisms permanently reconstruct their structure for open-ended survival. By this, I assume that organizational closure may be defined as semiotic closure, that is, a semiotic regime of causation at work in biological systems.[15] Definitively, we should talk of semiotic closure because the global control of dynamics is exercised through the aegis of processes and constraints that have been selected as significant behaviours.

[15] The distinction between processes and constraints as two different regimes of causation at work in biological systems has been proposed by Mossio and Montévil (2015), who claim: ″processes refer to the whole set of changes (typically physical processes, chemical reactions, etc.) that occur in biological systems and involve the alteration, consumption, production and/or constitution of relevant entities. Constraints, on the other hand, refer to entities which, while acting upon these processes, can be said from the appropriate viewpoint to remain unaffected by them. [...] we suggest defining constraints as entities which exhibit a symmetry with respect to a process (or a set of processes) that they help stabilise″ (Montévil and Mossio, 2015, pp. 6-7).

4. Final Remarks

Definitively, «no life could ever have emerged unless it was allowed to explore the external milieu as a pre-requisite for its own self-description» (Favareau, Cobley, Kull, 2012: 13). At higher macroscopic scale, exploration of the external milieu allows animals to exit from their somatic boundaries and to access the universe of signs (Piaget, 1976, p. 20). Contrary to physical objects, indeed, "life is an agent that sustains and establishes relations" - Kull argues (Kull 2014c).

As remarked by Étienne Bimbenet[16], signification primarily belongs to life and then to language.[17] This amounts to say that signification (organic codes, memories) is a natural process coextensive to biological life and to evolution. One the foremost tenet of biosemiotics is that the production of meaning is located "at the level of living processes" and not "in the human mind as producer of sign relations" (Favareau, Cobley, Kull, 2012, p. 115). As Bailly and Longo have pointed out, any reactions of an organism (even of a cell) who moves by changing its relationship with respect to the external, is meaning.

> In this way, gesture, which begins in motor action, set the roots of signification between the world and us, at the interface of both. The chemical, thermal signal, which affects amoeba and cell, is "significant" for the living, regarding its current internal change, its action, and its movement. The neuron, reached by a synaptic discharge which deforms its membrane and its electrostatic field, reacts with a biochemical cascade, with a subsequent deformation of its electrostatic field, even by changing form and place of synaptic connections. In other words: it reacts with an action, a gesture at its scale, with its internal and external mobility; at its level, this reaction is meaning. (Bailly, Longo, 2011, p.63).

One might ask why a scientific approach at living organisms should include the reintroduction of semiosis in life processes. As I attempted to show, it is along the pathway towards the semiotisation of life that I glimpse one possibility (of course, this is not the only possible solution) to bridge the gap between nature and culture or between science and humanities. Certainly one of the

[16] Étienne Bimbenet, Maître de Conférences à l'Université Jean Moulin Lyon 3.

[17] Statement of Etienne Bimbenet in our e-mail correspondence, June 10th, 2015: "dire que la signification appartient à la vie avant d'appartenir au langage, ou que la signification langagière représente une transformation et une "aventure" de la signification vitale, c'est un point auquel je crois profondément".

major distinction between sciences and humanities is that while "the sciences search for general patterns and principles, the humanities aim at understanding unique events. The sciences try to explain the world, while the humanities aim at interpreting it"(Bod R., 2015, p. 1).

Surely, the first step towards filling this gap is to provide an evolutionary theory of biological information, in terms of a natural process that, in turn, has been semiotically constrained by natural selection. It will be consequently clear that interpretative dynamics and meaningful events are at the heart of biological life (Longo, Pagni,2015).

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