

A Brief Introduction to Peirce in Biosemiotics

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1 Introduction

The relevance of Peirce's work to current semiotics cannot be understated. It is through his work that we have developed some of our most important analytical tools in the study of representation and reference centered around the conceptualization of the sign and everything that comes with it. This is just as true in biosemiotics, where theoretical abstractions have made an even bigger impact in the objects of our research, our methodology and our theoretical apparatuses. In this brief paper we will examine some of the central notions of Peirce's semiotics as related to the development of biosemiotics and its current state, what his concepts do for biosemiotics and the consequences of such an approach.

2 A Brief Historical Perspective

There are two historically relevant figures that are pivotal in the discussion of Peirce's place in semiotics: Kant and Frege. We'll start with the latter first. Logic was one of the axes on which Peirce centered his exploration of philosophical topics, and it is in this area that both Peirce and Frege excelled. First let's examine some central notions of Frege's own work.

2.1 Frege and Semantic Value

Frege, much like Peirce, was an anti-psychologist about logic (Potter 2010). This meant that he was convinced there is something about the world that does not necessitate mental powers in order to bring about the laws of logic. While we don't have enough time to even start scratching the surface of Frege's great contributions to logic, it's important to note that the convergences between Frege and Peirce

are critical¹ in that they give us a more robust sense of what is at stake when semantics are involved. To that is added the overlap in their thoughts about logic and notation, driving forward a formalized and architectonic vision of theoretical commitments and outcomes.

Perhaps the most famous and relevant distinction that Frege makes for semantics is that of *Sinn* and *Bedeutung*, introduced as such in the last decade of the 19th century, and usually translated as ‘sense’ and ‘reference’. While the distinction itself appears to be trivial, the concern behind it was rather of a formal nature: That an object has multiple ways of being accounted for resulting in different possible inferences from their presentation, that “an appeal to the difference between the signs does not explain the difference in content” (Potter 2010: 13). This plays out in Frege’s anti-psychologism by a sense of truth values, whereas expressions are true not by virtue of our perception, but as an independent fact of the world, a true sentence being one that refers to an actuality in it.

At the basis of the issue, *Sinn* refers to the mode of presentation of the reference, while the *Bedeutung* of an expression would be what it represents (Recanati 2008: 31). David Bowie and Ziggy Stardust both *refer to* or *denote* David Robert Jones. Both expressions have, however, different senses in that they are presented in different ways.

It is interesting to ask ourselves whether biosemiotics would be possible under a Fregean framework. A hint here can be seen in Barbieri’s brief inclusion of ‘sense’ and ‘reference’ in his Code Biology framework. Here, Barbieri assumes two types of semioses as axiomatic², “one based on coding and the other on interpretation” (2015: 164) which can be mapped on *Sinn* and *Bedeutung*, as meaning can obtain inside or outside of a semiotic system. The simplification of the difference points out to a couple of things: That the application of a purely Fregean terminology to biosemiotics would require an extensive elaboration of the terms as applied to non-linguistic organisms, much more than Barbieri does in this case, and that treating linguistic meaning in the same sense as biological meaning can be a dangerous way of self-confirming a theory without the original theory doing the work required for the confirmation.

For now we must put these concepts aside and move on to a different area of relevance. We will now see what Kant has to offer in relation to Peirce’s work and influence on biosemiotics.

¹While it seems that Peirce and Frege were not aware of each other’s work, there is some soft evidence for a tenuous connection between the two of them (Hawkins 1993).

²Barbieri states that “The origin of molecular copying and the origin of molecular coding produced [...] the first two types of semiosis” (2015: 33), one “based on coding and one based on interpretation” (2015: 150). While this requires more unpacking to make sense, it will not be treated here in depth.

2.2 Kant and the categories

If Frege is a contiguous force to Peirce, Kant is a figure that precedes them both. Peirce's work on his categories may be one of the most relevant stepping stones in his semiotic system. And referring to them is not possible without first mentioning Kant's influence in this point (Pietarinen 2015: 373). Categories are generally conceived as sets of kinds, the types of things there are in the world. But how can we verify that the categories we postulate are actual? To answer that, Kant shifts the question so as to ask what are the things that are *given* when cognizing anything. These are the *a priori*, basic concepts that are needed for perception and reference. Following Aristotle, Kant considers four different groups for his categories, *quantity*, *quality*, *relation* and *modality* (B104-B105), each containing three categories for a total of twelve different categories. While the specificity of these is not too relevant for our purposes right now, it is important to note what they do for us in general. They give us a list of possible relations from which we can draw regarding what we can say about the world. That is, all categories relate to our judgments in that they are the necessary stepping stones that we have for even thinking about things. This complex system is built from logic (much like the Peircean categories, as we will see), developed from the way judgments appear to refer to things. And as such, they govern all possible judgments we can make about anything, including judgments such as 'Peirce is a biosemiotician' or 'Biosemiotics is Peircean'.

But what is the takeaway of this for biosemiotics? Kant's influence on biosemiotics is extremely powerful, if rather silent. Jakob von Uexküll was a reader of Kant and some of his most important ideas are connected to his philosophical upbringing. Could we have a Kantian biosemiotics without Peirce? While I believe this is possible, it would seem we would be missing much of the reason for having a conceptual apparatus proper to sign relations. Kantian categories do enough initial work to make us wonder if the metaphysics of categorial judgments are correct and work our way through them as applied to thoughts in non-linguistic organisms (raising the question of what counts as thought in this particular framework). This, however, is not enough by itself to be of foundational relevance to biosemiotics.

2.3 Peirce, reference and categories

Let's go back to the concept of reference. Frege's distinction between sense and reference is of enormous relevance in understanding how some identity claims are less trivial than we would expect. But what does that have to do with Peirce? For one thing, Peirce coins a rather different sense through which we can deal with identity relations. But instead of dealing with these technicalities, let's see what sign terminology can say that is different from Frege's own distinction.

Peirce's work on his sign theory didn't happen quickly. It evolved with Peirce's thought, and his early theoretical musings are often at odds with his later thought. What stops in thought and language when dealing with sense and reference is extended in understanding the role of indexicals for a theory of signs (Short 2004). The indexical sign makes cognition not necessarily preceded *solely* by cognition: It allows the picking out of elements by virtue of the connection between the object and its index. But the index is more than a conceptual connection, its own nature is causal or nonconceptual. Smoke, sound, fever, thunder, these are all comprised by the treatment of the index. Peircean signs extend the field of view beyond matters of language towards the nonhuman.

What about Kantian categories? Peirce develops a system of categories in response to Kant's own thought, simplifying the twelve categories into three, *firstness*, *secondness* and *thirdness*, each covering "quality, reaction and representation" (Pietarinen 2015: 373). The concepts behind Peircean categories do not imply the universality of judgments we see in Kant. In fact, Peirce states that

For Aristotle, for Kant, and for Hegel, a category is an element of phenomena of the first rank of generality [...]. The business of phenomenology is to draw up a catalogue of categories and prove its sufficiency and freedom from redundancies, to make out the characteristics of each category, and to show the relations of each to the others. (C.P. 5.43)

This differentiation Peirce makes between Kant and himself is at the origin of his own commitments: He condemns the view that the phenomenal is disconnected from the thing in itself (Pietarinen 2015: 373)³. Yet Peirce's categorical thought has very specific derivation: Categories are considered *modes of being*, and this will expand each of the three categories in a way that we can use the terminology in semiotics in a different way that we would if we only counted with Kantian categories.

2.4 History matters

One important point to take away from this historical overview and comparison is that semiotics is not independent of other explorations in knowledge. Peirce is as much a product of his age as he is a response to previous philosophers. But the conceptual apparatus he developed is fruitful in ways that we have not yet seen. Peirce's theory of signs and philosophical backing in the categories are two of the

³It's important to note that "As Kant insisted – and, of course, both Peirce and Jakob von Uexküll had thoroughly assimilated Kantian principles – 'raw experience' is unattainable; experience, to be apprehended, must first be steeped in, strained through, and seasoned by a soup of signs" (Sebeok 2001: 36-37).

essential components of a robust semiotic centered around this particular tradition. Biosemiotics is in a special position because it seems to stand at a crossroads between the scientific and the philosophic, but this is as much an innovation as it is a product of a specific, expanding intellectual history. In what remains we will explore Peirce's contributions to current biosemiotics and some of the prospects for exploring his concepts and philosophy within the field.

3 Biosemiotics with Peirce

While the father of biosemiotics is traditionally considered to be Jakob von Uexküll (and for good reason), the current standing of the field owes Peirce just as much. The construction of a modern biosemiotics takes as much from the turn in general semiotics as it does from biology, but in order to reach biosemiotics with Peirce, we had to count with a top-down approach, that is, starting from the traditionalist position of linguistics and working our way towards ethology.

Current biosemiotics works under a strong Peircean framework (Anderson et al. 2010 [1984]; Kull et al. 2009; Barbieri 2015), and that is because sign theory does a lot of work in reframing how we understand biological organisms and their action in their environments. But it is far more than that. The philosophical foundation given by sign theory is an expanding and complex one, one that cannot be decided by dogmatism alone.

Let's examine, for instance, how Anderson et al. incorporate Peirce in the crucial 1984 manifesto 'A Semiotic Perspective on the Sciences': They start by assuming that the universe, as stated by Peirce, is 'perfused with signs' (Anderson et al. 2010 [1984]: 382) in that they

suggest, nodding to Peirce, that the universe originated with the sign. This thirdness would have to presuppose secondness, and in turn firstness. The evolution from free energy-information, interaction, communication, meaning, and condensed meaning stored in knowledge systems can be all understood as further by-products in the ontogeny of the universe-system" (2010 [1984]: 401).

Here we can start tracing part of the value given to Peircean metaphysics by biosemiotics in its original, more formal expressions. Construing our subject matter as expanding from the kernel of signs can provoke all sorts of reactions from us now, but it serves an important purpose: That of having a ground on which to stand when referring to sign action in things we would not refer to as having the property of cognition. We also start seeing how the concepts of Peirce we have just seen do play an important role in semiotic theory. These do not simply refer to phenomena we are accustomed to, but rather conceptualize things

we need to know in order to refer to semiosis in living, non-linguistic beings. Let's start examining some terminology more closely now.

3.1 The Sign Relation

The sign relation is the central concept for general semiotics. This is quite simple, as we use 'signs' as placeholders for 'referring to something by means of something else'. Now, a sign in Peirce's view, is a triadic relation between an *object*, a *representamen* and an *interpretant*⁴. This is important because it furnishes us with the technology to analyze sign action into its different components, to the degree that we can apply this formulation to behavior even when reportability is out of the question. While this is not enough, we can have a simple understanding of a meaningful relation between, say, a lion observing its prey being careless and flanking it. The sign relation is the essential building block for semiotics in that we give a consistency to our understanding of meaning. That is, meaning for biosemiotics does not require the fixation of a concept or belief by means of having a previous reference. Instead, a sign relation is entailed by perceiving something and reacting to that perception. The interpretant in our example does not need to be 'my prey is distracted', but rather it can be the act of attacking itself.

A couple of examples from Emmeche go like this:

The shrieking sound of a vervet monkey can be a representamen of a snake determining another monkey to hide in a tree, the act of hiding being the dynamic interpretant of the sign. A sequence of nucleic acid nucleotides sometimes functions as a genetic sign for a specific array of amino acids, resulting in an "object", i.e., a protein, produced in a specific context (Emmeche 1991).

This very basic triad can have all sorts of applicability when dealing with potentially significant phenomena. But it is fair to ask if this application is not rather far-fetched, for what stops us from applying the sign relation to any unrelated set of elements? While this is an ongoing debate, we need to limit the way we can apply relations. After all, the definition Peirce gives implies a triadic relation is necessarily irreducible. This we translate informally into the idea that the elements of the sign relation *must* be implicated in the act of interpretation (MS 7). In other words, you can't have an interpretant of any sort without also having a representamen and an object. However, these concepts are not to be mapped to physical instances by necessity, they are abstractions of acts of cognition *lato*

⁴We will refer to the terms of the sign relation with these concepts throughout the paper, but it is important to remember that each has been named something different at certain points. It's quite important to remark that the representamen has also been called *sign*, but we will do our best to avoid any confusion with this matter.

sensu.

The question that remains here is how the relation is entailed. But this is not a question we will be able to solve in this space. In fact, it is a question that can and will play a significant role in the philosophical discussions in biosemiotics.

3.2 Interpretation and instantiation

One keyword we only mentioned in passing before is that of *interpretation* (which is not the same, as you know, as an *interpretant*). In order to reach this idea, let us consider Peirce's basic classification of signs, *icons*, *indices* and *symbols*, all of which are built upon the basis of the sign relation. Briefly, an icon is a relation of resemblance, an index is a relation of causality and a symbol is a relation of convention. Evidently, this is but the tip of the iceberg of sign classifications, but for now it will do. What is important to point is that these types of relations require a number of things. An index requires an apparently causal connection between the object and the representamen—but this is not sufficient to have a sign! The representamen is not conditioned to one specific 'answer', but it is an 'answer' nevertheless. The causal relation is a causal relation so as perceived by some organism that generates an interpretant. So if you see smoke behind the trees where your car is parked, this may act as an indexical of your exploding car. What the relation requires in actuality is the possibility of being interpreted. Peirce assigns a value of *mind* to reality that goes far beyond the concept of the human mind for interpretation, and this has been construed in different ways, namely:

- panpsychism (the idea that everything possesses mental properties)
- physiosemeiosis (the idea that semiosis is entailed by physical systems)
- pansemiosis (the idea that *everything* is composed of signs)
- the more moderate view of biosemiotics, which simply entails that sign action is effective in the biological world.

A problem faced by biosemiotics is that of begging the question, but the way to deal with this is axiomatic: life and semiosis are coextensive, and the basic operative semiotic organism is the cell (Emmeche et al. 2002). All questions regarding the standing of life must be investigated properly, but they are not easy to answer. We make this question clearer by asking about semiotic thresholds and *assuming* the threshold between the semiotic and the non-semiotic at the level of the cell (though cases could be argued at the level of viruses, for instance). A Peircean interpretation allows us at least to make a stronger case for the instantiation of

signs in living systems, coupled with ethology and chemistry. This still leaves many questions open: Can there be symbols in the world of a cell? Is metabolism a semiotic process of interpretation? These and many others are questions that biosemiotics cares about.

There is still much more to understand about this basic classification of signs. Perhaps a good way to tackle this is by going straight to the categories. As we may remember, the categories refer to modes of being, that is, they cover phenomena in the world in their most basic expression. These categories, phenomenological as they are⁵, are relevant to sign research in that, being the possibilities in perception, they reveal to Peirce the specific condition of signs:

On the basis of this categorically animated investigation, he was led to three classifications: that of signs in themselves being qualisigns, sinsigns, and legisigns; that of signs in relationship to their objects being iconic, indexical and symbolic; and that of signs in relationship to their interpretants being rhematic, dicent, or suasive (Colapietro 2008: 44)

While the categories appear to be related to knowledge and not to being since they *allow* us to find and analyze signs, there's an important part uniting both conceptions, and that is Peirce's idea of continuity or *synechism*. He sees mind and matter in continuity to avoid strong dualisms, and thus the categories are both part of the mental and of the physical. Despite the fact that the categories are ontological in nature, they are derived from phenomenology, and this can be granted because Peirce attempts to naturalize the mental to a certain degree.

3.3 Synechism and tychism

Synechism is an ontological principle of its own⁶, and it is the underlying proposition for the existence of the categories. However, much like the sign relation, its extension can be rather dangerous for our theories. We will examine these dangers later, but for now we must resist extending concepts under the assumption that a theory needs to mark its territory so as to be applicable to something rather than to everything (for if it's applied to everything, it's useless). With that in mind, let's assume thus that synechism acts as the principle that:

- Allows the existence of categories from its ontology.

⁵Or *phaneroscopic*, in Peircean parlance.

⁶Peirce, though, regarded it as a logical principle on its own (CP 6.173).

- Connects the perceiver to the world.
- Naturalizes sign relations.

All of these points are essential for semiotics. And the principle of naturalization is the *chief* driver of biosemiotic enquiry. When examining the principle of synechism as related to the infinite possibility of signs, we find that Peirce's thought is *evolutionary*. Peirce is a firm believer in what he calls *tychism*, the idea of "absolute chance" (CP 6.102). This, for him, means that the universe must be evolutionary of necessity, with mental properties being a natural part of the growth of the universe. Peirce constantly fought dualism, so he thought an evolutionary approach would turn the tables against the idea of the mental and the physical being distinctly separated (as in substance dualism). Naturalization thus opens the door to the examination of sign action in all living systems, at least metaphysically speaking. The case Peirce makes for a developed semiotics gives the examination of semiosis as part of the living a strong background, but much like signs, we need interpretation in order to make our theories of biosemiotics work.

3.4 Categories

We have already introduced the concept of categories. But now we can explain them more specifically. As we know, these are considered by Peirce to be *modes of being*, which we could understand as properties of things as related to their complexity (and perhaps even to what we can say about them). Peircean categories, while not being exclusive of potential expansions, are minimally speaking three, Firstness, Secondness and Thirdness, each with a specific constitution and based on synechism. While these three categories have been also called Quality, Reaction and Representation, or Possibility, Actuality and Reality (Stjernfelt 2007: 13), we can examine them further and attempt to give them a more precise definition. Basically, the premise of a continuum in reality can be acknowledged, for Peirce, within a phenomenal analysis. As such, Peirce recognizes that there's three categories to experience that can be elucidated and formalized.

3.4.1 Firstness

Firstness, quality or possibility is what Peirce recognizes, according to Stjernfelt, as the

quality of experience: in order for something to appear at all, it must do so due to a certain constellation of qualitative properties. Peirce often uses sensory qualities as examples, but it is important for the understanding of his thought that the examples

may refer to phenomena very far from our standard conception of ‘sensory data’, e.g. forms or the ‘feeling’ of a whole melody or of a whole mathematical proof, not to be taken in a subjective sense but as a concept for the continuity of melody or proof as a whole, apart from the analytical steps and sequences in which it may be, subsequently, subdivided (Stjernfelt 2007: 13).

As an example, Peirce uses the notion of *redness* as a sui generis quality (CP 1.25). We finally start seeing how Peircean semiotics establish a type of theory of perception with its own specific terminology.

3.4.2 Secondness

Firstness appears to be the simplest element we can find in our phenomenal experience, but it is only analyzable through a more complex set of experiences, so to speak. However, its individuality doesn’t do anything for us. Secondness (reaction or actuality) bridges Firstness by making qualities patent. Houser sees Secondness as “that which is as it is in relation to something else” (Houser 2010: 90). To expand on this, we can take this example from Peirce:

Standing on the outside of a door that is slightly ajar, you put your hand upon the knob to open and enter it. You experience an unseen, silent resistance. You put your shoulder against the door and, gathering your forces, put forth a tremendous effort. Effort supposes resistance. Where there is no effort there is no resistance, where there is no resistance there is no effort either in this world or any of the worlds of possibility (CP 1.320).

This may sound rather convoluted, but the idea is that Secondness is the expression that puts quality into matter (CP 1.527). As Pietarinen puts it in a poetic fashion, Secondness implies “the struggle to achieve something, the shock of sensing change” (Pietarinen 2015: 374).

3.4.3 Thirdness

Thirdness (representation, reality) subsumes the previous categories into a more complex one. Here we see *mediation* (CP 1.328). Peirce himself specifies that by Thirdness, he means “the medium or connecting bond between the absolute first and last” (CP 1.337) in that the elements in a perceptual instance become patent, both in their quality and the imprint of said quality in something different from the quality itself. But this is not only limited to perceptual instances, it is reflected in many metaphysical theses, such as how natural laws are derivations of

Thirdness itself.

The categories as presented by Peirce start then being a phenomenological exploration with huge metaphysical implications, but also depending on certain other propositions in order to work (remember synechism).

The complications that come from studying Peirce give, as a result, quite a number of potential interpretations (as we saw in 3.2). There is a certain vagueness that allows us to speak much about the things we've put on the table, but at the same time many of these can be easily taken to mean far more than we could desire for our semiotic theories. We will take a quick look into some of the possibilities a Peircean framework offers for different perspectives of biosemiotics now.

4 Biosemiotics through Peirce

We have set some of the fundamental building blocks for talking about a potential semiotic biology based on Peirce's work on phenomenology and metaphysics. This task is, as we may have noticed, intrinsically philosophical, but that doesn't mean it can't be applied to the analysis of biological phenomena. Let's now see how Peirce has been used by different biosemiotic accounts and what his place is in current biosemiotics.

4.1 Hoffmeyer's Peirce

Jesper Hoffmeyer, one of the key figures of current biosemiotics, makes ample use of Peircean terminology throughout his work. He introduces the basic sign concept as described by Peirce (Hoffmeyer 2008: 20-21), trying to move it away from the conception of exclusive applicability to human interpreters. One specific example he gives starts with a triad involving a slap that causes a deformation over the skin's sensory cells:

With the application of pressure, there emerges an interpretant in the form of a context-dependent sequence of action potentials that create a kind of *cellular echo* of the disturbance. This interpretant, the echo, now becomes part of a more complex sign [...]. There, the pattern of action potentials from many different sources, tactile as well as kinesthetic, is processed under the formation of a stereognostic codification of the experience of pressure (2008: 23).

Right off the bat we have an application of the sign as a sort of reaction model applied over cellular mechanisms, from the transduction of a physical disturbance to a particular perception of touch. This at first reads like a theory of perception involving a different type of descriptions, but to this Hoffmeyer responds stating

that a chemical description is not quite enough, with biosemiotics offering a union of the psychophysical “for free” (2008: 24). How so? Because of the categories. For Hoffmeyer, causality becomes an essential topic, making use of Aristotelian causes as part of his ontology. To him, causality “follows from the recognition that actions or processes can either play out within relations of Secondness or within relations of Thirdness (but not, however, within relations of Firstness [...])” (Hoffmeyer 2008: 67). The categories create in Hoffmeyer’s biosemiotics a basal constituent of reality, and causal processes that we can identify through science appear at the level of Thirdness.

4.2 Brier’s Peirce

From a different perspective, we have another heavily Peircean approach in what has been called *cybersemiotics*, a different (yet similar) take on biosemiotics that derives in specific conclusions. For Brier,

Peircean biosemiotics is based on Peirce’s theory of mind as a basic part of reality, (in Firstness) existing in the material aspect of reality, (in Secondness) as the “inner aspect of matter” (hylozoism) manifesting itself as awareness and experience in animals, and finally as consciousness in humans (Brier 2008: 40).

The evolutionary aspect of Peircean thought becomes all the more relevant here as the theory implies a specific direction of evolution *towards* more complex consciousness. An important point in Brier’s interpretation rests in the idea that intentionality is not necessary for sign action, for Peircean biosemiotics cover unintentional cognitive phenomena, as opposed to a direct symbol grounding that only relates to the intentionality of sign usage. Interestingly, Brier opposes Frege and Peirce, albeit subtly, when he states that an approach that justifies beliefs as mapped to truth values starts on the logical side in order to describe mental processes, situating Peirce on abductive reasoning, seeing

the development of knowledge as a dynamic relation between belief, doubt, desire, and inquiry, and the self-correcting nature of semiosis. Beliefs are certain behavioral dispositions that manifest themselves in a given context based on certain desires. They may be changed through processes of inference, which change our representations of the world. Truth and reality, thus, to a certain extent, depend on the social construction of inquiry. But, on the other hand in his triadic evolutionary view, semiosis can be viewed as self-correcting in its reproduction of Thirdness (Brier 2008: 42).

Brier’s Peirce has a different take on the nature of scientific inquiry, because the nature of sign action can be applied to cognition *lato sensu* and to scientific

practices.

4.3 Peirce for Tartu Biosemiotics

Relevant figures in biosemiotics usually agree on core premises. Peircean signs are taken as primitives for the theory in general, but the specificities usually derive in different possibilities and extension of Peircean theory. While there is nothing quite specific about Tartu biosemiotics dealing with Peirce (as most of it comes from the Copenhagen connection in the so-called Copenhagen-Tartu School of biosemiotics), there are certain proposals set against the backdrop of Peircean terminology. Take, for instance, Kull's proposal for a triadic layering of natural semiotic capabilities (Kull 2009). Here, the talk of semiotic zones or threshold is coupled with a Peircean understanding of sign types, with the vegetative level being capable of recognition (icons), the animal level, of association (indexes) and the cultural level, of combination (symbols) (Kull 2009: 15). There is no denying the powerful influence of Peircean terminology in biosemiotics. The expansion and recombination of Peircean influences with the early cybernetic turn in Tartu-Moscow semiotics has shown to be a fruitful interaction for the development of semiotic theory.

Yet, Peirce is a very complex thinker, and much of his theory can and will be subject to scrutiny. Now we will take a look at some of the criticisms that have been raised against Peircean biosemiotics.

5 How right is Peirce?

Even if we have only seen only a very superficial level of Peirce's philosophy of semiotics, it should come across as a highly complex edifice of theory. The categories and the sign relation itself are interwoven and supported by a number of investigations that have impacted the way we talk about signs and reference, especially in the realm of ascribing sign action to non-linguistic living beings. But Peirce was not infallible, and his musings should not be considered simply axiomatic to semiotics.

Perhaps the most vocal opposition against a Peircean framework for biosemiotics comes from Barbieri's proposal for Code Biology. Barbieri takes the Peircean framework to entail *pansemiosis* (Barbieri 2015: 156), so limiting its explanatory power is of the utmost importance. To this he adds the criticism that Peircean models cannot be taken as radical, but they must be empirically tested. This unfurls into a methodological criticism and a division between trends in biosemiotics: "one is the extension of Peirce's model to all living creatures, the other is a scientific approach that aims at *discovering* which semiotic processes actually

take place in living systems” (Barbieri 2015: 167, emphasis in the original). The culmination of this criticism appears in two points, that Peircean biosemiotics is nothing but a reformulation of previously known biological terms in order to fit Peirce’s own terminology; and that biosemiotics is possible only if we ditch *ad hoc* definitions and move to an experimental setting.

Another type of criticism that also comes from Barbieri is *institutional* in nature. Biosemiotics is predominantly Peircean, and with semiotics gaining intellectual traction, “the *Peirce industry* has grown into an impressive enterprise that, like the *Darwin industry* in biology, is producing a steady flow of books, journals, congresses, grants and University positions” (Barbieri 2015: 168).

Finally, perhaps one of the most worrying criticisms, is that

The scientists that were supporting the Peircean approach were often using the arguments employed by the supporters of *Intelligent Design*. In retrospect this is hardly surprising, because ‘interpretation’ is indeed a form of ‘intelligence’, and Peirce himself promoted the idea that there is an *extended mind* in the Universe. The difference between the two cases is that in *Intelligent Design* the ‘interpreting agency’ is outside Nature whereas in Peircean biosemiotics is inside it. The common factor is that in both cases all facts of science are reinterpreted in a *postmodern* framework simply by changing the meaning of words (Barbieri 2015: 168)

The jury is still out on this, but these are valid academic concerns for a semiotics trying to come with its own naturalized framework.

In the theoretical arena, we can still debate the merits of Peircean theory for biosemiotics. Are signs simply a way to rename cybernetic cell processes? How do we even limit the Peircean framework in the face of its apparently explosive expansion? Vehkavaara says of biosemiotics that it can be taken “as a mere heuristic device, eliminable language-game, illustrative metaphor, or decorative topping for primary biological theory” however, “biosemioticians hope it could bring up some new substantial theory or irreducible concept to biology” (Vehkavaara 2007: 18). He goes on to state that Peirce’s own view on signs rests more on impression than on their being actual scientific results (21). In addition to that, metaphysical claims about the sign in biosemiotics tend to be vague: “Quite commonly in biosemiotic literature, it is left unspecified (or the specification is clearly unjustified) what is the object or the interpretant of the considered sign and who (or what) is the ‘interpreter’ that executes the sign-transformation” (Vehkavaara 2007: 29). Besides this theoretical *vagueness*, biosemiotics may axiomatize metaphysical hypotheses and make overtly strong claims regarding the ontology of the sign. These are all claims that can be examined through biosemiotics, but importantly

they must play a role in how we understand Peirce as applied to current research. And not just that, we can justifiably take issue with the philosophical underpinnings of biosemiotics, but in order to, say, criticize the possibility of icons in nature, we need to understand what the terms refer to and how we even got to the point where we can argue *for* icons as signs.

Peirce's contribution do much work for semiotics, but it is wise to always keep a critical eye regarding the metaphysical claims that have been made to support our semiotic models, even outside of biosemiotics.

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