Re-Thinking the Pragmatic Theory of Meaning

Repensando a Teoria Pragmática do Significado

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Abstract: A close reading of Peirce's pragmatic maxim shows a correlation between meaning and purpose. If the meaning of a concept, proposition or hypothesis is clarified by formulating its practical effects, those also can be articulated as practical maxims. To the extent that the hypotheses or propositions upon which they are based are true, practical maxims recommend reliable courses of action. This can be translated into a broader claim of an integral relation between semiosis and goal-directed or teleological systems. Any goal-directed system, to be propagating, must be capable of coordinating the information in its internal or endergonic processes with exergonic information found in its environment. Signs are critical links between these two sources of information and must also serve as steering mechanisms for that system as well. If signs detected or represented information in the environments without using that information to steer the system, it would have no practical effect on the system; conversely, if a system could steer itself, but had no representation of exergonic information, it would fail to be propagating. Obviously, to get food, it must not only find it, but must also use that information to direct its behavior in a manner that makes use of that food. Using concepts found in complex systems and modern information theory, it is argued that this analysis requires a distinction between information and meaning. The result of this investigation is the claim that meaning can be understood as the propagating work of information. The remainder of the paper follows some of the ramification of this analysis for Peirce's semiotic theory.

Keywords: Meaning. Information. Pragmatism. Complex systems.

Resumo: *Uma leitura cuidadosa da máxima pragmática de Peirce revela uma correlação entre significado e propósito. Caso o significado de um conceito, proposição ou hipótese seja esclarecido pela formulação dos seus efeitos práticos, eles também podem ser articulados como máximas práticas. À medida que as hipóteses ou proposições sobre as quais são baseados sejam verdadeiras, máximas práticas recomendam linhas de ação confiáveis. Isso pode ser representado como uma afirmação mais abrangente de uma relação integral entre semiose e sistemas orientados a metas ou teleológicos. Para ser propagador, qualquer sistema orientado a metas deve ser capaz de coordenar a informação, em seus processos internos ou endergônicos, com a informação exergônica encontrada em seu ambiente. Sinais são ligações importantes entre estas duas fontes de informação e devem igualmente servir também como mecanismos orientadores para aquele sistema. Se os sinais detectarem ou representarem informações nos ambientes sem usar a infor-*

mação para orientar o sistema, não terão efeito prático algum no sistema; inversamente, se um sistema puder orientar a si mesmo e não possuir nenhuma representação de informação exergônica, deixará de ser propagador. Obviamente, para obter alimento não basta apenas encontrá-lo, mas também usar a informação para orientar seu comportamento de forma a fazer uso desse alimento. Por meio dos conceitos encontrados em sistemas complexos e na teoria moderna da informação, argumenta-se que esta análise requer uma distinção entre informação e significado. O resultado desta investigação é a afirmação de que o significado pode ser entendido como o trabalho propagador da informação. O restante deste ensaio segue algumas das ramificações desta análise da teoria semiótica de Peirce.

Palavras-chave: *Significado. Informação. Pragmatismo. Sistemas complexos.*

Peirce's great advance among theories of meaning was to see the problem through the lens of an experimental scientist. The scientist's solution to figuring out what things mean is to translate concepts, terms, hypotheses, or propositions into the practical effects they could have that would be conducive to the design of a laboratory experiment. If we want to know what 'hard' means, we need to identify what hard things do in an observable way, and under controlled conditions. This is nicely illustrated by Peirce in an account of the meaning of lithium:

> if you search among minerals that are vitreous, translucent, grey or white, very hard, brittle, and insoluble, for one which imparts a crimson tinge to an unluminous flame, this mineral being triturated with lime or witherite rats-bane, and then fused, can be partly dissolved in muriatic acid; and if this solution be evaporated, and the residue be extracted with sulphuric acid, and duly purified, it can be converted by ordinary methods into a chloride, which being obtained in the solid state, fused, and electrolyzed with half a dozen powerful cells, will yield a globule of a pinkish silvery metal that will float on gasolene; and the material of that is a specimen of lithium. (CP 2.330)

As Peirce explains, "the peculiarity of this definition […] is that it tells you what the word lithium denotes by prescribing what your are to *do* in order to gain a perceptual acquaintance with the object of the word" (CP 2.330). As he says, "All pragmatists will further agree that their method of ascertaining the meanings of words and concepts is no other than that experimental method by which all the successful sciences […] have reached the degrees of certainty that are severally proper to them today; this experimental method being itself nothing but a particular application of an older logical rule, "By their fruits ye shall know them" (CP 5.465). As he explains, his own experience in the laboratory has led him

> … to believe that every physicist, and every chemist and, in short, every master in any department of experimental science, has had his mind moulded by his life in the laboratory […] But when you have found […] the typical experimentalist, you will find that whatever assertion you may make to him, he will either understand as meaning that if a given prescription for an experiment ever can be and ever is carried out in act, and experience of a given description will result, or else he will see no sense at in what you say. (CP 5.411)

Given these various formulations, Peirce's pragmatic maxim has often been viewed as a forerunner of Percy Bridgman's operationalism and, in retrospect, the verificationist theory of meaning (see ROSENTHAL, 1977, p. 338; MISAK, 1995). As A.J. Ayer concisely formulates the latter: "a statement is held to be literally meaningful if an only if it is either analytic or empirically verifiable" (1952, p. 9). Indeed, a few statements by Peirce are very suggestive of the verificationist account:

> It will serve to show that almost every proposition of ontological metaphysics is either meaningless gibberish – one word being defined by other words, and they by still others, without any real conception ever being reached – or else is downright absurd; so that all such rubbish being swept away, what will remain of philosophy will be a series of problems capable of investigation by the observational methods of the true sciences… (CP 5.423)

Or, as he says elsewhere, "… nothing that might not result from experiment can have any direct bearing upon conduct, if one can define accurately all the conceivable experimental phenomena which the affirmation or denial of a concept could imply, one will have therein a compete definition of the concept" (5.412).

It may be reasonably argued that the pragmatic maxim as Peirce ultimately intends it is actually something of the converse of the classic verificationist theorem. As opposed to Ayer's formulation, Peirce is arguing that any statement may be meaningful, but its meaning is best clarified when it is articulated practically, as he defines it. Thus, unlike the positivists of his time, he did not reject metaphysics outright, only those aspects not subject to clarification by pragmatic means: "So, instead of merely jeering at metaphysics, like other prope-positivists […] the pragmaticist extracts from it a precious essence, which will serve to give life and light to cosmology and physics" (CP 5.423).

It is perhaps Justus Buchler who gave one of the clearest accounts of the intent of the pragmatic maxim in a long-ago essay:

> The aim of "How to Make Our Ideas Clear" is to provide a way of defining and of understanding which avoids the older appeal to either mere intuitive familiarity or mere abstract definition. The problem is, in other words, what type of *equivalent* must be given for a sign (idea, belief, thought, term, proposition) which would not be guilty of the subjectivity or verbalism of the older criteria […] Now the equivalent of a sign is a translation or interpretation of it (an "interpretant"), and the interpretation which constitutes the meaning of the sign is a rule or habit of action. By these means we come to understand the referent of our signs. (BUCHLER, 1952, p. 25)

With this approach, Peirce hoped to supplant the Cartesian model of intuitive notions of clear and distinct ideas.

As Peirce developed his larger semiotic theory, the pragmatic maxim becomes a springboard for a deeper, more complex account of meaning, that no longer sees it merely as a semantic problem, so to speak, but a dynamic process that engendered habits of action which informed and regulated sign agencies. Meaning is not ultimately achieved by swapping one set of signs by another, but in the translation of signs into ultimate logical interpretants, understood as habits of action (CP 5.491). The most complete account of a concept consists "in a description of the habit which the concept is calculated to produce" (CP 5.491). I would like to run with this idea, by connecting it

with some advances in complex systems and information theory. The result, I believe will build on Peirce's theory, and retain the core insights of his program, but it will also involve re-thinking some of the basic concepts.

The Pragmatic Maxim

As we know, the first version of the maxim was composed in French by Peirce and later published in volumes 6 and 7 of the *Revue philosophique*: "Considérer quels sont les effets pratiques que nous pensons pouvoir être produits par l'objet de notre conception. La conception de tous ces effets est la conception complète de l'objet" (Consider all the practical effects that we think can be produced by the object of our conception. The conception of all these effects is the complete conception of the object.) (CP 5.18; 5.358n1). It is certainly easier on the ears than the famously mangled prose of the English version of "How to Make Our Ideas Clear," in *Popular Science Monthly*, 1878: "Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our concept of these effects is the whole of our conception of the object" (CP 5.402). If the translation is passable, what is lacking in the French version is a reference to the notion of 'practical bearings'. If we perform an experiment and erase the first clause of the English formulation ('which might conceivably have practical bearings'), it reads more like the French version. If Peirce thought it important enough to amend the original version by that phrase, it may be important to figure out what he meant by 'practical bearings' in this context, and how it might differ from 'practical effects'.

"By practical," Peirce explains in a letter to Ferdinand Schiller, "I mean apt to affect conduct; and by conduct, voluntary action that is self-controlled." And, in the same context, claims to admire Schiller's definition of the practical as that "whatever tends to the control of events" (CP 8.322; see SCHILLER, 1906, p. 386n.1). As Schiller explains his point in a rebuttal of criticism by A.E. Taylor, pragmatism advocates a critical link between purpose and truth in the sense that any process of discovery is guided by an interest in knowing some truth. Schiller's example is instructive. To know what the 100^{th} decimal place of ð is requires someone to do the calculation, to set up an algorithm, and to do the work necessary to arrive at that answer. But that decision presupposes a desire to know, and that "will only be made if the point becomes one which it is practically important to decide" (SCHILLER, 1906, p. 384). There may be little practical difference between using ð to the 11^{th} place and using it to the 100^{th} place in calculations. On the other hand, as Peirce points out, there may be other practical interests in following such calculations, for example, in proving that ð is irrational or transcendental. There may also be interest in identifying any patterns in ð, which seems to have driven recent attempts to use supercomputers to calculate it to as many as 1 trillion digits.

The larger sense of Schiller's point may be that what is practical is what is tied to purpose, understood as the work in achieving an end, which requires controlling events to achieve that end. To act for a purpose requires that we control or constrain events to achieve a certain end. For Peirce, this embodies the idea of self-controlling conduct, and seems evident in the laboratory experiment, the model for the pragmatic maxim. An experiment is practical in the sense that it attempts to control events for the purpose of getting certain results that will show that the application of that hypothesis to those

events is either prone to error or not. Depending on that outcome, such a hypothesis will have a tendency to affect conduct of those assessing the hypothesis in regard to those events (see CP 5.27). "A practical attitude of mind," Peirce says, "concerns itself primarily with the living future […] the pragmaticist is obliged to hold that whatever means anything means that something will happen (provided certain conditions are fulfilled) …" (CP 8.194). If we have reason to believe that something will happen in the future, we have also the means to control for those events, and control our conduct toward those events.

William James seems to say something similar in his lucid entry on "pragmatic and pragmatism" for Baldwin's *Dictionary of Philosophy and Psychology*:

> The doctrine that the whole "meaning" of a conception expresses itself in practical consequences, consequences either in the shape of conduct to be recommended, or in that of experiences to be expected, if the conception be true; which consequences would be different if it were untrue, and must be different from the consequences by which the meaning of other conceptions is in turn expressed. If a second conception should not appear to have other consequences, then it must really be only the first conception under a different name. In methodology it is certain that to trace and compare their respective consequences is an admirable way of establishing the differing meanings of different conceptions. (CP 5.2)

Peirce seems to acknowledge the value of this formulation by James, "whose definition differs from mine only in that he does not restrict the "meaning", that is, the ultimate logical interpretant, as I do, to a habit, but allows percepts, that is, complex feelings endowed with compulsiveness, to be such. But practically, his view and mine must, I think, coincide, except where he allows considerations not at all pragmatic to have weight" (CP 5.494).

However, even in this formulation, James seems to confuse pragmatism as a theory of truth rather than a theory of meaning , and it is instructive to follow out this important difference with Peirce. James says that since "true ideas are those that we can assimilate, validate, corroborate, and verify," and false ideas are those we cannot; and, to the extent that has a "practical difference" for us "the true, to put it very briefly, is only the expedient in the way of our thinking, just as the right is only the expedient in the way of our behaving" (1909, p. 823-824). True ideas will generally be better guides to our interaction with the world, and so our conduct, and so is practical in that sense. Peirce would not dispute that, but he would dispute the claim that the test of a truth claim is in its practicality. Although the pragmatic maxim could certainly be applied to our concept of truth, and among its practical effects could be that it serves as an expedient guide to our conduct with the world and with others, the verification of a truth claim is a distinct process, articulated with great originality by Peirce in the systematic connection among abductive, deductive, and inductive inferences. For Peirce, the pragmatic maxim remains an account of how to clarify meanings and, consequently, the basis of a theory of meaning, but not a criterion for truth. As Christopher Hookway notes, the pragmatic maxim helps with "the clarification of hypotheses enables us better to understand their strengths and weaknesses. It puts us in a position to decide whether they are worth taking seriously and to see how we should go about testing them." (2004: p. 120).

Because the pragmatic maxim works to clarify hypotheses in terms of their testable consequences, Peirce links it with abduction, understood as the logic of hypothesis formation: "If you carefully consider the question of pragmatism you will see that it is nothing else than the question of the logic of abduction. That is, pragmatism proposes a certain maxim which, if sound, must render needless any further rule as to the admissibility of hypotheses to rank as hypotheses, that is to say, as explanations of phenomena held as hope suggests: and, furthermore, that is *all* that the maxim of pragmatism really pretends to do …" (CP 5.196).

The logic of abduction, at least in one of its principal formulations, shows how a hypothesis can be formulated on the basis of surprising observations, that is, a novel hypothesis, if true, would explain the surprising observation, and from that we may conclude that the hypothesis is plausible and worthy of testing (CP 5.189). In this sense, such formulated hypotheses are *pragmatisch* in Kant's sense: "The physician must do something for a patient in danger, but does not know the nature of his illness. He observes the symptoms, and if he can find no more likely alternative, judges it to be a case of phthisis" (1789, A824; B852). The hypothesis is contingent only, but specifies "the actual employment of means to certain actions." The physician will discover whether his diagnosis is correct if he acts upon this hypothesis, on this belief, by engaging in a set of practical procedures for addressing the tuberculosis, or by making further observations consistent with the disease, as the result of such procedures, and he is willing to take that risk because it is the best hypothesis he has.

Kant's sense of pragmatic may help us finally come to an understanding of the difference and correlation between 'practical effects' and 'practical bearings' in Peirce's original formulation of the pragmatic maxim: The pragmatic maxim entails a practical maxim (or hypothetical maxim in Kant's language). If we test a hypothesis, for example, that a diamond is hard, by determining the practical effects of that claim, we also, at the same time, delimit a corresponding practical maxim. If a diamond is hard, then it will cut glass, correlates with a practical maxim: To cut glass, use a diamond cutter. In this way we have a clearer sense of the notion of "practical bearings" in Peirce's original formulation. Whereas the practical effects are ways we would clarify the meaning of proposition, and prepare it for testing, we can also translate those practical effects into practical bearings for some agent, in terms of what an agent is to do in order to achieve some end or result.

Christopher Hookway has attempted to show something like this in his admirable analysis of pragmatic maxim (2004, p. 129ff). Although my point here is the same as his, I would modify his approach by employing the fairly well-received language of practical syllogisms, found in Georg Von Wright's work and his followers, for example, instead of the formulations he proposes (Von WRIGHT, 2004). As an illustration, if we propose the hypothesis (H), that diamonds are hard, and apply the pragmatic maxim to its clarification:

> If in doing A (applying diamond tipped cutting tool across glass) , then E, (an observable effect of glass being cut) would result.

Such a hypothetical proposition will correlate with the conclusion of a practical syllogism, thus serving as a practical maxim, namely,

> If you want to attain an end, E (cut glass), then do A (apply a diamond tipped cutting tool across the glass).

In effect, the hypothesis becomes a "maxim of conduct" (CP 5.27), and in one passage, Peirce spells this out very clearly: "Pragmatism is the principle that every theoretical judgment expressible in a sentence in the indicative mood is a confused form of thought whose only meaning, if it has any, lies in its tendency to enforce a corresponding practical maxim expressible as a conditional sentence having its apodosis in the imperative mood" (CP 5.18). In this way, Peirce's definition of practical as "apt to affect conduct; and by conduct, voluntary action that is self-controlled," makes perfect sense. Assuming by voluntary action, Peirce means intentional action, then such practical maxims will affect conduct to the extent that a la Von Wright, agents want to attain an end they believe can be attained by doing a certain set of actions. The latter will be determined by the reliability of the hypothesis, that is, whether in fact doing A results in E over the long run. Peirce hints at this form of practical reasoning in the following passage:

> Now to say that a man believes anthracite to be a convenient fuel is to say no more nor less than that if he needs fuel, and no other seems particularly preferable, then, if he acts deliberately, bearing in mind his experiences, considering what he is doing, and exercizing self-control, he will often use anthracite. A practical belief may, therefore, be described as a habit of deliberate behavior. (CP 5.538)

Should the hypothesis prove reliable (anthracite is a reliable fuel), we also have reliable belief to act upon (if you need heat, use anthracite coal). Peirce, as we know, is not an advocate of Bayesian theories of confirmation (CP 2.101; 2.744). The fact that an observation that is predicted results, does not add credibility to a hypothesis because it results in a positive increment to its prior likelihood, but because over a period of such tests, it has a tendency to produce the same result reliably. We act upon the hypothesis or belief not because it has more credibility, but because it is more reliable in the sense that it produces less error than other known alternatives. Peirce asks

> What is a good abduction? What should an explanatory hypothesis be to be worthy to rank as a hypothesis? Of course, it must explain the facts. But what other conditions ought it to fulfill to be good? The question of the goodness of anything is whether that thing fulfills its end. What, then, is the end of an explanatory hypothesis? Its end is, through subjection to the test of experiment, to lead to the avoidance of all surprise and to the establishment of a habit of positive expectation that shall not be disappointed. Any hypothesis, therefore, may be admissible, in the absence of any special reasons to the contrary, provided it be capable of experimental verification, and only insofar as it is capable of such verification. This is approximately the doctrine of pragmatism? (CP 5.197)

If this interpretation of the pragmatic maxim has merit, it argues that meaning and purpose are correlative. Although Peirce disagrees with F.C.S. Schiller's account of pragmatism in almost every respect, there is one point of certain agreement, namely, his doctrine that "all meaning depends on purpose" (CP 5.175). Indeed, if meaning and purpose are correlative, then not only does meaning depend on purpose, but purpose depends on meaning.

Semiosis and Teleology

If the claim that meaning and purpose are correlative has merit, I want to show how it can be more fully explained in a collaborative use of Peirce's semiotic theory and more scientifically based models found in theories of complex systems, particularly in the notion of a propagating organization. Propagating organizations, in turn, are claimed to be good models for living systems. The result of such analysis, then, should be not only a stronger account of the relation between meaning and purpose, but a demonstration of how such correlations are integrated in living systems. It will, however, lead to some proposals for modifying Peirce's semiotic theory.

As a first step, I want to claim a broader version of the thesis of the correlation of meaning and purpose, namely, that semiosis is integral to teleological systems. This would explain why sign activity is coincident with living things to the extent that they are goal-driven systems. The crux of the argument is this (see also LISZKA, 2008). If a system is understood as having an internal organization that functions in the context of an external environment, then a goal-directed system must be one that can steer its internal operations in a manner that will tend it toward certain outcomes, relative to the constraints of that environment, and in a manner that sustains that functioning. This turns out to be exactly the critical characteristic of propagating organizations. If that is the case, they must also have the capacity to detect states of affairs in their environment in order to direct themselves toward these goals. This is obviously critical for living systems which need to detect sources of energy in its environment and avoid predation or disease in order to continue living. It is my thesis that signs not only play an essential role in the detection of environmental states-of-affairs, but also serve as steering mechanisms in propagating organizations, thus supporting the correlation between semiosis and goal-directedness. As Tom Stonier states the case: "meaning may be defined as the capacity of an intelligent or proto-intelligent system to discriminate between various aspects of environmental information and act upon an appropriate stimulus in a functional manner" (STONIER, 1991, p. 124).

As we know, Peirce has a rather broad sense of teleology, which he articulated under various concepts. Systems as elementary as thermodynamic ones are *finious* since they tend toward irreversible states of uniform distribution of particles; chance events are also finious, since they tend toward central tendencies as described by the central limit theorem (CP 6.127; CP 6.297; PEIRCE, 1889, 4741). The evolution of living systems on a large scale are also finious in this sense: "… evolution is nothing more nor less than the working out of a definite end. A final cause may be conceived to operate without having been the purpose of any mind …" (CP 1.204). Thomas Short does an excellent job of interpreting Peirce's theory of teleology in this respect, and showing a progressive continuum from finious processes to purposive agency (SHORT, 2007) which, as I have tried to point out elsewhere, would also correspond to different types of semeiosy (LISZKA, 1996, p. 32-34; LISZKA, 2008, p. 208). As Short points out, the critical difference for Peirce between teleological and non-teleological (or mechanical) systems for is that, in the latter, the end is likely regardless of the mechanism by which it is realized. In mechanistic systems, the means determine the end state. Consequently, a mechanistic account cannot explain why the end is the inevitable result in certain systems, despite a variety of means. Natural selection will always work to the end of adapting organisms to their environment, but whatever the means adopted, that end

tends to result. What is fated, so to speak, in teleological processes – and what makes them irreversible (or more precisely – highly unlikely) – is the end; in mechanistic processes, what is fixed are the means (see LISZKA, 2007, p. 639). It is more likely that an organism adapted to its environment will survive, so the fact that adapted organisms survive is a more likely result of natural selection. Essentially, we can think of such goal-directed processes as intelligent, in a broad sense of the term, since they are corrective or self-corrective processes. Mechanical processes are "dumb" in the sense that they repeat the same action regardless of consequences. Peirce argues that

> … when a microscopist is in doubt whether a motion of an animalcule is guided by intelligence, of however low an order, the test he always used to apply when I went to school, and I suppose he does so still, is to ascertain whether event, A, produces a second event, B, as a means to the production of a third event, C, or not. That is, he asks whether B will be produced if it will produce or is likely to produce C in its turn, but will not be produced if it will not produce C in its turn nor is likely to do so. (CP 5.473)

This understanding of goal-directedness is consistent with Larry Wright's classic and sensible account of goal-directed behavior: it can be said that a system behaves in a certain way if it tends to bring about a certain goal or result, and that behavior is brought about by the fact that it tends to bring about the goal (1976, p. 39). In other words, certain behaviors are selected, either intentionally or non-intentionally, precisely because they tend to bring about a certain result (see SHORT, 1997, p. 132). For example, in the case of the primitive bacteria, *e. coli*, its flagellum rotates counterclockwise, causing it to move forward into the presence of a glucose gradient, because such behavior tends to move it forward into the glucose gradient, providing it with energy sufficient for it to live. Conversely, the detection of toxins in its environment will cause the flagellum to move clockwise, in turn causing it to tumble randomly, leading to different directions. There can be a variety of means of motility, but the end— sustenance is gotten to and toxins or predators avoided—will generally result and, if not, such organisms are not around to function at all. These behaviors are not in any sense intentionally selected by the primitive organism, but have been the result of natural selection over time.

One of the clearest, naturalistic-based arguments linking semiosis and goal-directedness is made by Fred Dretske (1992). It also explains why sign-activity is not just one of several possible adaptive functions of life, but is integral to the very possibility of life (LISZKA, 2008, p. 188). Living things have to be propagating organizations, in Stuart Kauffman's elaboration of that concept, understood as systems which transforms energy to do work, sufficient at least to sustain their metabolism (2000, p. 98-103). Living things must be capable, then, of finding the energy in their environment capable of supporting the work of living. As such they need an efficient means of energy detection, and sign activity becomes that means. Most likely, primitive indices are probably the first to emerge to play that role. As Fred Dretske makes it clear indices work in this respect in a manner that Peirce noted: they vary as an outside environmental condition varies, thus cueing the organism to what the index indicates. A wind vane, for example, indicates the direction of the wind by being physically moved by the wind (CP 2.286).

However, the most important point which Dretske makes in this regard is that indices must become steering mechanisms as well, correlating sign and goal-direction.

This is for the following reasons. In order for a system to detect energy sources in its environment, and acquire them in a way beneficial to the organism, there must be a connection between the detection of those outside events and behavioral habits internal to the living organism. More than just cueing the organism to something outside of itself by varying as those events vary, it must also vary the conditions or events within the organism in such a way as to create a positive feedback loop between the environmental condition and the organism's behavior (DRETSKE, 1992, p. 55ff; see LISZKA, 2008, p. 195ff). If indices did nothing but detect environmental states, and did not consequently steer any internal states, then indices would be of no practical use to the organism. On the other hand, if organisms could steer themselves, but had no indices, then it would grope blindly in its environment. The result is that the sign acts as a steering mechanism for the organism (DRETSKE, 1992, p. 80ff). In Peirce's language, the index is associated with a dynamical interpretant and, in the long run, a final interpretant as the organism acquires that pattern of action as a habit (CP 4.536; 5.491). In using the basic cell as an example, Stuart Kauffman puts this point succinctly: "The cell, we want to say, has embodied knowledge and know-how with respect to the proper responses to yuck and yum, which was assembled for the agent and its descendants by heritable variation and natural selection" (2008, p. 39). In Peirce's language, we would say that cells have acquired a set of practical maxims, the result of the experiments of natural selection.

Since these processes are integral to living systems, we can pick any living organism that exemplifies such processes. For example, deciduous trees defoliate when there is a reduction in the plant hormone, auxin, and an increase in the hormone ethylene. The production of auxin, in turn, is triggered by cues from receptor proteins in the tree that are sensitive to changes in air temperature and sunlight, which when lowered or lessened as they are in the fall in temperate climates, also lessens auxin production. The result is the creation of abscission zones at the base of leaves, leaving the cell structure weakened, and the leave is prone to fall from the tree. Defoliation is a viable survival strategy that allows trees and plants to store energy in the form of nitrogen and carbon, and save energy needed to maintain leaf viability in the winter months.

The *e. coli* is a well studied bacteria that exemplifies similar processes of connection between indices and steering mechanism (see LISZKA, 2008, p. 196-7). *E. coli* are commonly found in the human gut, and they get their energy source from the glucose in their surrounding environment. As one of the leading experts on the organism, Howard Berg, describes it, "*E. coli*, a self-replicating object only a thousandth of a millimeter in size, can swim 35 diameters a second, taste simple chemicals in its environment, and decide whether life is getting better or worse" (2001, p. 1). The process of chemotaxis in *E. coli* has been very well detailed in studies, and clearly supports the idea that chemoreceptors on its membrane act as indices, performing a steering function by chemically communicating with the flagellar basal structures to elicit appropriate motor responses in the flagellum (see LUKAT, Stock and Stock, 1990). As Berg summarizes:

> It modifies the way in which it swims to move toward regions in its environment that it deems more favorable. Each flagellum is driven at its base by a reversible rotary motor, driven by a proton flux. The cell's ability to migrate in a particular direction results from the control of the direction of rotation of these flagella. This control is effected by intracellular signs generated by receptors in the cell wall that count molecules of interest that impinge on the cell surface. (2003, p. 3)

There is a detailed understanding of the flagellum mechanism, and a clear understanding of the chemical cascade that causes it to move either clockwise, thus tumbling in different directions, or, counterclockwise, and continuing to move in the same direction (see BERG, 2001, p. 3). This establishes a feedback loop, a habit of action in Peirce's language, that results from detection of a sufficiently dense glucose gradient. The detection of a glucose gradient causes the organism to continue in the direction of the gradient, while the detection of lessening amounts of glucose in the gradient causes it to tumble randomly in search of other sources of energy. In this case, we have a connection between the index and goal-directedness, between sign and purpose.

The Model of Propagating Organizations

According to Stuart Kauffman, "semiotic behavior can identify a source of free energy […] from which work can be extracted and propagate in the cell" (2008, p. 40). "The cell operates as an information-processing unit, receiving information from its environment, propagating that information through complex molecular networks, and using the information stored in its DNA and cell-molecular systems to mount the appropriate response" (2008, p. 28). Such processes define what Kauffman calls *propagating organizations* which, in his view, must be part of "a theory that unifies matter, energy, information, and propagating organization" (2008, p. 40).

If we begin with a simple definition of organization as a "non-random pattern of sub-units comprising any system (STONIER, 1997, p. 14), by a *propagating* organization, Kauffman means a dissipative organization, capable of using energy available within that system to do work connected to some constraint infrastructure, which contributes to some purpose, result, or product (see 2000, p. 81ff). It is important to stress in this account that what is *propagating* about this organization is that it has set up a set of operations and behaviors in its environment that are successful and sustainable. A propagating organization is capable of coordinating its internal processes to its external environment. Simply put, propagating organizations use energy and information from its environment to organize itself in a manner that interacts with that environment that allows it to continue using energy and information from its environment in a sustainable manner.

One important feature of propagating organizations is their ability to transduce energy and information. As Scott Camazine and his colleagues point out, propagating organizations have key amplifying processes that lead to growth of the system or sustainability of the system in the context of some environment (see CAMAZINE et al. 2003, p. 17). Certainly energy transductions are well understood. The transformation of burning oil to lighting lamps in the home by means of power generating plant is a good example (see STONIER, 1997, p. 31). When oil burning produces steam, and turns the turbine to generate electricity along wires that light the bulb in the lamp, we have a conversion of chemical energy into heat, heat into mechanical energy, mechanical into electrical, and electrical into electromagnetic radiation. Photosynthesis is a good example of energy transduction of light into chemical energy in plants. Sound waves represent a mechanical coding of information, and when they impinge upon the ears, they are converted from pulses of mechanical energy into nerve impulses by the motion of microscopic hair-like organelles in the inner ear (STONIER, 1997, p. 33). A well understood

example of biological transduction is the translation of the information in DNA into proteins. Transfer RNA molecules are transcribed from the DNA of the cell. One end of the tRNA is attached to a specific amino acid by a special activating enzyme. Each tRNA molecule contains an anticodon that fits an mRNA codon for that particular amino acid, and so is schematized for that amino acid. The process of translation begins when an mRNA strand is formed on the DNA template and enters the cytoplasm. At the point of attachment of the mRNA to a ribosome, the matching tRNA molecule, with its accompanying amino acid, plugs in momentarily to the codon in the mRNA. As the ribosome moves along the mRNA string, a tRNA linked to its particular amino acid fits into place and the first tRNA molecule is released, leaving behind its associated amino acid, which is linked to the second amino acid by a peptide bond. As the process continues, the amino acids are brought into line one by one, following the exact order dictated by the DNA – the result being a protein of a particular sort. Transductions of information have a family resemblance to Peirce's notion of sign translation, the claim that "meaning [… is] in its primary acceptation is the translation of a sign into another system of signs" (CP 4.127), or that "a sign is not a sign unless it translates itself into another sign in which it is more fully developed" (CP 5.594; see LISZKA, 1996, p. 24ff).

In general propagating organizations have the capacity for doing propagating work, that is, first, they are capable of detecting energy and information needed for propagating work; second they are capable of transducing such information in a way that, third, links that information with internal steering mechanisms. When coordinated such processes constitute goal-directed behavior, generally speaking. Goal-directed behavior sets up an interaction framework between organism and environment, in the case of living systems, much like an experiment, in which behaviors and dispositions are tested for "validity", and corrected accordingly. This process of correction – adopting different means to the same end, when one means fails, is an ability at the most fundamental level to be adaptive, and so sustainable within that environment. Peirce argues that "The theory of natural selection is that nature proceeds by […] experimentation to adapt a stock of animals or plants precisely to its environment, and to keep it in adaptation to the slowly changing environment" (CP 2.86). This is certainly an analogy expressed by other thinkers (see POPPER, 1972).

This critical point to make in all of this is that *the capability of linking exergonic and endergonic processes not only constitutes teleological behavior, but also semiotic*. The three processes constituting propagating organizations also mirror the three conditions for semiosis according to Peirce: a sign must refer to something, it must convey some information about its referent, such that the information it conveys directs, or has a "significate effect" on, the behavior or processes of that agent, literally speaking, it must be capable of informing the agent (CP 5.473, 5.475, 2.228, 8.191; see LISZKA 1996, p. 25). These three conditions must be triadically related for semiosis to occur. It is no accident that there is a parallel between the triadic character of purpose and the triadic character of semiosis in Peirce's thinking:

> Every sufficiently complete symbol is a final cause and influences real events, in precisely the same sense in which my desire to have the window open, that is, the symbol in my mind of the agreeability of it, influences the physical facts of my rising from my chair, going to the window and opening it. (NEM 4, p. 254; see LISZKA, 1996, p. 32ff)

Indeed, Peirce often uses the purposive or intentional act as an example of triadic relations:

> The merchant of the Arabian Nights threw away a datestone which struck the eye of a Jinnee. This was purely mechanical, and there was no genuine triplicity. The throwing and the striking were independent of one another. But had he aimed at the Jinnee's eye, there would have been more than merely throwing away the stone. Tehre would have been genuine triplicity, the stone being not merely thrown, but thrown *at* the eye. (CP 2.86)

Information and Meaning

The thesis that meaning accrues in the linking of exergonic and endergonic processes is also advocated by Tom Stonier: "Meaning is a relationship between information which exists in the environment of a potential recipient of such information, and the internal information environment which already exists within the recipient" (STONIER, 1997, p. 124). Peirce's theory, however, is not just that meaning accrues from correlations of systems of information – which is certainly one of the condition of semiosis – but that such correlations result in propagating work for the system, that is, work that corrects itself in its environment to its goals. If Stonier's account has merit, it begs for a distinction between information and meaning.

Many accounts of information treat it semantically and epistemically, as bits of meaning that are believed or known by some agent to be the case – and Peirce appears to be in this category. This is contrary to the classical Shannon notion of information, which involves a non-semantic, non-epistemic account of this fundamental concept. As Stonier complains, "… there exists a major source of confusion in the field of information science: 'information' is confused with 'meaning'. A large school of thought does not consider information to be information unless it has meaning" (1997, p. 186). "Once this distinction" between information and meaning "is clearly understood, according to Dretske, one is free to think about information (though not meaning) as an objective commodity, something whose generation, transmission, and reception do not require or in an way presuppose interpretive processes" (1999, p. vii). Indeed, Stonier claims that –"Information, as a basic property of the universe, can exist in its own right, independent of any vehicle or carrier which might be transporting or storing it, and it does not need to have meaning in order for it to exist." Dretske argues that signs *carry* information and, thereby, may have a meaning, but not every bit of information a sign carries is meaningful (1999, p. 44). He gives an enlightening example. Someone may hear the doorbell ring. That sound carries a number of bits of information, not only that someone is outside the door, but that the doorbell has been depressed, the electrical circuit has been completed to trigger the inside bell, that electrons are flowing through the wiring, and an indefinite number of other bits of information (1999, p. 72). The sound, however, acts as an index, steering the behavior of the person to come to the front door and cautiously open it to see who is there. The fact that the sound of the doorbell also carries information that the bell was depressed by someone has no particular meaning in this context. However, if after trying to depress the doorbell no sound is emitted, and the visitor starts to knock on the door, the fact that the visitor depressed the doorbell may have meaning for the occupant in trying to fix a broken system (see LISZKA, 2008, p. 202-203).

For Shannon, information is defined by the state of organization of elements within a system. This organization is characterized in the most elementary fashion as binary states, the presence or absence of which constitutes one bit of information (see LISZKA, 2008, p. 197-202). For example, the flip of a coin would have one bit of information. Tom Stonier thinks of information in a similar way, calling it another name for the organization we encounter in all systems (1997, p. 12). This is also consonant with the definition given by the physicist, Anton Zeilinger. For him, an elementary system is a system that has one binary state, essentially a binary difference in a feature of that system, which is quantified as one bit of information. The archetypal elementary system is the spin of an electron. When the electron's spin is measured the only possible outcome is either 'up' or 'down', regardless of which axis it is measured along (see ZEILINGER, 1999; see Von BAEYER, 2001). Zeilinger, like John Wheeler before him, conceptualizes information as a physical entity, and so is capable of articulation in terms of matter and energy, and has causal force. It is certainly a view espoused by Stonier, who claims that "… energy and information are readily interconvertible" (1997, p. 194).

For Shannon – using Boltzman's notion of entropy analogously – the more random the organization of bits in a system, the more *information entropy* the system has. Just as, for any thermodynamic system, the more entropy the less energy available for work, so to the more information entropy (i.e., the more random the organization of bits), the less meaningful work that information is able to do in some propagating organization (see LISZKA, 2008, p. 200-201). This has led me to claim that *meaning is the propagating work of information* (LISZKA, 2008, p. 201). We can adopt Kauffman's definition of work as "the constrained release of energy" (KAUFFMAN, 2000, p. 97), and by *propagating* work, we mean that work that successfully sustains a propagating organization. This claim is something suggested in Stonier's position that "meaning is the product of 'information work'" (1997, p. 187), and apparently espoused by by Dretske as well: "… meaning, or something's *having* meaning, is to do the kind of work expected of it …" (DRETSKE, 1992, p. 80). "Representational structures acquire their meaning […] by actually *using* the information it is their function to carry in steering the system of which they are a part" (DRETSKE, 1992, p. 81). To use Peircean language, the propagating work of information generates the practical effects realized in a system that operates on that information. If that information is found to be workable through the trial and error of experimentation in its environment, its practical effects are translated into habits of action, which act as practical maxims for that system. *Meaning and teleology, thereby, become correlated.* As Peirce says in the context of the meaning of a proposition:

> The meaning of a proposition is itself a proposition. Indeed, it is no other than the very proposition of which it is the meaning: it is a translation of it. But of the myriads of forms in to which a proposition may be translated, what is that one which is to be called its very meaning? It is, according to the pragmaticist, that form in which the proposition becomes applicable to human conduct […] that form which is most directly applicable to self-control … (CP 5.427)

"To develop its [the sign's] meaning," Peirce says, "we have, therefore, simply to determine what habits it produces, for what a thing means is simply what habits it involves" (CP 5.400).

Some Consequences for Peirce's Semiotic Theory

The distinction of information and meaning, and the characterization of the latter as the propagating work of the former, appears to require some re-assessment of Peirce's semiotic theory. How does Peirce's notion of information compare with this naturalistic, non-semantic version of Shannon's concept? As Andre De Tienne has shown, Peirce has two concepts of information which he believes can be reconciled to a large degree (De TIENNE, 2005; see QUEIROZ, El-HANI, 2007). The early version clearly involves a semantic notion of information since it is thought of as the product or result of the breadth and depth of terms in a proposition, that is, the reference and sense (or content) of the sign. Information is modeled in the standard proposition, and occurs when a predicate is applied to a subject or referent. Thus, a young student studying biology may be surprised with the information that the predicate 'mammals' applies also to the subject or referent, 'whales', and so is informed accordingly in this sense (see CP 3.608; LISZKA, 1996, p. 28).

Peirce's later account, however, may be more consistent with Shannon's and Stonier's non-semantic notion of information, but it is too unformulated to tell for sure. In this version, information appears to be identified in somewhat Medieval language as a form that is communicated or emanates from the dynamic object:

> That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions. This form is really embodied in the object, meaning that the conditional relation which constitutes the form is true of the form as it is in the object. In the sign it is embodied only in a representative sense, meaning that whether by virtue of some real modification of the Sign, or otherwise, the Sign becomes endowed with the power of communicating to an interpretant. (MS 793, p. 2-4)

Elsewhere he says, "in every case an influence upon the Sign emanates from its Object, and…this emanating influence then proceeds from the sign […] and produces an effect that may be called the Interpretant, or interpreting act, which consummates the agency of the Sign" (MS 634, p. 23). In his correspondence with Lady Welby, Peirce gives some more hints about the properties of forms:

> I use the word "Sign" in the widest sense for any medium for the communication or extension of a Form (or feature) […] In order that a Form may be extended or communicated, it is necessary that it should have been really embodied in a Subject independently of the communication; and it is necessary that there should be another subject in which the same form is embodied only in consequence of the communication. The Form, (and the Forms is the Object of the Sign), as it really determines the former Subject, is quite independent of the sign … (LW, p. 196)

There is language here that suggests that Peirce's notion of form may have similar properties to Shannon's and Stonier's notions of information as organization. De Tienne does an interesting job of trying to explicate this process of emanation through what he calls exformation, transformation, and information. I believe, however, that this process may be more clarified by modifying Peirce's notion of information in the way proposed here, and inserting it within the well-developed aspects of Peirce's semiotic theory.

Using the Shannon notion of information, we can re-state the three necessary conditions for semiosis such that a sign, in order to function as such for some agent, must be able to carry some information, must be able to convey that information within a system, and must be able to convey that information so that it has a "significate effect" on an agent, literally speaking, it must be capable of informing the agent (CP 5.473, 5.475, 2.228, 8.191; see LISZKA, 1996, p. 25). These three conditions must be triadically related. An index, for example, must serve to connect some information about something with the behavior of the sign agent toward that information before it can be said to function as a sign. As in the case of *E. coli*, the chemical presence of glucose sends cascading messages to the chemical motor of the flagellum, which then causes it to move toward the direction of the glucose gradient. Thus the index connects source, information, and behavior in a positive feedback loop. The interpretant, then, can be understood as the work of the information conveyed by signs. "When a sign determines an interpretation of itself in another sign, it produces an effect external to itself, a physical effect…" (CP 8.191).

The Shannon account of information allows us to recast some of the sense of Peirce's semiotic (see LISZKA, 2008, p. 209ff). The account of qualisigns, sinsigns, and legisigns are about how signs function as *bearers* or *carriers* of exergonic information. The account of semes, phemes, and delomes is about how signs *convey* information endergonically. Icons, indices, and symbols are about how exergonic and endergonic information is linked. The account of the various interpretants, is how the carrying, conveying, and linking of information is translated into the habits of action which constitute the sign agency.

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