PEIRCE IN 21ST CENTURY SCIENCE AND PHILOSOPHY: NEW PROSPECTS

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Eliseo Fernández

Linda Hall Library of Science and Technology

5109 Cherry St.

Kansas City, MO 64110, USA

marcieli@swbell.net

ABSTRACT

This paper aims at three main goals by examining the reception by philosophers and scientists of some of Peirce's important contributions.

Peirce anticipated in an almost prophetic manner new ideas that would be eventually discovered independently by other researchers, My first point consequently addresses the need to explain the puzzling lack of direct influence of his thought on the interplay of science and philosophy through most of the last century.

Next, after reviewing some of these new ideas (e.g. objective or real indefiniteness in quantum physics, universality of semiotic transactions in biosemiotics, etc.) I explain their eventual and reluctant adoption as prompted by the need to account for some anomalous or unexpected findings (e.g. quantum entanglement, the genetic code, etc.). In order to make room conceptually for these discoveries it became necessary to modify in radical ways some entrenched notions. Often these turned out to be precisely those which presented obstacles to the assimilation of the Peircean ideas.

Finally, based on the previous results, I sketch a strategy for facilitating and fostering the application of Peircean thought in science and philosophy. It essentially consists of combining Peirce's ideas with other new and fertile conceptions that rose after the end of his work. This strategy is illustrated with a case in which it seems to have been quite successful: **biosemiotics**. I conclude by proposing further applications of this approach within relational interpretations of quantum physics and relational realism in the philosophy of science.

Key words: **Peirce, biosemiotics, quantum physics, relational realism**

Introduction: The idiosyncrasy of Peirce's thought and the idiosyncrasy of its reception

The tragic circumstances that afflicted Peirce and his work during his life are undoubtedly well known to the members of this audience.[1] After his death the suppression of his writings and the mangled and fragmentary character in which many of them were published during the first half of the last century greatly hindered the propagation and reception of his ideas. However, the sustained efforts of numerous scholars since the mid 20th century have achieved remarkable progress in retrieving, transcribing and publishing considerable parts of the Peircean corpus. But even with this availability the insights therein revealed have not been consistently applied to the resolution of current philosophical and scientific problems —a resolution that may turn out to be impossible without them.

This state of affairs moves us to inquire whether there are other factors conspiring against the adoption —or the considerate rejection— of Peirce's ideas by contemporary thinkers. In the following I sketch in general terms some characteristics of the Peircean theses that are partially responsible for the peculiarities and anomalies of their reception. At the same time I apply some of those very theses to disclosing the nature of those obstacles, both in their general character as well as in the particular cases under consideration.

In order to meet the limitations of this brief presentation I will confine my exposition to the mere statement of the ideas considered, without attempting to report the supporting arguments advanced by Peirce or other authors. Readers of this contribution will find notes and bibliographic references pointing to original citations and commentaries in which those arguments are developed in detail. I will also confine my attention to a group of ideas of special interest to the sciences of nature and its philosophy, leaving aside important contributions to the human sciences and mathematics that have suffered a similar fate.

Peirce's ideas applied to themselves and to their own evolution

One of the distinct features of Peirce's thought is his capacity for adopting some epistemic ideals of modern philosophy while simultaneously rejecting other aspirations intimately associated with them. In particular, it is important to note his adoption of the Kantian ideal of architectonic systematicity while equally rejecting any attempt at implementing such an ideal through the traditional "axiomatic" route. By "axiomatic" I mean the application of a purely deductive chain of reasoning, departing from initial indubitable premises that involve ultimate and non-analyzable elements.

In contrast to the ”axiomatic” approach, the unity of the Peircean system lies in the complementary application of abductive, deductive and inductive inferences linked into a network of mutually supportive argumental threads. This consilience gains an inferential strength that far surpasses the weight of each separate argument. Peirce illustrates the nature of this reciprocal support with the image of a very strong cable made up by the cooperation of many relatively weak filaments. The strength of the “axiomatic” chain, on the other hand, can never exceed that of its weakest link.

This rejection of ultimate elements and indemonstrable premises leads to a theoretical architecture of a new stamp. The static simile of a theoretical building yields way to a comparison with the dynamic architecture of living beings, marked by growth, development and evolution. A concept’s meaning becomes constantly enriched through the modifications and novelties impinging on other concepts with which it happens to be connected within a theoretical context.

Peirce offers the example of the term “electricity,” remarking how much more it signified in his time than in Franklin’s days: “… men and words reciprocally educate each other; each increase of a man's information involves and is involved by, a corresponding increase of a word's information.” CP5:513 (1868).

In consequence, if we embrace this view of the development of ideas, our examination of Peircean conceptions should not be confined to inquiring what Peirce might have meant by this or the other statement. It should also be extended to conjecturing what he would have said if he had been informed of other important notions discovered after his death —since in combination with them his ideas would have gained new meanings and implications. Accordingly, the examination of the influence of Peirce’s ideas upon later day philosophical and scientific developments should take into account the possible transformations of those notions after making contact with such novelties. Here we will focus on a few key findings unveiled by physics and biology during the last century.

Rediscovery of some Peircean ideas by quantum physics

Concerning physics, our task includes elucidating the possible connections between two remarkable and discordant facts in the history of the interplay between philosophy and physics during the past century: 1) the negligible impact of Peirce's works on the philosophy of physics through most of this period,[2] and 2) the recent and independent rediscovery by several physicists of some of his most original conceptions. I am referring here to a cluster of provocative ideas which are closely related to each other and to the Peircean category of firstness. They include objective chance (tychism), real possibility, the mutability of physical laws, and the impossibility of absolute precision. Conceptions quite akin to these have been advanced in some current interpretations of quantum physics under such labels as **objective indefiniteness**, **objective randomness**, **objective fuzziness,** and **genuine fortuitousness**.

These expressions and similar ones have been appearing in the last two decades in different and mostly independent approaches to the resolution of acute philosophical difficulties for interpreting the epistemological and ontological import of quantum physics. Such problems have afflicted the theory since its inception —in spite of its unparalleled success as an instrument for predicting and explaining phenomena and for spanning a vast and growing realm of technological applications.

Among these new approaches we must mention Rovelli's relational interpretation, Aage Bohr [3] and Ole Ulfbeck's interpretation based on "genuine fortuitousness," Mermim's "Ithaca interpretation," Anandan's relationality interpretation, and Mohrhoff's "Pondicherry interpretation." Neglecting their differences, we will lump them together under the designation of "relational interpretations." Other approaches seeking to ground quantum physics in the concept of information (by such authors as Bub, Pitowsky and Zeilinger) also use some of the notions mentioned above. None of these scientists appears to have been influenced by Peirce's work, a circumstance which renders this convergence of ideas even more remarkable.

Quantum novelties in the light of the Peircean categories

In this concise treatment there is no room for a review of the philosophical problems of quantum physics or of the different features characterizing the solutions attempted by each of the relational interpretations.[4] Instead, I propose to give an over-simplified view of the conceptual roots of some problems, couched in the terminology of the Peircean categories. Then I will highlight some common features of those interpretations that show clear affinity to ideas that Peirce first advanced for the solution of other, more general, problems.
Since Newton's time, what we now call classical physics has been based on an explanatory scheme of great simplicity. Peirce traced this "natural simplicity" to some innate and spontaneous dispositions of our cognitive faculties for adjusting our behavior to the consequences of changes irrupting in the environment. We are biologically programmed to represent physical phenomena as manifesting a world of objects that are sharply individuated by their localizations in space and time and that undergo continuous, causally ordered transformations. "… Our minds having been formed under the influence of phenomena governed by the laws of mechanics, certain conceptions entering into those laws become implanted in our minds, so that we readily guess at what the laws are." CP: 6.10 (1891.)

The classical explanatory scheme proceeds by drawing a trenchant distinction between some contingent and measurable properties of the phenomena (**initial conditions**) and some mathematical transformation rules (**laws of evolution**) that constrain the possible course of events. When they are applied to the quantities describing the initial conditions the laws consequently yield through calculations a set of quantities that represent the prediction of a future event.

The initial conditions are a mathematical characterization of objects and facts endowed with actual existence and individuated by the exact determination of their spatial and temporal properties, represented by their metric relations to frames of reference and clocks. This individuation instantiates the Peircean category of **secondness,** which rules the actual existence of individual objects. Physical objects are totally determined by their intrinsic (non-relational) properties and a web of **dyadic relations** underlying their patterns of action and reaction in space.

On the other hand, the laws of evolution have no existence as individuals. Their reality resides in representing habits or inflexible tendencies in the course of phenomena. They consistently enact the same events every time that the same initial conditions are satisfied. In Peircean terms this physical necessity instantiates the category of **thirdness**, which mediates between possibility and actuality by means of non-reducible **triadic relations** —relations that take on their most perspicuous form in the logical concatenation of our thoughts.

After a long parade of initial successes (mechanics, electrodynamics, thermodynamics, etc.) this explanatory scheme ran into insurmountable barriers during the early decades of the 20th century. These limits were revealed by repeated failures in explaining recalcitrant phenomena, including, for example, the photoelectric effect and some features of the emission and absorption of electromagnetic waves (e.g. the “ultraviolet catastrophe”). This prompted the introduction of new concepts which proved incompatible with the classical explanatory scheme and led to the exploration of the structure of matter at levels of resolution where classical notions fail to apply.

It is quite remarkable that Peirce was able to foresee the general features of this situation almost four decades in advance, and without knowing the aforementioned anomalies:

> When we come to atoms, the presumption in favor of a simple law seems very slender. There is room for serious doubt whether the fundamental laws of mechanics hold good for single atoms, and it seems quite likely that they are capable of motion in more than three dimensions. CP: 6.11 (1891.)

Finally, after many attempts and difficulties, a new explanatory scheme was discovered through the labors of some of the most brilliant physicists in history. Through this new theoretical device, known as the “quantum formalism,” scientists can predict and explain phenomena at subatomic scales with unparalleled precision. On the other hand it has proved extremely difficult to make out what kind of reality may hide behind some of the baffling phenomena predicted by the theory. This is the source of enormous perplexity.

What conception of reality is suggested by the quantum perplexities?

The image of the physical world arising from quantum theory defies our most basic intuitions. Quantum objects are indistinguishable and not re-identifiable. The theory forbids assigning to them definite trajectories and sharp locations at the same time. Their actions cannot be ordered according to the causal, spatial and temporal relations that bind classical events. It is impossible to ascribe to them properties independent of the instrumental procedures that produce, detect and measure them. This list can be extended considerably to include paradoxes of superposition (e.g. Schrödinger’s cat) and quantum entanglement.

After seven decades of protracted and intense intellectual efforts, we remain far from reaching a consensus regarding what kind of reality manifests itself through these defiances of common sense. In the grips of philosophical despair some scientists have sought refuge in solutions that appear to others as ontologically extravagant: perpetual multiplication of parallel universes, action of the future on the past, the unreality of time and, in some relational interpretations, the unreality of matter.

Among the most recent and promising proposals, relational interpretations represent a partial convergence from independent origins. We must limit our considerations to examining their common features. For us, as students of Peirce, the most remarkable characteristic of these approaches is their tacit repudiation of the nominalistic metaphysics dominant in modern philosophy and science since before the "scientific revolution."

As a matter of fact, a common feature of these proposals is to uphold the **relational nature of physical reality**, thereby reversing the terms of the nominalistic ontology. Relations cease to have a reality subordinated to that of their *relata*. On the contrary, the reality of any related individual entities is altogether dependent on the reality of the relations. In these interpretations the quantum formalism follows directly from the assumption that there are no fundamental deterministic laws but only probabilities for physical events, which are constrained by symmetries. **Reality is relational** in the precise sense that an entity is real only in relation to another entity that is interacting with it. The elements that constitute physical reality are then the **relations of interaction between systems**, not any preexistent objects. The very idea of an isolated system, basic to the classical perspective, appears now as a contradiction in terms. The so-called "intrinsic" properties (e.g., masses or charges of particles) are really relational and only assignable to the interactions of the systems that detect or measure them. Rovelli says: "Quantum mechanics is a theory about the physical description of physical systems relative to other systems, and this is a complete description of the world." Since there is no description from outside the world, every description must be linked to a perspective. Nothing just happens — every event happens only through and within the interactions of systems.

The application of these ideas plausibly dissolves the most notorious quantum perplexities. We cannot present here the complete arguments, but the following example illustrates their general lines. One of the antinomies of the standard interpretations is that the theory allows that a property of a system **S** can have a definite value for an observer **A** and at the same time an indefinite value for another observer **B.** In the relational interpretations this is no longer a paradox, but rather a natural consequence of their perspectival stance. When one takes into account that any comparison between the outcomes obtained by **A** and **B** demands a physical interaction between **A** and **B** (there are no disembodied observers), then the new outcome predicted by the theory is consistent with those previously obtained.

Objective randomness

In classical physics, randomness and the probabilities that quantify it have a subjective character –they are traits of the cognitive states of researchers and have no counterpart in physical reality. This notion entails an absolute determinism in the *dénouement* of events and the perennial and immutable nature of the laws that govern them. As we know, Peirce, through his doctrine of **tychism** (from *tyché*, chance), firmly opposed these conceptions and argued for the existence of real spontaneity in nature and for the emergence of genuine novelties. He further concluded that physical laws are not absolutely rigid and are themselves subject to evolutionary changes.

Several interpretations of quantum physics, not just the relational ones, have rediscovered these Peircean theses. Indeterminism is widely accepted, but the most radical version of tychism is the "genuine fortuitousness" proposal of Aage Bohr and Ulfbeck. Here, reality is also denied to elementary particles and fields of force, the basic ontic ingredients of ordinary physics. The only actual existents are "clicks" —as the authors call the events recorded by the detectors or counters of the alleged particles— which randomly irrupt into space and time **and are not caused by anything**. The causal relations we attribute to the macroscopic phenomena we experience arise from the probability distribution of the collective behavior of the "clicks," which is predicted by the rules of the quantum formalism. But —and this is crucial— the authors are able to derive those rules directly from general principles regarding only the symmetries (invariance relations) of space and time and independently of the standard formulations of quantum physics.

The rediscovery of Peircean semiotics by biology

Before drawing conclusions on the role of Peirce's ideas in physics, where in general they have been independently rediscovered, we must examine the case of biology where they have only recently been applied after sustained reflection on his writings. Biosemiotics is an emerging discipline rooted in Peircean semiotics.[5] It is founded on the discovery that semiotic transactions (e.g., the emission, transmission and reception of signs, the processing of information, the construction, transcription and translation of codes, etc.) are coextensive with the emergence, the functioning and the evolution of all living forms and systems of organisms —from the internal dynamics of bacteria up to the whole biosphere. The discovery of the genetic code at mid-century promoted the use of an expanding semiotic vocabulary, namely information, transcription, translation, encoding, decoding, messenger molecules, and more. Initially these terms were regarded as mere metaphoric devices to be later eliminated in favor of more traditional biological and chemical concepts. This has not happened, and now biosemiotics is attempting the opposite task of reformulating basic biological conceptions in terms of the essential role played by semiotic interactions in the phenomena of life.

From the beginning, the founders of the discipline (Thomas Sebeok, Jesper Hoffmeyer, Claus Emmeche, Kalevi Kull, and several others) found inspiration in Peircean semiotics. The synthesis of Peirce's ideas with the almost forgotten investigations of Jakob von Uexküll was a decisive event.[6] This synthesis was developed by Sebeok under the label of "zoosemiotics," which he later re-baptized as *biosemiotics*. In contrast to the situation we found in physics, the reception of Peirce’s ideas in biology is marked by the direct influence of his writings. Far from passively adopting Peirce’s ideas, biosemioticians have rigorously criticized them, while at the same time combining them with more recent notions which are in no way anticipated in those ideas.

Lessons for the future

The examination of similarities and differences in the incorporation of Peircean conceptions in physics and biology yields valuable lessons for those like us who wish to propagate, study and apply Peirce’s ideas.

Let us begin with the similarities. In both cases the incorporation was brought about by unexpected empirical discoveries foreseeable neither from within the conceptual frames of those disciplines nor from Peirce’s speculations. Also in both cases the incorporation was motivated by the impossibility of assimilating the new results within those frames, which were subsequently reorganized in terms of the new ideas.

Regarding the differences, we have already noted that in physics Peirce’s ideas were rediscovered *de novo*, while they were brought into biology through a sustained reflection on Peirce’s writings and their successful combination with ideas unrelated to them.

I think that the best way to draw lessons from this examination is to apply Peirce’s ideas to Peirce’s ideas —notably his view on the creation of novelties in nature as well as in human thought. For Peirce creative thought reaches its most perspicuous form in mathematics and is based on what he calls **theorematic** reasoning. Contrary to **corollarial** reasoning, which is limited to deducing what is implicit in the premises, creative reasoning includes abductive steps that inject new premises which are not deductible from the other premises but are logically compatible with them. If we accept this view we must try to develop new heuristic procedures to lead us to such new premises. I will suggest one.

Instead of limiting our examination to the cases in which Peirce anticipated new ideas, we must consider also those cases in which —though possible— he failed to anticipate them. Let us take, for instance, the concept of **symmetry** in physics, which is equally applied to phenomena, equations and laws. Symmetry is manifest in a situation where some relations of interest remain invariant after applying a certain group of transformations. Here the term "group" has a technical meaning concerning the algebraic structure of the operations. We can say without exaggeration that the concept of symmetry is the most important instrument of synthesis and discovery in the physics of the twentieth century. Its effects are comparable to those brought about by the introduction of the concept of energy in the nineteenth century. This notion is also essential for articulating the relational realism that inspires some contemporary views in the philosophy of science. Some contemporaries of Peirce (Poincaré, Lorentz, Larmor, and others) were able to partially foresee the general features of this concept. What ingredients in Peirce's thought impeded, through their presence or absence, his anticipation of this idea? If we are able to grasp these ingredients they will guide us to conjecture which notions we need to add to Peirce's in order to anticipate the role of symmetry and maybe to lead us to other ideas which have not yet been discovered.

The success in incorporating Peircean conceptions into biosemiotics should encourage us to apply this strategy for disseminating and expanding these ideas through their combination with other fruitful conceptions that have appeared during the last century. The "modal turn" of Peirce's last two decades (see Lane 2007), with its recognition of the full reality of unactualized possibilities, initiated a process of deep modifications of his conceptions in semiotics, modal logic and synechism, which was left unfinished. These unfinished tasks are full of opportunities for applying the strategy I am proposing.

NOTES

[1] Details can be found in Houser 1989.

[2] There are some notable exceptions. A direct influence of Peirce's ideas can be seen in the works of Finkelstein, Shimony, Beil, Wheeler, and others. See some of their woks listed in References.

[3] Aage Bohr, Nobel Prize in Physics 1975, should not be confused with his father, Niels Bohr, one of the main creators of quantum mechanics.

[4] An excellent introduction to quantum mechanics, its development, and its philosophical problems can be found in Bitbol 1996 and 1998.

[5] Excellent chronicles of the origin, evolution and current status of biosemiotics are given in Favareau 2007 and Kull 2005.

[6] A main concept in this synthesis is that of *Umwelt* (see Deely 2004.)

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