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First philosophy naturalized: Peirce's place in the Analytic tradition[1]

A primeira filosofia naturalizada: o lugar de Peirce na tradição analítica

Paul Forster
University of Ottawa – Canada
pforster@uottawa.ca

Abstract: Charles Sanders Peirce's epistemology appears paradoxical when compared to Rudolf Carnap's and W. V. Quine's. Like Carnap, and unlike Quine, Peirce thinks scientific knowledge rests on logical principles that must hold if talk of truth and falsehood is to be meaningful. He also shares Carnap's view that these principles are prior to and independent of findings in the natural sciences, a view Quine famously rejects. However, like Quine, and unlike Carnap, Peirce insists that there is no knowledge beyond what is gained through empirical testing, that the truths of logic are epistemologically on a par with truths uncovered in the natural sciences and that they tell us something about the way things are, rather than being empty of factual content as Carnap contends. The air of paradox arises from Peirce's simultaneous allegiance to views commonly thought to belong to incompatible epistemological theories. Sorting through this paradox by comparing Peirce's conception of knowledge to Quine's and to Carnap's helps us better appreciate his importance in the philosophical tradition and the depth and originality of his views.

Keywords: Peirce. Quine. Carnap. First philosophy. Naturalism.

Resumo: *A epistemologia de Charles Sanders Peirce parece paradoxal quando comparada a de Rudolf Carnap e W.V. Quine. Como Carnap, mas diferentemente de Quine, Peirce considera que o conhecimento científico reside em princípios lógicos que devem se sustentar para que o discurso sobre o verdadeiro e o falso tenha sentido. Ele também compartilha a visão de Carnap de que esses princípios são anteriores à, e independentes das constatações nas ciências naturais, uma visão que Quine notoriamente rejeita. Todavia, como Quine, mas diferentemente de Carnap, Peirce insiste que não há conhecimento além daquele que é obtido por meio de testes empíricos, que as verdades da lógica estão epistemologicamente a par das verdades descobertas nas ciências naturais, e que nos revelam algo sobre como as coisas são, em vez de carecerem de conteúdo fatual, como Carnap afirma. Um ar de paradoxo emerge no comprometimento*

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simultâneo de Peirce às visões comumente consideradas próprias das teorias epistemológicas incompatíveis. A análise desse paradoxo pela comparação da concepção de conhecimento de Peirce ao de Quine e Carnap nos ajuda a apreciar melhor sua importância na tradição filosófica e na profundeza e originalidade de suas razões.

Palavras-chave: *Peirce. Quine. Carnap. Primeira filosofia. Naturalismo.*

Charles Sanders Peirce's epistemology appears paradoxical when compared to Rudolf Carnap's and W.V. Quine's. Like Carnap, but unlike Quine, Peirce holds that scientific knowledge rests on logical principles that must be true if talk of truth and falsehood is to be meaningful. With Carnap he also thinks that these principles are prior to and independent of findings in the natural sciences, a view Quine famously rejects. Like Quine, but unlike Carnap, Peirce insists that there is no knowledge beyond what is gained through empirical inquiry, that the truths of logic are of the same epistemological kind as truths in the natural sciences and that they reveal something about the way things are, rather than being empty of factual content (*inhaltsleer*) as Carnap contends. The air of paradox arises from Peirce's simultaneous allegiance to views commonly thought to belong to incompatible epistemological theories. Comparing Peirce's conception of knowledge to Quine's and to Carnap's, I argue that there is no paradox or tension in his views about logic and its relationship to natural science. While the comparison I make does not show the superiority of Peirce's philosophy over Carnap's or Quine's, it does show its originality and importance in the philosophical tradition.

Peirce shares Quine's and Carnap's aim of putting philosophy on a proper scientific footing. Like them, he views philosophy as "nothing more than a branch of science" (CP 1.663) and the logic of inquiry—the counterpart to what Quine and Carnap call "epistemology"[2]—as the science of science (CP 5.537).[3] However, he has his own idea of what this project requires.

Peirce considers Quine's project of pursuing epistemology within the parameters of psychology (and natural science, more generally) untenable.[4] He thinks that as a "special science" psychology "ought itself to be based on a well-grounded logic" and in light of this holds that "it is indeed a vicious circle to make logic rest upon a theory of cognition" (CP 3.432).[5] The suggestion is that inasmuch as findings in psychology

2 Following Peirce, I use the terms "principles of logic" and "principles of inquiry" interchangeably. For him, the science of logic deals with the forms of inference involved in the pursuit of truth. So construed logic extends beyond deduction to abduction (the logic of theory formation), induction (the logic of confirmation) and the theory of scientific method and truth. This contrasts with Quine for whom the central notion of logic is deducibility. I do not trade on these terminological differences in what follows (see QUINE, 1992, p. 14).

3 See also RLT 117.

4 See QUINE, 1969, p. 68-89.

5 Peirce also writes: "Psychology must depend in its beginnings upon logic, in order to be psychology and to avoid being largely logical analysis. If then logic is to depend on psychology in its turn, the two sciences, left without any support whatever, are liable to roll in one slough of error and confusion" (CP 2.51). He says "[…] the too frequent practice

are justified by logical principles of inquiry, they do not provide an independent ground for a theory of inquiry. The problem is not merely that psychological inquiry involves inferences—he thinks every sort of inquiry does that and there is no form of justification that does not rely on reasoning of some sort or other. The problem is rather that controversies in psychology cannot be broached without assuming views about the scope and relevance of first-person evidence, the legitimacy of appeals to unobservable or non-physical states and processes, and the relative importance of behavioral, biological and physiological evidence, among other things. Positions on these matters, he thinks, rest in turn on views about the logical principles appropriate to forming and testing hypotheses. The circularity he is concerned to avoid arises when a theory of the principles of inquiry are justified by findings in psychology that are in turn warranted by these same principles. To avoid this circle, he thinks it necessary to justify theories of the logic of inquiry independently of results drawn from methodologically contested sciences like psychology (and any other natural science). For him, the science of logic is "widely distinct" from the natural sciences and thus qualifies—to Quine's way of thinking at least—as first philosophy (CP 2.41).[6]

Quine dismisses worries about the circularity of appealing to the findings of the natural sciences in defence of a theory of scientific inquiry as "needless logical timidity".[7] Once we recognize that there is no test for knowledge outside experience, he thinks we are obliged to surrender any demand for a justification of the principles of scientific method that is independent of knowledge of the natural world gained by this method.[8] This response to the charge of circularity does not address Peirce's concern, however. In rejecting justifications of logical principles that appeal to findings in the natural sciences he is not insisting on a foundation for the logic of inquiry that is altogether outside the scope of empirical science. To the contrary, he insists that the science of logic, though prior to and independent of knowledge gained in the natural sciences, poses no exception to the view that "all knowledge whatever comes from observation" (CP 1.238). Logic, for him, remains "an observational science, like any other positive science, notwithstanding its strong contrast to all the special sciences […]" (CP2.227).[9] But how are we to understand this claim?

[…] of basing propositions in the science of logic upon results of the science of psychology […] is to my apprehension as unsound and insecure as was that bridge in the novel of *Kenilworth* that, being utterly without any sort of support, sent the poor Countess Amy to her destruction; seeing that, for the firm establishment of the truths of the science of psychology, almost incessant appeals to the results of the science of logic […] are peculiarly indispensable" (EP 2:412). Finally, he writes to F.C.S. Schiller that: "[w]hen you say that Logical consequences cannot be separated from psychological effects, etc. in my opinion you are merely adopting a mode of expression highly inconvenient which cannot help, but can only confuse, any sound argumentation. It is a part of nominalism which is utterly antipragmatistic, as I think, and mere refusal to make use of valuable forms of thought" (CP 8.326). See also CP 1.102, CP 5.173, CP 8.144f, CP 2.210, CP 8.242 and EP 2:386.

6 See W 1:422, and QUINE, 1969.

7 QUINE, 1974, p. 2.

8 QUINE, 1981, p. 21-22.

9 For Peirce, the logical principles of inquiry "do not depend on any particular state of things, and hence we say we have not derived them from experience" but this is merely "to say,

On Peirce's account, logic—inasmuch as it uncovers the principles of reasoning involved in rational inquiry—reveals the "general conditions of the attainment of truth" (NEM 4:196).[10] The theory of the logic of inquiry is prior to, and independent of, findings in the natural sciences in the sense that the principles necessary for the attainment of truth hold whatever turns out to be the case in the actual world (CP 1.240-41). Unlike the natural sciences, the science of logic delimits the scope of truth and falsehood without determining which among the logically possible states of affairs actually obtain.

Despite its differences from the natural sciences, inquiry in logic, on Peirce's view, pursues the same experimental method as every other form of inquiry does. As he sees it, logical principles are justified by mathematical reasoning, reasoning that he contends is deductive. Yet the conclusions arrived at in logic by mathematical reasoning are warranted by experience—specifically by means of experiments carried out on symbolic constructions, or, "diagrams". To illustrate, consider Peirce's account of how to justify the following deductive (i.e. mathematical) inference:

All humans are mortal.
Socrates is human.
So, Socrates is mortal.

On Peirce's method, the first step is to construct a diagram that depicts conditions in which the premises are true (whether they are true or not).[11] The next step is to try to modify the diagram in such a way that it shows the conclusion of the inference to be false while the premises remain true. Observing this to be impossible, Peirce thinks we are warranted in concluding that the inference is valid—that in any world in which the premises are true, the conclusion is also true. A similar experimental procedure shows that the inference remains valid whatever terms are substituted for Socrates, humanity and morality and thus that the original inference is an instance of a more general logical principle: *Nota notae est nota rei ispsius*.[12]

Peirce sees no methodological difference between testing inferences and logical principles by means of experiments performed on diagrams and testing physical theories by means of experimental apparatus. In the Michelson-Morley experiment, for example, a beam from a single source of light is sent through a half-silvered

any other experience would have furnished the premisses for them as well as that which we have experienced; while to discover the material laws [e.g. laws in the natural sciences] we require to have known just such facts as we did" (W 1:422). See also W 5:380-81, CP 1.417, CP 2.84, CP 4.530 and NEM 4:105.

10 As truth is a property of signs, for Peirce, logic is part of semiotics. In logic, on this view, "we observe the characters of such signs as we know, and from such an observation […] we are led to statements […] as to what *must be* the characters of all signs used by a 'scientific' intelligence, that is to say, by an intelligence capable of learning by experience" (CP 2.227). See also CP 1.539 and CP 2.220.

11 Peirce considers Euler diagrams, Venn diagrams, Boole's algebra and his own system of logical graphs as various systems for constructing logical diagrams.

12 "[T]he predicate of the predicate is the predicate of the subject," which Peirce says, "is laid down in several places by Aristotle as the general principle of syllogism" (CP 2.590).

mirror so that it is split in two, with one half of the beam directed at right angles to the other. Each of these separate beams is directed to a second mirror that reflects it back to the point at which they were divided. Any difference in the time at which the beams arrive at this point indicates a difference in the speed of their travel, a difference attributable to the differential effects of the flow of ether across the earth's surface. In this experiment, as in the diagrammatic experiment designed to test the validity of the syllogism cited above, certain public objects are configured to realize conditions predicted to isolate and produce certain results—effects of the ether in one case and effects on the truth of certain propositional signs in the other—and the observed results are generalized to all similarly conducted experiments. In the physical case the experiment reveals something of the behaviour of light under carefully engineered conditions and in the logical case the experiment reveals an abstract relation among terms and propositions. But in both cases, Peirce insists, inquiry proceeds by one and the same experimental method. Though the conclusions uncovered by experiments in logic are justified without appeal to findings disclosed in the natural sciences, the science of logic remains an experimental science.

For his part, Quine agrees with much of what Peirce claims in behalf of the importance of diagrammatic reasoning in philosophy. To his way of thinking, Peirce's experiments on diagrams exploit "a useful and much used manoeuvre" that he calls "semantic ascent" (QUINE, 1960, p. 271). Peirce shifts from examining the things represented by diagrams—in our example, Socrates, humanity, mortality and the relations that hold among them—to examining the diagrams themselves. Quine applauds this way of proceeding because, unlike abstract logical entities and relations, diagrams (or, rather their instances) are "tangible objects of the size so popular in the marketplace, where men of unlike conceptual schemes communicate at their best." (QUINE, 1960, p. 272). Like Peirce, he thinks that conclusions arrived at by diagrammatic reasoning have the same epistemological status as results arrived at in other sciences. For him, findings in logic are justified in precisely the same way, and are true in precisely the same sense, as results in any other domain of scientific inquiry—the natural sciences included. Finally, Quine is at one with Peirce in insisting that the truths uncovered by diagrammatic reasoning have ontological import. Like results in any other science, findings in logic tell us something about the way the world is.[13]

Their agreement on these matters notwithstanding, Peirce insists, as Quine does not, that there is a philosophically important difference between the results uncovered through inquiry in logic and those uncovered in the natural sciences. Unlike the latter, findings arrived at by diagrammatic reasoning are warranted independently of any knowledge of what the actual world is like. The experiment

13 Quine does not think the use of semantic ascent distinguishes philosophical inquiry from inquiry in other sciences. He thinks the method is also used in high-level theoretical physics. For example, he thinks the conception of time and length in the theory of relativity "is too radical to be efficiently debated at the level of object talk unaided by semantic ascent" (QUINE, 1960, p. 272). While acknowledging that "we can expound physics in its full generality without semantic ascent [but] can expound logic in a general way only by talking of forms of sentences," he denies that the sentence "If all Greeks are men and all men are mortal, all Greeks are mortal" "owe[s] its truth […] more peculiarly to language than other sentences do" (QUINE, 1960, p. 273-274).

designed to test the validity of the deductive inference given above reveals that Socrates is mortal in any world in which all humans are mortal and he is human, and this conclusion is true whether or not there are any actual humans, whether or not they are mortal and whether or not Socrates is among them. Similarly, the experiments that test the *nota notae* principle show that in any world where all members of a certain class *A* are members of class *B* and all the members of class *C* are members of class *A,* then all the members of *C* are members of *B*—and that this too holds whether or not these classes actually have members. Peirce insists that these experimental findings reveal substantive facts about reality—specifically, about what combinations of states of affairs are possible in the world—yet, he notes, these conclusions do not depend on or imply any claims about what is actually the case. In light of this, he thinks diagrammatic reasoning gives us a method of justifying logical principles of inquiry that is independent of inquiry in the natural sciences, a method that avoids the vicious circularity that he thinks infects any approach, like Quine's, that vindicates principles of scientific method by appeal to findings in psychology or physics. In short, Peirce maintains an important philosophical difference between the truths of logic and the truths of the natural sciences, all the while holding (as Quine does) that one and the same method of inquiry applies in every science—logic and philosophy included—and that there is no foundation for empirical science firmer than the findings of empirical science itself.

To Carnap's way of thinking, Peirce's effort to preserve something of first philosophy and resist the incorporation of philosophy into the natural sciences that Quine advocates is deeply confused. Like Peirce, Carnap holds that inquiry in the natural sciences presupposes principles of scientific inquiry. Investigation into matters of empirical fact, he insists, rests on a logically prior analysis of the meaning of terms, the relevant evidence and the logical principles for assessing it. In further agreement with Peirce, he thinks inquiry in logic proceeds by applying rules for forming and transforming symbols, without regard for the way things actually are.[14] However, in stark contrast to Peirce, he rejects the suggestion that conclusions arrived at through inquiry in logic are informative about reality in the way that findings in the natural sciences are. As he sees it, the truths of logic—the conclusions Peirce establishes by diagrammatic reasoning included—are analytic. That is, their truth is determined solely by the syntactic and semantic rules governing the use of symbols, rules that neither rest on, nor imply, knowledge of fact beyond these symbols. For example, Carnap thinks the logical necessity of inferring that Socrates is mortal given that Socrates is human and all humans are mortal is accounted for by a purely syntactic transformation rule—that from expressions of the form "If *P*, then *Q*" and "*P*", "*Q*" follows—and

14 Carnap says, for example: "[…] the development of logic during the past 10 years has shown clearly that it can only be studied with any degree of accuracy when it is based, not on judgment (thoughts, or the content of thoughts) but rather on linguistic expressions, of which sentences are the most important, because only for them is it possible to lay down sharply defined rules. And actually, in practice, every logician since Aristotle, in laying down rules, has dealt mainly with sentences," (CARNAP, 1959, p. 1). In his later work, he incorporates formal semantics in his view of logical analysis but the objects of analysis remain linguistic expressions (CARNAP, 1956). Cf. CP 2.555.

semantical rules that stipulate that "Socrates" denotes Socrates, "*x* is human" is true in the relevant language iff *x* is human and "*x* is mortal" is true in this same language iff *x* is mortal. The truths derivable from these linguistic rules (e.g. "If Socrates is human and all humans are mortal, then Socrates is mortal") are, for him, utterly devoid of factual content and remain true no matter what empirical inquiry might reveal to be the case in the actual world. While agreeing with Peirce that truths uncovered through logical inquiry are independent of findings in psychology and other natural sciences, he insists that this is because logical inquiry is an activity fundamentally distinct from empirical science, an activity aimed at clarifying the meaning of cognitive expressions (true and false), not to amassing truths about the world as inquiry in the empirical sciences aims to do. On this view, to insist, as Peirce does, that logic and the natural sciences are on a par methodologically is to conflate questions of meaning and questions of truth, the analytic and the synthetic.

There is little reason to think Peirce would be moved by Carnap's criticism. As noted, he grants Carnap's point that logic concerns itself with delimiting which states of affairs are meaningful, rather than which are actually the case[15] and is even willing to say that "the logician does not assert anything" (CP 4.79)—meaning by this that the truths of logic do not imply anything about what is the actually the case.[16] What he is not prepared to grant is Carnap's claim that logical principles have no footing in matters of fact pertaining to the nature of reality. As he sees it, the principles of logic affirm the conditions that must obtain in order for there to be signs capable of representing the world (truly and falsely). Signs, for him, are objects in the world no less than tables or electrons and to uncover the conditions necessary for them to function as cognitive representations is to say something substantive about reality. A sign, for him, is "anything which is supposed to stand for another and which might express that other to a mind which truly could understand it." (W 1:257). Given this conception, he thinks it not only intelligible but compelling to view logic as uncovering the general properties that allow objects in the world to be represented. Since Peirce, like Carnap, thinks representable objects are the only ones that can be conceived (or discussed or debated), he thinks they are the only objects it makes sense to deem real or unreal. But this is just to say that the properties of objects that underwrite their conformity to the principles of logic enter into their very nature—they form part of what it is to be an object cognitively speaking. Although the truths disclosed through inquiry in logic do not distinguish the actual world from unactualized possible worlds—inasmuch as they hold in every world in which there is a truth to discover—they are not empty of factual content because they represent (i.e. are true in virtue of) features that objects really have, not just features of the language

15 Peirce says the principles of logic are "[…] so broad as to hold not only for the universe we know but for every world that poet [sic] could create" (CP 1.417).

16 See CP 4.79. Peirce elsewhere says: "A logical principle is said to be an *empty* or merely formal proposition, because it can add nothing to the premisses of the argument it governs, although it is relevant; so that it implies no fact except such as presupposed in all discourse…" (CP 3.168).

we devise to conceive of them. Logic is thus a "positive science" (CP 3.428),[17] one that involves "a search for real truth"(RLT 115) about the world.[18]

It is a similarly safe bet that Peirce would reject Carnap's charge that he conflates the epistemological status of logical and empirical claims. He agrees with Carnap that, in contrast to natural scientists, logicians study the possibilities allowed for by systems of representation without regard for what is actually the case. He would also grant that any conclusions arrived at by diagrammatic reasoning are analytic—if by this it is meant that they merely explicate the cognitive content of a set of premises assumed to be true. But he does not think this marks logical inquiry off from other domains of empirical inquiry as a different sort of activity or that it distinguishes logical truths as a distinct kind of knowledge. As he sees it, there is far more to logical inquiry than deducing theorems by appeal to prior definitions, axioms and postulates—Carnap's semantical rules included. Indeed, he contends that the most important cases of inquiry by diagrammatic (i.e. explicative) reasoning involve steps that are not justified in this way. For example, there is nothing in the question of whether the real numbers are countable that implies that it can be settled by Cantor's method of diagonalization. Nor is there anything in the formulation of the question of whether arithmetic is finitely axiomatizable that suggests the technique of Gödel numbering as a method of showing that it is not. Cases such as these involve the "invention of an idea" [i.e. new methods of proof] not at all forced on us by the terms of the [theorem to be proved]" (NEW 4:8). Peirce contends that novel proof strategies such as these are arrived at by creative insight involving inferences—abductions—that cannot be formalized in a set of strict transformation rules. Moreover, he thinks pursuing these strategies is akin to carrying out an experiment guided by a hypothesis in physics. As in the case of testing the validity of inferences, these experimental proofs involve the modification of diagrams (i.e. making inscriptions and erasures), observation of the consequences produced, and inductive generalization of the observed results to similar cases. Even though the results of diagrammatic reasoning are deductive (i.e. the theorems follow necessarily from propositions assumed to be true by legitimate inference rules) and explicative (i.e. there is no information in the conclusion not contained in the premises) the conclusions are arrived at by reasoning that goes far beyond the mere derivation of corollaries from definitions of terms by strict rules of inference.

It might still be thought that Peirce gives short shrift to Carnap's intuition that there is a fundamental epistemological difference between claims like "Some dogs are black," which can be confirmed or falsified on the basis of information gained from observing the way things are in the actual world, and claims like "All black dogs are black" which he considers true necessarily once the meaning of the words are fixed and that holds whatever the natural sciences may reveal to be the case (CARNAP, 1963, p. 916). If, as Peirce believes, logical truths are on the same

17 "By a *positive* science I mean an inquiry which seeks for positive knowledge; that is, for such knowledge as may conveniently be expressed in a *categorical proposition*" (CP 5.39). Logical truths are hypothetical inasmuch as they assert what is true given premises assumed, but not asserted, to be true. Yet these hypothetical truths are categorical inasmuch as their truth remains a matter of "positive categorical fact" concerning the relations with which they deal (CP 5.39).

18 See RLT 115, and NEM 4:xv.

footing as claims about the actual world, how does he account for these apparent epistemological differences?

From what has been said, it is clear that Peirce cannot explain these differences by appeal to Carnap's distinction between claims true by virtue of the rules of language and claims true by virtue of empirical facts. As he sees it, "All black dogs are black" informs us about what it represents. It affirms that any object in the world falling under the term "black dog" falls under the term "black" and is not, as Carnap would have it, merely an explication of the rules governing the use of the symbols it contains. Moreover, he thinks "All black dogs are black" is fallible. It is warranted by experimental testing and there is, for him, no way to rule out conclusively that further experience might show it to be untenable.

It is also worth noting in passing that Peirce would not be satisfied with Quine's account of the difference between "Some dogs are black" and "All black dogs are black". He agrees with Quine that "All black dogs are black" is in principle subject to revision in the face of failed predictions just as "Some dogs are black" is. However, he thinks there is more to the fact that "All black dogs are black" seems immune to falsification than, as Quine maintains, that its denial involves a more drastic revision of our theory of the physical world than the denial of a claim like "Some dogs are black" does. Quine's explanation leaves out what he thinks is a crucial distinction between claims like "All black dogs are black" which are true necessarily—i.e. that hold not only in the actual world but in all possible worlds in which there are truths to discover—and truths like "Some dogs are black" which are not. It also fails to acknowledge Peirce's point that truths in logic are warranted without regard for the truth or falsehood of claims in the natural sciences.

For Peirce, the key to understanding the difference between "Some dogs are black" and "All black dogs are black" lies in the nature of the diagrams involved in logical inquiry. As he sees it, the belief that "All black dogs are black" is warranted by the impossibility of constructing a diagram that represents the class of black dogs as having a non-black member. Since, for him, the diagrams used to show the truth of this claim do not involve signs that represent the way the world actually is, they reveal its truth to be independent of any facts that the natural sciences might disclose and that it holds in any world in which there is a truth to be discovered. Though an experimental finding on a par methodologically with findings in the natural sciences, "All black dogs are black" is necessarily true and logically prior to results in the natural sciences.[19]

Its status as a fallible experimental finding notwithstanding, Peirce allows that the belief that "All black dogs are black" is less vulnerable to error than findings in the natural sciences. However, he attributes this to a special connection between the diagrams studied in logic and what they represent. As he sees it, logical diagrams are what he calls "icons". They are signs that represent their subject-matter by instantiating it—as a paint chip represents a colour by possessing it. If, for example,

19 "All knowledge whatever comes from observation; but different sciences are observational in such radically different ways that the kind of information derived from the observation of one department of science (say natural history) could not possibly afford the information required by another (say mathematics)" (CP 1.238). See also W 5:380-381, CP 1.417, CP 2.84, and NEM 4:105.

we represent the class of black things by a circle and represent the class of black dogs by a second circle drawn within the first one, then the relation among the points circumscribed by these two circles is the very same relation of class inclusion that the diagram represents to hold between black things and black dogs. Inasmuch as this diagram represents abstract logical relations by exemplifying them, it qualifies as an icon. Peirce insists that conclusions arrived at by experimenting on diagrams are fallible—inquirers can misread logical diagrams and draw unwarranted conclusions from them. However, he insists that as icons the diagrams themselves are inherently reliable as representations of logical relations. A diagram cannot misrepresent its own structure and that structure instantiates the very relations the diagram is used in logical inquiry to represent. On this view, observing the structure of diagrams is not merely a helpful way to conduct logical inquiry, it is the essence of logical inquiry inasmuch as the structures exhibited by diagrams are the very subject-matter of logical inquiry. This marks a significant contrast between logic and those sciences in which the concern is not with the abstract relations instantiated by symbols but rather with the nature of the objects those symbols represent. Given a symbolic representation of the world—a theory of black holes, say—and valid conclusions drawn from it, Peirce thinks there is no guarantee, as there is in logic, that the structure of one's symbolic representations corresponds to the intended subject-matter. This leaves inquiry in the natural sciences vulnerable to sources of error that do not arise in logical inquiry and this, he thinks, is what accounts for the greater security of findings in logic. It is important to note, however, that, for Peirce, this difference in security does not reflect a difference in the sort of knowledge uncovered in logic and the natural sciences. Results in both domains of inquiry are justified by the same experimental method and are true in one and the same sense of "truth". The difference is rather one of subject-matter—abstract relations exemplified by iconic diagrams, in the case of logical inquiry, and the configurations of objects and events in the natural world, in the case of the natural sciences.

When compared and contrasted with the philosophies of Carnap and Quine, Peirce's epistemology seems to be a curious hybrid:

a) Like Quine, he thinks logic and philosophy rest on the same epistemological footing as the natural sciences. Yet like Carnap he holds that the truths uncovered in logic are warranted without regard for what the natural sciences reveal to be the case. For him, findings in logic remain prior to, and independent of, knowledge of the natural world even after the aim of providing a foundation for empirical science firmer than empirical science itself is given up.

b) Like Quine, Peirce holds that findings in every field of inquiry are justified by a single set of methodological principles and are true in a univocal sense. Yet, like Carnap, he thinks findings in logic are necessarily true and capable of a degree of certainty that findings in the natural sciences never attain.

c) Like Carnap, Peirce thinks logical principles delimit meaningful possibilities of truth and falsehood without determining which of these possibilities

is actually the case. But, like Quine, he thinks the truths uncovered in logical inquiry have factual content. For him, logic is a positive science, one that issues in conclusions that inform us about reality, just as the truths uncovered in the natural sciences do.

d) Finally, like Carnap, Peirce insists that within the domain of scientific truths there is a set of principles that must hold if there are to be any truths at all and these do not rest on facts uncovered in the natural sciences. Yet, like Quine, he thinks the test of the truth of these logical principles—as with scientific claims generally—is prediction.

From Quine's standpoint, Peirce's epistemology seems an unwelcome throwback to a discredited search for a first philosophy—a ground for knowledge outside the scope of the natural sciences. From Carnap's perspective, Peirce's attempt to ground logic in matters of fact disclosed experimentally is a metaphysical confusion. To Peirce's way of thinking, however, these criticisms are unpersuasive because motivated by views that fail to acknowledge both the continuity of logical inquiry with inquiry in other sciences and the status of logic as a form of inquiry that is prior to, and foundational for, the natural sciences. Inasmuch as it unites views long thought to be irreconcilable, Peirce's philosophy is both more ingenious and profound than even many of his most ardent admirers appreciate. For this reason it merits serious attention.

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Endereço/ Address

Paul Forster
Department of Philosophy
University of Ottawa
55 Laurier Ave E
Ottawa, ON
K1N 6N5
Canada

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