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William H. B. Mcauliffe

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WILLIAM H. B. MCAULIFFE



Abstract

One of C. S. Peirce's most misunderstood ideas is his notion of abduction, the process of generating and selecting hypotheses to test. Contemporary philosophers of science have falsely cited Peirce's idea of abduction as a conceptual precursor to the modern notion of inference to the best explanation, a mode of inference used to decide which of competing explanations of a phenomenon to regard as true. Here, I examine how the misunderstanding originated by exploring influential discussions of inference to the best explanation in the works of Gilbert Harman, Bas van Fraassen, Paul Thagard, and Peter Lipton. While all these authors either failed to cite, or incorrectly cited, Peirce, I show that Thagard has noted a sense in which Peirce's early work provides a precursor to the modern notion of inference to the best explanation. However, a careful reading of Peirce shows that "abduction" has never been a proper synonym for "inference to the best explanation." So Peirce is not to blame for the misunderstanding. I conclude by defending the philosophic importance of abduction and demonstrating how applying Peirce's criteria for good abduction to debates in evolutionary theory can move the field forward.

Keywords: Charles Peirce, abduction, inference to the best explanation, adaptationism, group selection, induction.

1. Introduction

Peirce believed that inquiry involves three types of reasoning—abduction, deduction, and induction. While Peirce's beliefs about reasoning, especially abduction, changed over time, in his mature work the following picture of reasoning emerges: abduction

generates and chooses hypotheses to test; deduction determines the entailments of a hypothesis; induction ascertains whether the evidence accords with the hypothesis in question (CP 5.145, 1903).¹ Peirce both identified abduction and coined the word.² His concept of abduction is one of the most original contributions he made to the study of reasoning. It is also one of the most poorly understood. Peirce's concept of abduction has been distorted by contemporary philosophers of science, who mistakenly claim that it is a conceptual precursor to a kind of inference called "inference to the best explanation" (IBE), i.e., an inference to the truth of a hypothesis if it would best explain the given phenomenon.³ Many philosophers believe IBE is integral to both scientific and ordinary reasoning. But Peirce's idea of abduction is quite different from IBE. In this paper, I will trace the source of this misattribution and explore its negative consequences.

In section 2, I will show that Peirce's notion of abduction does not address how to choose one theory over others given a body of evidence. Rather, abduction is best interpreted as a method for arriving at hypotheses and selecting a hypothesis to test. Put another way, inference to the best explanation is supposed to be the *last* stage of inquiry, whereas abduction corresponds to the *first* stage of inquiry. Readers familiar with this point may wish to skim this section.

In section 3, I will investigate what may have led to the identification of abduction with IBE. While other authors have already noted the difference between abduction and IBE,⁴ so far as I know no one has investigated how the confusion began. One possible explanation I will explore is that philosophers have failed to sort out shifts between Peirce's early statements of abduction and his later statements. Peirce eventually rejected his earlier views: "in almost everything I printed before the beginning of this century I more or less mixed up hypothesis [or abduction] and induction" (CP 8.227, 1910). Some philosophers do note that Peirce's earlier work on abduction differs from his later work.⁵ However, this cannot be the whole story. Influential accounts of inference to the best explanation have cited passages from Peirce's work that do not support a connection between abduction and IBE,⁶ making it difficult to identify the origin of the misunderstanding. To get to the bottom of this muddle, I will analyze several prominent accounts of inference of the best explanation that refer to Peirce, or abduction, or both. These influential works on IBE may have led contemporary philosophers to believe, falsely, that abduction is the same thing as IBE. This analysis will also reveal whether the popularizers of IBE are simply sloppy or confused, or are correctly citing passages in Peirce's earlier work in which abduction is described as a process similar to IBE.

In section 4, I will conclude the paper by summarizing my findings and suggesting an important but neglected reason for distinguishing abduction and IBE: the logic of abduction is a major concern in

science.⁷ Here, I will elucidate the importance of abduction in science by showing that Peirce's criteria for good abduction can advance areas of science that are stagnating because of disagreements over how abduction should be carried out. I will apply this argument to contentious areas of evolutionary biology and psychology. I thus argue against philosophers⁸ who believe that abduction is not a rational process but instead a matter to be studied by sociologists of science. I am confident that abduction is a worthwhile process for philosophers to study and that it has already been fruitfully investigated by some. More philosophers should take note.

2. *Peirce on Abduction*

Peirce wrote on abduction over several decades, and his views evolved over that time. His earlier statements, as he himself noted in 1910, conflated abduction with induction (CP 8.227). At least as late as 1892, Peirce thought of abduction as an "induction from qualities" (CP 6.145, W 8:151).

Clarifying what this means requires understanding Peirce's notion of induction. The younger Peirce saw induction as the kind of inference involved when "we generalize from a number of cases of which something is true, and infer that the same thing is true of a whole class" (CP 2.624, W 3:326 1878). It is ampliative in that something new is learned, namely, a generalization about a whole class of objects. To borrow an example from Peirce, a tourist in Turkey might infer from the fact that all Turkish governors he has observed are honored with canopies held over their heads, that all Turkish governors are honored this way.

In contrast, "[h]ypothesis [or abduction] is where we find some very curious circumstance, which would be explained by the supposition that it was a case of a certain general rule, and thereupon adopt that supposition" (ibid.). For example, a tourist in Turkey might infer that a Turkish man is a governor because this would explain why there are men holding a canopy over his head. It is an induction "from qualities" because there is no quantitative ratio from which to make an inference, but rather an imprecise weighing of the qualities of the object in question against the qualities of the class of objects to which it might belong (CP 2.632, W 3:329–330, 1878). In Peirce's example, the honorific canopy is taken as a central indicator of the presence of a Turkish governor and no one else, and so it is given great weight in the inference. Stated this way, the rule makes explanatory power central and comparisons to IBE plausible.

Even here, however, there are indications that Peirce really has something else in mind. He warns, "The hypothesis should be distinctly put as a question, before making the observations which are to test its truth" (CP 2.634, W 3:331, 1878). Unlike induction, abduction does

not infer the truth of a hypothesis, but rather poses it as a question. As I will show in section 2, Peirce later renamed an induction from qualities “abductive induction,” which is a species of induction that exhibits some qualities of abduction. The idea that abduction poses a hypothesis as a question remains in his later theory of abduction.

In Peirce’s later writings, abduction is clearly distinguished from induction. In 1903, he spelled out the three kinds of reasoning: abduction, deduction, and induction (CP 5.145, EP 2:205). His ideas about deduction had not much changed—deduction still draws necessary consequences of a hypothesis. However, Peirce had changed his mind about abduction and induction. Induction determines how well the consequences deduced from a hypothesis accord with the facts. This version of induction is not ampliative, but rather strictly evaluative. In contrast, on Peirce’s new conception of abduction, it is the “process of forming an explanatory hypothesis. It is the only logical operation which introduces any new idea” (CP 5.171, EP 2:216, 1903). Peirce nicely summarizes the crucial differences among these types of reasoning: “deduction proves that something *must* be; induction shows that something *actually is* operative; abduction merely suggests that something *may be*” (ibid.).

However, not all of Peirce’s later work on abduction emphasizes the creation of hypotheses. Rather, Peirce also described abduction as “the process of choosing a hypothesis” (CP 7.219, EP 2:106, 1901). Choosing well can help people find the truth faster than chance guessing or investigating dead ends. To help choose well, Peirce lay out criteria for selecting which hypothesis to test (CP 7.220, EP 2:107–110, 1901). First, the hypothesis should be experimentally verifiable. Second, the hypothesis should, if true, explain the facts in question. These two guidelines are necessary conditions of a hypothesis’s worthiness of consideration.

The other guidelines are not necessary for selecting a hypothesis to test, but rather are economic considerations—they increase the likelihood that the truth will be found more quickly. Peirce spelled out three different aspects of the economics of research. First, time and money should be conserved. If a hypothesis is unlikely, but can be refuted quickly if false, then we should make testing it a priority, as we should hypotheses that are inexpensive to test.

The second consideration is “the value of the thing proposed, in itself” (CP 7.220, EP 2:107, 1901). Peirce meant that scientists should pay attention to signs indicating that a certain hypothesis is true. These signs divide into two types, the “instinctive” and the “reasoned.” Instinctive hypotheses are those that “naturally recommend themselves to the mind” (CP 7.220, EP 2:108, 1901) and have value because of the human capacity to devise plausible theories. “Reasoned” hypotheses

have supportive background evidence. However, Peirce quickly warned the reader “that unless it be very solidly grounded, likelihood is far better disregarded.” This is related to Peirce’s distinction between “security,” which is characteristic of induction and refers to the tendency for a process to bring one to the truth, and “uberty,” which is characteristic of abduction and refers to the productivity of a process and its ability to bring about undiscovered truths (CP 8.384, 1913). Peirce favored uberty over security in abductions, because likelihoods are often misleading guides that lead us to overlook potentially fertile hypotheses.⁹

The third aspect of the economy of research concerns a hypothesis’s relation to other possible investigations. It is preferable first to test hypotheses that are relevant to a wide range of phenomena, are easily interpretable, and whose falsification would rule out entire classes of hypotheses to which they belong. Finally, a guideline that runs throughout Peirce’s work¹⁰ is that “we must not make hypotheses that will absolutely stop inquiry” (CP 7.480, 1898) because doing so ensures that, if the phenomenon is explicable, its explanation will never be discovered. Therefore, any hypothesis that renders the explanandum a mystery should be a last resort.

Is abduction hypothesis-generation or a selection process for testing? K. T. Fann’s view is that the two possibilities collapse into one: “of the trillions of hypotheses that might be made only one is true. The problem of constructing a good hypothesis is, thus, analogous to the problem of choosing a good hypothesis” (1970, p. 42). This echoes Peirce’s sentiment that “the only way to discover the principles upon which anything ought to be discovered is to consider what is to be done with the constructed thing after it is constructed” (CP 7.220, EP 2:107, 1901). Peirce was referring to the criteria mentioned above. On this reading, hypothesis generation is not purely instinctual, at least if that implies that the hypothesis was formed on no rational grounds. Rather, abduction is principled—hypotheses are formed in such a way that they meet certain criteria.

I believe Fann’s interpretation is plausible; I would emphasize, however, that abduction need not be a process with only one step. As abduction is, “after all, nothing but guessing” (CP 7.219, EP 2:107, 1901), there is no guarantee that the first hypotheses constructed will meet the criteria for testing. For example, a colleague may point out that the hypothesis would not be able to account for some aspect of the phenomena that the scientist had not considered. The most charitable way to interpret Peirce is to view abduction as a process with multiple steps. A hypothesis is first formed with the criteria for good abduction in mind. Then, the hypothesis is evaluated to see if it is testable, economical to test relative to rival hypotheses, highly likely, etc. If not, then the process repeats. The relative speediness of this process is underwritten

by humans' innate ability to generate plausible hypotheses (CP 5.173, EP 2:217–218, 1903).

3. *Contemporary Philosophers and Abduction*

Despite the evidence presented above, a review of the contemporary literature on IBE reveals that “abduction” has become a synonym for “IBE,” suggesting that many philosophers of science see Peirce’s notion of abduction as a precursor to IBE. The mistake is not limited to articles focused on evaluating the cogency of IBE, but has become commonplace in many areas of philosophy of science.¹¹ For example, literature has accumulated over Jerry Fodor’s (2000) challenge to defenders of the computational view of the mind to explain “abduction.” Those involved in this discussion mean “inference to the best explanation” when they say “abduction.” Peter Carruthers, for instance, seeks to explain how a massively modular mind can house the capacity for “inference to the truth of a hypothesis on the ground that it provides the best explanation of the data (so-called ‘inference to the best explanation’ or ‘abductive inference’)” (2006), p. 356.¹² On the same page he distinguishes this kind of inference from the other two elements of scientific reasoning, “creative hypothesis-generation and inferences drawn from those hypotheses.” Instead of identifying abduction with hypothesis-generation, Carruthers identifies abduction with IBE.

The confusion even extends to encyclopedias of philosophy. *The Stanford Encyclopedia of Philosophy* actually entitles its article on IBE “Abduction” (Douven 2011a). It claims that induction is similar to abduction but that they differ in that induction is based on frequencies and statistics whereas abduction is based on explanatory considerations. This corresponds roughly to Peirce’s early, confused views on abduction. The article has a supplemental entry exploring the different interpretations of Peirce’s notion of abduction (Douven 2011b). Of widely read sources, this entry comes closest to clarifying the differences between Peirce’s notion of abduction and IBE.

Christopher Hookway’s (1995) entry on abduction in *The Oxford Companion to Philosophy* describes abduction as a method for choosing a hypothesis to accept and notes its similarity to IBE. It goes on to claim that later in his life Peirce used “abduction” in a wider sense to include hypothesis generation and selection for testing. But Peirce did *not* begin using “abduction” in a wider sense; rather, he rejected his earlier statements because they confused abduction with induction.

The Routledge Companion to Philosophy does not have an entry on abduction, but its entry on IBE refers to volume five of Peirce’s *Collected Papers* as an “important source for Peirce’s views about inference to the best explanation, which he calls ‘abduction’ or ‘hypothesis.’” (Vogel 1998) This is a bewildering reference, as volume five contains

Peirce's *later* thought on abduction. Yet, the mistake is not uncommon; I will later show that Peter Lipton makes the same error.

The confusion has permeated philosophy to the point that it is no longer felt to require argument. Where did the confusion start? Are philosophers justifiably confused? Or is their scholarship just sloppy?

The initial and most influential advocate for IBE is Gilbert Harman. Harman defines IBE as “infer[ring], from the premise that a given hypothesis would provide a ‘better’ explanation for the evidence than would any other hypothesis, to the conclusion that the given hypothesis is true.” (1965, p. 89) He aims to show that induction is either an invalid rule of inference or a valid special case of IBE. Either way, IBE, like induction, represents the final step of reasoning. But Harman equates IBE with several terms that Peirce used for abduction: “‘The inference to the best explanation’ corresponds approximately to what others have called ‘abduction,’ ‘the method of hypothesis,’ ‘hypothetic inference,’ ‘the method of elimination,’ ‘eliminative induction,’ and ‘theoretical induction.’” (Ibid., pp. 88–89) Harman does not refer to Peirce or any other author. There is no way to determine whether Harman is referring to Peirce’s earlier writings, or to Peirce’s later writings, or not referring to Peirce at all.

Most contemporary literature on IBE is based on Harman’s work, meaning that the equation of IBE with abduction has no foundation. The pervasiveness of Harman’s version of abduction is evident even in the work of philosophers who know the difference between IBE and abduction. For example, Psillos knows the difference between Peirce’s notion of abduction and the contemporary notion of IBE (2011), but he decides that he is “going to leave aside any attempt to connect what follows with Peirce’s view on abduction” and instead “take Harman’s as the *locus classicus* of the characterization of IBE.” (2002, p. 614)

Another promising line is the work of Bas van Fraassen, whose criticisms of IBE have been widely discussed by philosophers.¹³ He cites Harman as the modern advocate of IBE, but he also notes that “the idea is perhaps to be credited to C. S. Peirce” (van Fraassen 1980, p. 23)¹⁴, citing Paul Thagard.¹⁵ Thagard sets out to specify what it means for an explanation to be the “best.” He claims that there are precursors of IBE in the works of Peirce, William Whewell, David Hartley, Leibniz, and Descartes.

Like Harman, Thagard gives no citations establishing any of these attributions. There is, however, a clue about what passage in Peirce’s work he has in mind. Thagard uses Peirce’s example of inferring that a man is a priest because the man speaks Latin, dresses like a priest, abstains from sex, and so on. (1978, p. 82) There is again no citation, but the example is from CP 6.525–6.526, 1901. But these passages are evidence that abduction is *not* IBE! Peirce concluded from his discussion of the priest example that “the first starting of a hypothesis

and the entertaining of it, whether as a simple interrogation or with any degree of confidence, is an inferential step which I propose to call *abduction*" (CP 6.525, 1901). Peirce was associating abduction with hypothesis construction, not with inferring the truth of a hypothesis. In the following paragraph (CP 6.526, 1901) Peirce wrote that testing a hypothesis "consists in remarking that, if it is true, observations made under certain conditions ought to have certain results . . . and noting the results . . . and, if they are favorable, extending a certain confidence to the hypothesis." Peirce called this process "induction."

Later in the paragraph Peirce mentioned the priest example again to distinguish induction based on quantifiable ratios from induction based on qualitative traits. The latter is used to figure out if a person is a priest. The inference is made by testing whether the person has the traits that priests usually have, say, by seeing if the man understands Latin. Notice that this corresponds to Peirce's early notion of abduction. Here, Peirce called this process an "abductive induction." It is an induction because, like a quantitative induction, it involves weighing how many priest-like traits the man has from the total pool of priest-like traits. But there is no way of quantifying the weight to be given to any one trait, as few readily observable traits are necessary or sufficient for being a priest.

Peirce thought that abductive induction is similar to abduction in two ways. First, unlike most induction, abductive induction involves originality. Second, how to weigh the various qualities involves "a certain element of guess-work" (CP 6.526, 1901), just as abduction is "nothing but guessing" (CP 7.219, EP 2:107, 1901). The lesson is that abductive induction has traits that are similar to abduction, but it is not abduction. It is just a special case of induction. Insofar as abductive induction is similar to IBE, Peirce came to the opposite conclusion as Harman, who believed that induction is a special case of IBE.

How Thagard came to cite Peirce's work as a precursor to IBE may be key in understanding how IBE and abduction became confused. A year before the publication of Thagard's paper in the *Journal of Philosophy* spelling out what makes an explanation the best, he published an article in the present journal (1977) arguing that Peirce's discussion of the priest example shows that his early notion of abduction is problematic unless it is construed as an early statement of IBE. Even assuming Thagard's conclusion is true, remember that even in the early years Peirce indicated that what he really had in mind with abduction was hypothesis generation and selection (CP 2.634, W 3:331, 1878), a point that Thagard does not mention.

But Thagard's crucial omission is that, while he does note that Peirce eventually saw abduction as suggesting a hypothesis for testing, he does *not* note in either the *Transactions* paper or in his *Journal of Philosophy* paper that once Peirce had reformulated abduction he renamed

an induction from qualities “abductive induction.” Thagard instead only insinuates in his *Transactions* paper that the younger Peirce usually called an induction from qualities “hypothesis” but that he started calling it “abduction” once he had decided that it is a method of hypothesis generation. The distinction that he needed to make explicit somewhere—probably in his *Journal of Philosophy* paper—is that it is abductive induction, not abduction, which is a precursor of IBE. So while it is not inaccurate to cite Peirce for describing a concept that is a precursor for IBE, it is extremely misleading to not make explicit which of Peirce’s concepts is in fact the precursor of IBE. Other philosophers of science have not sorted through these differences and instead have supposed that abduction, not the more obscure abductive induction, anticipated the modern form of IBE.

A final potential source of confusion worth examining is the work of Peter Lipton, who has written an entire book on IBE (2004) that has received much attention.¹⁶ In his book Lipton briefly mentions that Peirce’s and Hanson’s views are precursors to the views he develops. (2004, pp. 56–57) He cites Peirce’s lecture “Pragmatism and Abduction” (CP 5.180–5.212, 1903; Lipton points the reader especially to 5.189). Elsewhere (2000, p. 184), he says that “one version of the model was developed under the name of ‘abduction’ by Charles Sanders Peirce,” citing CP 5.180–5.189, 1903. Peirce is acknowledged as the father of abduction (and thus, supposedly IBE); but the passages Lipton cites tell a different story. Peirce’s lecture begins by comparing abduction to a perceptual judgment, which is “the starting-point or first premiss of all critical and controlled thinking.” (CP 5.181, EP 2:227) Perceptual judgment is the radical extension of abduction defined by Peirce as “an act of *insight*, although of extremely fallible insight . . . it is the idea of putting together what we had never dreamed before of putting together which flashes the new suggestion before our contemplation.” (Ibid.) So far Lipton has provided evidence that abduction is the starting point of inquiry, not the ending point, and that abduction involves coming up with a new idea.

The passage Lipton thinks is crucial (CP 5.189, EP 2:231) is more ambiguous. Peirce wrote:

[T]he operation of adopting an explanatory hypothesis,—which is just what abduction is,—[is] subject to certain conditions. Namely, the hypothesis cannot be admitted, even as a hypothesis, unless it be supposed that it would account for the facts or some of them. The form of inference therefore is this:

The surprising fact, *C*, is observed;

But if *A* were true, *C* would be a matter of course,

Hence, there is reason to suspect that *A* is true.

Much turns on what Peirce meant by “adopting.” Is it adopting a hypothesis “upon probation” (CP 7.239, 1901), or adopting a hypothesis as true? If Peirce means the latter, then Lipton has a case for associating abduction with IBE.

But close examination shows that the latter view does not fit with the passage as a whole. Peirce noted that a hypothesis cannot be accepted, *even as a hypothesis*, unless it could explain the facts. This qualification makes no sense for the adoption of a hypothesis as true. A hypothesis need not be true merely to count as a hypothesis. In contrast, a scientist might mistakenly construct a hypothesis to explain a phenomenon but fail to realize that it could not account for all the relevant facts. That hypothesis can no longer rank as a potential explanation. In addition, the form of inference presented does not adjudicate between competing hypotheses. All potential explanations would, if true, make the facts a matter of course; but that does not tell the scientist which hypothesis to adopt as true. That is why Peirce’s argument concludes that the scientist has reason to *suspect* the hypothesis is true. A suspicion requires empirical confirmation. So, there is no reason to interpret this passage as evidence that Peirce viewed abduction as a method for adopting a hypothesis as true.

Finally, another passage from the same lecture that Lipton cites is inconsistent with his interpretation of Peirce. Peirce explained how the logic of the pragmatic maxim¹⁷ and the logic of abduction collapse into one logic. He explained that “pragmatism proposes a certain maxim, which, if sound, must render needless any further rule as to the admissibility of hypotheses to rank as hypotheses . . . as explanations of phenomena held as hopeful suggestions.” (CP 5.196, EP 2:234, 1903) Abduction judges qualified hypotheses as suggestions. This process is not inference to the best explanation. A scientist cannot justifiably infer the truth of a hypothesis that is still just a hopeful suggestion. Any philosopher relying on Lipton to understand abduction would be led astray.¹⁸

A defender of Lipton may object that I have moved too quickly here, that Lipton’s defense of IBE does have something to say about the logic of discovery. Indeed, in Lipton’s version of IBE, hypotheses can be considered for testing only if they meet the criterion for a contrastive explanation, or an explanation why some state of affairs, X, rather than some other state of affairs, Y, obtains. (2004, p. 73) That is, the only hypotheses that can be considered for selection are those that point out what in the causal history of X is different from Y such that it makes sense that X is the case and not Y. This is a necessary criterion for abduction because for Lipton IBE is a matter of choosing the best of the available contrastive explanations. So hypothesis generation occurs with the knowledge in mind that an inference to the best contrastive explanation will later be conducted. However, Lipton makes this

argument in order to cite an additional virtue of IBE, not to describe a constitutive part of it. Furthermore, Lipton makes this argument in complete isolation from Peirce's work. At best, the fact that Lipton cites CP 5.189 as an early statement of IBE suggests that he may have used this passage to form the above argument but failed to credit Peirce. Either way, the mere fact that Lipton tries to relate IBE to the context of discovery does not show that he understood Peirce's notion of abduction or how it relates to IBE; neither does it excuse the fact that he uses "abduction" interchangeably with "inference to the best explanation."¹⁹

4. Conclusion

There is no clear picture of how so many philosophers of science began neglecting the proper role of abduction and instead equating it with IBE. However, a plausible explanation is that Thagard, influenced by Harman, gave an incomplete exposition on Peirce's evolving notion of abduction and concluded that it was really IBE. Thagard's nod to Peirce in relation to IBE was part of an article that was published in a highly visible philosophy journal and was also cited by van Fraassen. Most contemporary philosophers of science read van Fraassen, and he is especially well-known for his criticisms of IBE. So it is plausible that philosophers of science have picked up the conflation of abduction and IBE from reading *The Scientific Image* and *Laws and Symmetry*. This seems especially plausible with respect to Lipton, who has clearly read van Fraassen's work carefully but seems to have only a passing acquaintance with Peirce's and Hanson's work. That Lipton's *Inference to the Best Explanation* is now also widely read by philosophers of science has probably only furthered the confusion. Alas, my thesis that Thagard is at the root of this mess is just an abduction for now. Someone would have to poll philosophers of science to see if my hypothesis holds water. I tentatively conclude that Peirce cannot be blamed because he refined his notion of abduction over the years, since there is little indication that a careful exposition of his work would cause confusion.

But is this anything more than quibbling about a trivial historical matter? The meaning of words change all the time. Why not "abduction"? I think it is misleading to say that "abduction" changed its meaning. What happened is that Peirce defined "abduction" and then philosophers of science took the word, assigned it a new meaning, and used Peirce's work to give IBE the illusion of a respectable pedigree. Peirce himself took the ethics of terminology very seriously (CP 2.220, EP 2:263–264, 1903). He noted that advancement of understanding requires good, informative terminology. Also, inquiry is a collective enterprise, and a meeting of minds cannot occur if the community does not have a shared understanding of their subject matter. Thus, those who distort the meaning of terms impede intellectual progress, a transgression that Peirce felt deserves harsh condemnation: "whoever

deliberately uses a word or other symbol in any other sense than that which was conferred upon it by its sole rightful creator commits a shameful offence . . . and it becomes the duty of the others to treat the act with contempt and indignation” (CP 2.224, EP 2:265, 1903). In my view, Peirce’s worries about terminology are right on target with respect to the mess contemporary philosophers have made of abduction.

Other authors have given important reasons why abduction is important and should not be confused with IBE. Minnameier (2004) argues that correctly distinguishing between abduction and IBE can lead to progress on central issues in philosophy of science, such as realism and epistemic virtues like unification. Campos (2011) sensibly concludes that equating abduction with IBE confuses abduction with induction and also masks the fact that Lipton’s account of IBE includes elements of both abduction and induction. Along similar lines, Paavola (2006) points out that brushing abduction under the rug in favor of IBE can lead to skewed interpretations of instances of successful inquiry, such as Ignaz Semmelweis’s discovery that antiseptic procedures can prevent puerperal infections. McKaughan (2008) wishes to move past interpretations of abduction as a process either of generating hypotheses or evaluating them and instead to focus on how abduction leads to judgments about how worthy of pursuit a hypothesis is. Other philosophers have also made insightful points about the utility of Peirce’s notion of abduction.²⁰

Many of these reasons can be subsumed under what I believe is the gravest danger in the confusion of abduction with IBE: it results in Peirce’s notion of abduction being ignored. That is acceptable to many philosophers, because they do not believe that there is a logic of discovery.²¹ For example, Reichenbach writes, “the act of discovery [of hypotheses] escapes logical analysis; there are no logical rules . . . that would take over the creative function of a genius. But it is not the logician’s task to account for scientific discoveries; all he can do is to analyze the relation between given facts and a theory presented to him.” (1951, p. 231) Further, I might add, a scientist is not making a logical mistake by not following the (unnecessary) guidelines for abduction. However, Peirce’s notion of logic is not limited to formal logic. Peirce’s notion is wider, encompassing all aspects of inquiry. If Reichenbach was referring to formal logic, then he was correct: abduction is not part of logic. But if he was implying that the “creative genius” bypasses epistemic considerations completely, he had said nothing to support that claim.

Norwood Russell Hanson is one of the few philosophers of science who have demonstrated how the logic of abduction plays a prominent role in actual scientific practice. Hanson argued through careful case studies of groundbreaking works in physics that abduction is a rational process. Many abductions in physics, far from being based on the whims of scientists, rely on clues from existing data and the pitfalls of

existing theories. I would argue that not only is abduction a central part of a rational inquirer's toolkit, but also that keeping Peirce's criteria for good abduction in mind can improve scientific practice by helping researchers go beyond unproductive debates about how hypotheses should be formed and selected.²² This is a logical offshoot of McKaughan's more general focus on using abduction to assess how worthy of pursuit a certain hypothesis is.

For instance, in evolutionary biology and evolutionary psychology there is heated debate about how to form and select hypotheses. I will examine two cases in detail in order to make clear how Peirce's criteria can help actual scientists do their work. First, there is considerable debate about how central a role natural selection should play in hypothesizing about the origin of a trait. While psychologists Steven Pinker and Paul Bloom (1990, p. 708) promote natural selection as the *only* tenable explanation of complex biological traits, other scientists, such as Stephen Jay Gould and Richard Lewontin (1979), argue that some Darwinian scientists prioritize adaptive²³ hypotheses too highly. This debate preoccupies not just scientists but also philosophers. Daniel Dennett (1995) fiercely defends adopting a "blithe" attitude toward adaptive hypotheses. Paul Griffiths (1996) disagrees.²⁴ He claims that standard adaptationism is not properly equipped to identify the adaptive problems that traits have evolved to solve correctly. Consequently, adaptationists often suggest wrong answers.

Peirce's preference for uberty over security in abduction suggests that the adaptationists may have the edge here. While it is important not to ignore non-adaptive hypotheses, such hypotheses usually produce little new understanding and do not drive research into fertile new directions. For example, some philosophers of science are skeptical of the common assumption among evolutionary psychologists that there are adaptationist explanations for many distinct psychological traits.²⁵ While these skeptics are not against adaptationism *per se*, they find many adaptive hypotheses to be highly speculative and unparsimonious. Consequently, they propose instead that most of humans' traits are merely the consequence of humans' increased brain size, small neurological changes, and brain plasticity. Even if this hypothesis is more likely, it paints a bleak picture for those who wish to gain a richer understanding of human psychology, for it is left to vague, general learning processes to explain an enormous array of behavior. Why human behavior is the way it is rather than some other way is left largely open, and the theory suggests few tests to answer this question.

A thoroughly adaptationist approach, on the other hand, can provide new insight into the nature of each complex psychological trait by both elucidating the selective pressures that led to its fixation and explaining why it has the features it has. Moreover, adaptationism provides a clear way of testing hypotheses: demonstrate that the trait in question

is heritable and a human universal (or nearly so), and then see if the nature of the trait conforms to the adaptive logic inherent to the hypothesis. This approach has yielded exciting progress on research questions of psychology that were dead in the water before an adaptationist approach was applied, e.g., why humans automatically encode the race of those they encounter, and why people experience the hot hand phenomenon.²⁶ By gaining insight into the specific selective agents that shaped the behavior of human ancestors, adaptationism provides much deeper knowledge and many more fertile hypotheses than does attributing much of human behavior to the brain's general ability to adapt to its circumstances on the fly. It seems that non-adaptive explanations should be a last resort, as in many cases they stall progress.

Another debate that never seems to go away among evolutionary biologists and philosophers of biology²⁷ is the importance of group selection, especially in explaining cooperative traits. Traits that benefit others at a cost to the benefactor are an evolutionary puzzle to the extent that providing those benefits causes the benefactor to incur a net fitness cost. This puzzle has been especially salient in the study of cooperation in humans, who are unique in their high level of cooperation with non-relatives.²⁸ Some researchers claim that standard mechanisms that have been successful in explaining non-human cooperation, mechanisms such as reciprocity or benefitting genetic relatives, can also explain human cooperation.²⁹ These explanations all assume that natural selection is acting differentially on the survival and reproductive success of individuals who bear certain alleles. Call all of these theories *individual selection theories*. Others believe that humans' high level of cooperation with strangers indicates that individuals are incurring net fitness costs and that cooperation must be explained in some way that can incorporate this fact. These authors believe that more cooperative groups—despite having more individuals whose fitness is decreasing—outcompete less cooperative groups, so that cooperation is selected for at the group level. These *group selection* theories take a variety of forms, e.g., some suggest that genes that benefit the group are selected, while others assert that cultural norms that some groups hold give them an edge on competing groups that do not have those norms.³⁰ This debate is about not just which theory better explains the data, but which kind of theory should be further investigated. Group selection theorists point to instances of cooperation that individual selection theory apparently cannot explain, and based on this inadequacy they conclude that figuring out how group selection could have produced human cooperation is the most fruitful way to proceed.³¹ Those who defend individual selection accounts of cooperation point to group selection's conceptual difficulties and its failure to yield any advances in knowledge.³²

The problem is that the evidence adduced so far by both sides can be interpreted differently depending on one's prior theoretical

commitments.³³ The debate has been going on for at least thirty years, and neither side seems to be able to convince the other that their evidence is decisive. Part of the issue is that choosing to test *one version* of a theory (e.g., cultural group selection) in particular rather than the *type of theory* it falls under (e.g., group selection theory in general) has led researchers to design tests that do not do a good job of ruling out an entirely different kind of explanation (e.g., individual selection theory).³⁴ Researchers already convinced on theoretical grounds that a certain type of theory is correct do not bother first to demonstrate the truth of their theoretical commitments. That is, these researchers are failing to adhere to one of Peirce's criteria for good abduction: test hypotheses that can rule out an entire class of hypotheses. Research would proceed more quickly if they first tested group selection theories in general directly against individual-level theories in general. Once a type of theory is ruled out, then individual versions of the theory within the general type of theory can be tested.

Max Krasnow and his colleagues (2012) took the Peircean route and developed an ingenious pair of studies to examine the evolutionary bases of punishment and reputation, two phenomena that are central to debates about human cooperation. The experiments were designed in such a way that all group selection theories make predictions that diverge from predictions common to all individual selection theories. It turns out that none of the predictions that were unique to group selection theories were supported, whereas all of the predictions unique to individual selection theories were borne out. If critical tests of this sort were done for all areas of the study of human cooperation, it would be clear which kind of higher-level theory researchers should use to generate hypotheses moving forward.

A philosopher of science who doubts that abduction has a rational basis can object that the mere fact that good abduction helps scientists move things along is not evidence that abduction is philosophically important. Neither is the fact that philosophers of science contribute to these debates (in these scientific times, who is to say what the value is of philosophers' discussions of science?).³⁵ But this phenomenon does show that abduction is a lively topic in contemporary philosophy. Should other philosophers of science follow suit? Or should they continue to dismiss the study of abduction as merely a sociological matter and continue writing about other topics, like IBE?

I believe abduction has philosophical value. For example, some aspects of good abduction are necessary. Scientists *must* form only testable hypotheses that would, if true, explain the facts in question. Otherwise, scientific practice would never get off the ground. Thus, two classic questions in the philosophy of science, "what constitutes a scientific explanation?" and "what theories are, even in principle, untestable?" are best seen as questions that address the requirements for abduction.

Philosophers who doubt that abduction is within the scope of the scientific method overlook an important point: just as there are supererogatory acts in ethics, there are scientific practices that, when done well, are good despite not being strictly necessary. Once scientists have testable theories, they must not deduce predictions that do not follow from the theories or accept theories based on bad evidence. In principle, those are the only necessary steps to (eventually) reaching the truth. However, Peirce realized that philosophy of science does not just boil down to an application of formal logic, but rather is the general study of how people can find out the truth about the world. There are objectively better and worse ways of seeking the truth, and ignoring abduction downplays the value of actually finding the truth rather than seeking it indefinitely.

While abduction and IBE are distinct concepts, they could be complementary. For instance, good abduction can help scientists avoid the “best of the bad lot” objection when invoking IBE.³⁶ That is, if the set of hypotheses in consideration probably does not include the true explanation, then choosing the “best” of those explanations is not justified. But if scientists only pursued promising lines of inquiry, then philosophers would not need to figure out how to salvage IBE from bad lots, because scientists would more often have good lots.

If I am correct that abduction is supported by rational considerations, then Peirce’s criteria are also worth evaluating in philosophy. For example, Dennett criticizes Jerry Fodor and Colin McGinn for suggesting that consciousness is a mystery that humans cannot solve.³⁷ This criticism only has force if there is a sound case against positing that the phenomenon in question is inherently mysterious. Figuring out whether Peirce’s maxim “do not block the way of inquiry” (CP 1.135, EP 2:48, 1898) is sound can help us decide whether Dennett’s criticisms are justified.

In short, keeping the distinction between IBE and abduction clear will strengthen scholarship on Peirce, on abduction, and on IBE. Peirce’s writings are a useful starting place for discussions of scientific reasoning, especially in suggesting what justifies the pursuit of a line of inquiry. Nothing Peirce said about abduction, however, will justify inference to the best explanation.³⁸

University of Miami
w.mcauliffe@umiami.edu

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NOTES

1. References to CP are to Peirce's *Collected Papers* (1931–1958) and are in the following format: (CP volume number, paragraph number, year).

2. "Abduction" in Peirce's writings is synonymous with "hypothesis" (CP 2.623, W 3:326, 1878), "retroduction" (CP 2.755, 1905), and "presumption" (CP 2.774, 1902). I will just use "abduction" for consistency. References to W are to the *Writings of Charles S. Peirce* (1982–2010) by volume and page number.

3. Harman 1965, p. 89. Advocates of the rule differ on the details, such as what makes a given hypothesis the "best" explanation. However, a general sketch of the rule will suffice here.

4. Minnameier 2004; Campos 2011. See also McKaughan 2008, which does not deal directly with IBE but does carefully distinguish between the different interpretations of Peirce's concept of abduction.

5. For instance, see Hookway 1995.

6. See the discussion of Gilbert Harman, Paul Thagard, and Peter Lipton in section 3.

7. A different version of this argument was made forcefully by Norwood Russell Hanson over fifty years ago, but not in the context of comparing abduction to IBE. See Hanson 1958.

8. For example, see Reichenbach 1951, p. 231; Popper 1959, p. 20n. See Fann 1970 pp. 1–5 for a summary of this position and a list of prominent philosophers, including R. B. Braithwaite, who defend it.

9. For a further argument for this preference, see Peirce's "An Essay toward Improving Our Reasoning in Security and in Uberty," EP 2:463–474, 1913.

10. See Haack 2014 for an overview of how this argument permeates several areas of Peirce's philosophy.

11. However, as one referee has correctly pointed out, this mistake is not commonly made among those familiar with Peirce or those he influenced, such as Norwood Russell Hanson. It is more a mistake common to philosophers of science who probably have not read much of Peirce's work.

12. The "massive modularity thesis" states that the mind is composed of many specialized, semi-independent parts that each arose through natural selection to solve a specific fitness problem that ancestral humans recurrently faced.

13. See, for example, Psillos 1996 and Okasha 2000.

14. There is, however, evidence that van Fraassen correctly understands Peirce's notion of abduction, further adding to the muddle. See endnote 11 of chapter 6 of van Fraassen 1989, p. 360.

15. Thagard, doctoral dissertation, University of Toronto, 1977; Thagard 1978. It is unlikely that anyone outside of University of Toronto's Department of Philosophy was influenced by Thagard's dissertation, but his 1978 article was

published in the *Journal of Philosophy* and thus was easily accessible and perhaps widely read.

16. See, for example, Barnes 1995, which responds to the first (1991) edition of Lipton's book.

17. Here is a statement of the pragmatic maxim: "Consider what effects which might conceivably have practical bearings we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" (CP 5.402, W 3:266, 1878). The application of this maxim to hypothesis construction elucidates whether the explanandum follows from the hypothesis, a necessary condition for good abduction.

18. Interestingly, it does seem as though Lipton learned Peirce's actual notion of abduction near the end of his life. See the acknowledgments section of Campos 2011.

19. For example, Lipton titles chapter 7 of the second edition of his book "Bayesian Abduction."

20. El Khachab 2013; Hintikka 1998.

21. See note 8.

22. As I will show, many philosophers have contributed to debates in science about how to choose hypotheses without explicitly acknowledging that they are discussing criteria for good abduction. Philosophers who have urged the difference between abduction and IBE have not stressed this point.

23. By "adaptive" I mean that the trait in question spread by natural selection, making the trait an "adaptation." "Adaptationism" is an approach to the life sciences that attempts to explain the origin and maintenance of complex biological traits as products or byproducts of natural selection. Those who adopt this approach are "adaptationists."

24. Notice that Griffiths calls an adaptationist inference to the best explanation "the 'adaptationist abduction'" (1996, p. 521).

25. Buller 2005; Fodor 2000.

26. Kurzban et al. 2001; Wilke and Barrett 2009.

27. E.g., see Williams 2008 and Wilson and Sober 1994.

28. Fehr and Fischbacher 2003.

29. Pinker 2012.

30. Fehr and Fischbacher 2003.

31. Fehr and Gächter 2002.

32. West et al. 2008.

33. For example, see Delton et al. 2011.

34. Ellis and Ketelaar 2002.

35. The debate in general, however, does strongly suggest that the decision to choose one theory over another to test may be defended on rational grounds. Adaptationists, for example, have a metatheory they can use to justify their hypotheses, namely, that the appearance of complex design in biological traits can be the product only of natural selection. Assuming the metatheory is well-confirmed, using it to generate hypotheses is rational. So against philosophers of science who reduce abduction to the whims of scientists, abduction is supported by rational considerations.

36. van Fraassen 1989, pp. 142–143.

37. Dennett 1995, pp. 381–383.

38. I am grateful to Susan Haack for helpful comments on this paper.