

C. S. Peirce and Abduction Inference

Alex Beckwith

Johnson County Community College, abeckwi1@stumail.jccc.edu

Follow this and additional works at: https://scholarspace.jccc.edu/honors_journal

Recommended Citation

Beckwith, Alex () "C. S. Peirce and Abduction Inference," *JCCC Honors Journal*: Vol. 10 : Iss. 1 , Article 2.
Available at: https://scholarspace.jccc.edu/honors_journal/vol10/iss1/2

This Article is brought to you for free and open access by the Honors Program at ScholarSpace @ JCCC. It has been accepted for inclusion in JCCC Honors Journal by an authorized editor of ScholarSpace @ JCCC. For more information, please contact bbaile14@jccc.edu.

C. S. Peirce and Abduction Inference

Abstract

Charles Sanders Peirce remains a largely forgotten American original thinker, whose interests and accomplishments span various disciplines in philosophy, mathematics, and science. He considered himself, first and foremost, a logician and claimed to have discovered a new logical method of analysis. In addition to the forms of deduction and induction that date back to Aristotle, Peirce's new method became known as abduction. Never satisfied, he kept changing his terminology and his intentions about what this new method was supposed to do. He tried to demonstrate how abduction worked at least a couple of times, but his explanations were never fully worked out and had problems. Today, abduction is used as a synonym for what philosopher Gilbert Harman called "inference to the best explanation." My paper draws from both primary and secondary sources to give a high-level overview of abduction for a general reader who has taken an introductory logic class.

Introduction

When Charles Sanders Peirce* died in April 1914 at age 74 on his 2,000-acre farm outside Milford, Pennsylvania, he was destitute. The farm that he had purchased in 1887 with his parents' inheritance never made a profit.¹ One of his Harvard professors, Charles William Eliot, never liked Peirce and later denied Peirce any work at the school after Eliot became university president in 1869.² Peirce had lost his coveted teaching position at Johns Hopkins University in January 1884 after being caught up in a social scandal.³ Similarly, he had been asked to resign from his long-standing job at the U.S. Coast Survey in 1891, after a public scandal about misappropriating funds resulted in the dismissal of the superintendent and several other Survey employees.⁴ For almost the last twenty-five years of his life, he was never able to find steady work again.⁵ It was a disgraceful end for an original American logician, mathematician, scientist, and philosopher, who is credited as the “father of pragmatism” and a founder of modern statistics. The philosopher Paul Weiss, writing in 1934, regarded Peirce as “the most original and versatile of American philosophers and America’s greatest logician.”⁶ Bertrand Russell described Peirce as “one of the most original minds of the later nineteenth century, and certainly the greatest American thinker ever.”⁷

Some of his notable accomplishments include: showing how to perform Boolean algebra by using a single binary operation,⁸ 33 years before the American logician Henry M. Sheffer published a mathematical proof;⁹ suggesting that these single binary operations could be done by electricity,¹⁰ anticipating the modern computer by 50 years; creating what is today called the

* “The pronunciation ‘*perce*’ (or ‘*purse*’), which is now the prevalent pronunciation of all forms of the surname in the neighborhood of Boston.” James Mills Peirce, quoted in “Note on the Pronunciation [sic] of ‘Peirce’,” *Peirce Project Newsletter* 1, no. 3/ 4 (December 1994), http://www.iupui.edu/~peirce/news/1_3/13_4x.htm.

Peirce quincuncial projection for mapmaking, which results in less distortion than other map projections,¹¹ and defining the length of a meter in terms of a certain wavelength of light, which was officially adopted as the metric standard from 1960-1983.¹²

He wrote prolifically, but the majority of his writings had, until recently, remained unpublished. Soon after his death, Harvard University obtained all of his papers—that amounted to almost 1,650 manuscripts totaling over 100,000 pages—from his widow but failed to microfilm them until 1964, almost fifty years after his death.¹³ His reputation rested on what he could publish in various academic and scientific journals of the time, but, today, thanks in part to organizations such as the Peirce Edition Project, his writings are being collected, edited, and published.

Throughout his life, Peirce viewed himself as a logician, despite being trained as a chemist and working as a scientist.¹⁴ Among his numerous contributions to scientific methodology, philosophy, mathematics, semiotics, and logic, he proposed a new method of inference that would incorporate more of the scientific process into reasoning. His new method is known today as *abduction*.

Despite his other accomplishments listed above, Peirce had problems trying to explain his new method. Unfortunately, he never settled on a consistent name and definition, which he later confessed even confused him. He later gave examples of what abduction looked like. He also tried to show how this new method related to both deduction and induction, the existing two methods of inference dating back to antiquity, by systematically transforming an initial argument from deduction to induction and, finally, to abduction. But his examples and his process, upon closer examination, don't really match his explanation. During the last ten years of his life, Peirce tried to incorporate abduction into his larger, unified, pragmatic methodology of scientific

discovery. He introduced a new, final abduction form that later created even more problems than he probably intended.

What is Abduction?

What, exactly, is abduction? According to the *Stanford Encyclopedia of Philosophy*, Peirce's view of abduction is centered on the idea that abduction is "the place of explanatory reasoning in *generating* hypotheses."¹⁵ But most modern definitions of abduction instead focus on the work of Gilbert Harman and his article "Inference to the Best Explanation,"¹⁶ which treats abduction as "the place of explanatory reasoning in *justifying* hypotheses."

Over the course of his life, Peirce kept revising what his ideas were about the subject—to the frustration of his audience. Austrian research scientist Martin Potschka, summarizing his research on Peirce's corpus about abduction, states:

Pierce held different opinions at different stages of his life, changing his views gradually and also independently from one item to another. . . . In each of those stages, construed for didactic purposes and subject to interpretation, Peirce easily got carried away and was not always consistent . . . Peirce pursued the implications of different hypotheses, and as a consequence varied his terminology from paper to paper. No systematic unity is to be found in Peirce's thought. . . . To arrive at some definitive received view of Peirce therefore is a difficult task. . . . For sure, his last words cannot be construed to be the most mature final word without qualifications.¹⁷

In 1864/1865, when Peirce was 25, he initially called his new method "inference *a posteriori*," which reflected his conception of how it worked: instead of using known causes to determine effects as in deduction (what he called "inference *a priori*"), one would work backwards, using observed effects to figure out what the possible original causes were.¹⁸ A couple years later, in reference to Kant, Peirce discussed "reducing the multitude of sense data by

means of hypotheses”¹⁹ and introduced the term abduction.[†]

However, unsatisfied with this term, Peirce soon started calling his new thinking “Hypothesis.”[‡] This term, however, is not to be confused with today’s common understanding of a hypothesis as “a tentative assumption made in order to draw out and test its logical or empirical consequences.”²⁰ Peirce intended to convey the notion that Hypothesis (abduction) was more about deriving the assumption logically.

Around 1871, when he was 31, Peirce began developing his Pragmatic Maxim, which formed the basis of pragmatism as a philosophical movement. It was also during this time that Peirce used the terms “Hypothesis” and “abduction” interchangeably and, as he later confessed, began to confuse it with induction.[§] He had intended to incorporate abduction as a third branch of logic that worked with the scientific method. Pragmatism would deal “with the economy of research in an age of methods; and logic [would be] the art of devising methods.”²¹ Peirce’s proposed methodology would involve a series of steps. Initially, Hypothesis/abduction would involve the scientist taking into consideration the observed facts and formulating a reasonable explanation of what could have caused the observed data. That reasonable explanation would be

† [C. S. Peirce], “Kinds of Reasoning”, 1.65; *Stanford Encyclopedia of Philosophy*, s.v. “Aristotle’s Logic,” <https://plato.stanford.edu/entries/aristotle-logic/#IndDed>. The word is probably derived from the Greek term *απαγωγή* (pronounced /apagôgî/, meaning “abduction”, “kidnapping” in Greek), — a likely mix-up of Aristotle’s term, *αναγωγή* (/anagôgî/, meaning “reduction”) in his book *Prior Analytics*, which Peirce later blamed on a corrupt text. The word is also strikingly similar to Aristotle’s word for induction, *επαγωγή* (/epagôgî/).

‡ Martin Potschka, “Peirce’s Concept of Abduction (Hypothesis Formation) across His Later Stages of Scholarly Life,” *The Commens Working Papers* 8 (February 6, 2018): 15. Peirce always capitalized Hypothesis when he referred to abduction. The result of abduction—hypothesis—was spelled with a lowercase “h.”

§ “Only in almost everything I printed before the beginning of this century I more or less mixed up Hypothesis and Induction. . . .” C.S. Peirce to Paul Carus, “On ‘Illustrations of the Logic of Science,’” 8.227.

the scientific hypothesis that would need to be proven. Next, deduction would be used to determine what experiments the scientist could set up to test this hypothesis. Finally, inductive inference would be used to validate whether or not the test results did indeed support the hypothesis.

But Peirce, apparently, was still unsatisfied and began using the term “retroduction” instead of Hypothesis or abduction around 1905, when he was 65, until his death in 1914. By labeling his idea retroduction, Peirce wanted to re-emphasize that his new inference would explain the logical movement “backwards” from effects to causes.²²

Martin Potschka has suggested three reasons why Peirce changed terminology again: (1) it is a better choice etymologically, reflecting his intention to show how abduction is the true meaning behind what Aristotle called “reduction;” (2) it is to emphasize that knowledge of the facts is important in abduction, because abduction is focused on creating educated guesses; and (3) it is another way for Peirce to create a formal syllogism to show how the rules of abduction work—something he failed to achieve before.²³

Because Peirce kept changing his terminology, he made it very difficult to find a consistent explanation of what abduction is, how it worked, and how it was different from both deduction and induction. In hindsight, it is very frustrating that he was unable to publish a book laying out clearly what his thoughts and ideas about abduction were. As Potschka writes:

Throughout his life, it is quite typical for Peirce to draft something like “I believe it to be the most important part of the book” when referring to parts that never become written (in this particular instance something most illuminating about abduction), besides drafting one book after the other without ever succeeding to publish. For many items there exist several drafts in his manuscripts, that he never succeeded to consolidate into analogy, later arguing that it is a combination of the three primary types.²⁴

Peirce did not have a tenured teaching job, which would have allowed him time to publish books while supporting himself and his family.** Instead, his growing financial difficulties—especially after he lost his government job with the U.S. Coast Survey in 1891 when he was 52—forced him to do odd work writing for encyclopedias and philosophical dictionaries and helping other scientists with their research with meager pay.

Deduction, Induction, and Abduction

Twelve years after Peirce introduced the concept of abduction, he published his paper, “Deduction, Induction, and Hypothesis” in the August 1878 edition of *Popular Science Monthly*, where he attempted to show how these three branches of logic related to one another.²⁵

Deduction

Peirce utilized two main examples to demonstrate how the arguments interrelated. Both examples start out as a deductive categorical argument in a Barbara syllogism.†† But he then ignored his first example (concerning Elijah and Enoch) and focused on his second one to demonstrate how to transform a deductive argument into the other two types. In his article, Peirce called the major premise the “rule,” the minor premise a “case,” and the conclusion the “result.” [Numbers are added to the examples to better show how statements are moved around.]

** His only teaching job at Johns Hopkins University lasted five years (1879-1884), until he was forced to resign, due to public scandal. He was unable to find any teaching jobs afterward.

†† A Barbara syllogism is what logicians call a syllogism with an AAA mood and in the first figure. It looks like this:

All M are P.
All S are M.
All S are P.

His original argument looked like this:

- | | | |
|-----|-----------------|----------------------------------------|
| [1] | <i>(Rule)</i> | All the beans from this bag are white. |
| [2] | <i>(Case)</i> | <u>These beans are from this bag.</u> |
| [3] | <i>(Result)</i> | These beans are white. |

However, to clarify the argument better to fit the Barbara pattern, the statements are rewritten as follows:

- | | | |
|-----|-----------------|--------------------------------------------------------|
| [1] | <i>(Rule)</i> | All beans from this bag are white. |
| [2] | <i>(Case)</i> | <u>All these beans are beans from this bag.</u> |
| [3] | <i>(Result)</i> | All these beans are white. |

Induction

Peirce then transforms the argument from a deductive argument into an inductive one by casting the original major premise (*rule*) as the conclusion and switches the original minor premise (*case*) and the original conclusion (*result*) to give new major and minor premises respectively:^{‡‡}

- | | | |
|-----|-----------------|----------------------------------------|
| [2] | <i>(Case)</i> | These beans are from this bag. |
| [3] | <i>(Result)</i> | <u>These beans are white.</u> |
| [1] | <i>(Rule)</i> | All the beans from this bag are white. |

However, again, the syllogism needs to be updated to make the quantification clear and keep the premises in a consistent location:^{§§}

^{‡‡} In this example, Peirce puts the case before the result; however, later in his article, he reverses the order.

^{§§} This looks like an AAA syllogism in the third figure, which is not a valid deductive categorical syllogism. But because we are talking about induction here, the validity rules do not apply. The form of the syllogism looks like this:

All M are P.

- [3] (Result) **All** these beans are white.
 [2] (Case) **All** these beans are **beans from this bag**.
 [1] (Rule) All the beans from this bag are white.

Abduction

Finally, Peirce transforms the original deduction into an abduction by keeping the original major premise (*rule*) the same, but swapping the minor premise (*case*) and the conclusion (*result*):

- [1] (Rule) All the beans from this bag are white.
 [3] (Result) These beans are white.
 [2] (Case) These beans are from this bag.

Once again, however, to follow modern practice, the argument needs to look like this:***

- [1] (Rule) All **these** beans from this bag are white.
 [3] (Result) **All** these beans are white.
 [2] (Case) **All** these beans are **beans from this bag**.

All M are S.

All S are P.

*** This appears to be an AAA syllogism in the second figure, which is also not a valid deductive categorical syllogism. Like the note on induction, validity rules do not apply in this case, either. The form of this syllogism looks like this:

All P are M.

All S are M.

All S are P.

Argument Transformation

After demonstrating one way how to invert the premises and conclusion of a deductive argument to create both a related inductive and a related abductive argument, Peirce states that there is another way to derive the same arguments. The examples Peirce had used up to this point contain all positive statements. This time, however, Peirce uses negation to modify the premises and conclusion to make similar arguments. It stems from the idea that if the truth of the premises entails the truth of the conclusion in a valid deductive argument, then a false conclusion would mean that at least one of the premises would also need to be false. Peirce keeps the same inference patterns he had just laid out, but this time, he shows two ways how a negative conclusion (*result*) affects the negative major premise (*rule*) or minor premise (*case*) in an inductive or abductive argument respectively.

Peirce begins this alternative method by returning to the deductive Barbara syllogism (note the change to the beans example):

(<i>Rule</i>)	All men are mortal.	Most of the beans in this bag are white.
(<i>Case</i>)	<u>Enoch and Elijah were men.</u>	<u>This handful of beans are from this bag.</u>
(<i>Result</i>)	Enoch and Elijah were mortal.	Probably, most of this handful of beans are white.

Deductive arguments follow the pattern: *Rule—Case—Result*.

To create an inductive argument (*Result—Case—Rule*), Peirce explains that if one denies the conclusion (*result*) but admits the minor premise (*case*), then the major premise (*rule*) must also be denied.^{†††}

^{†††} Peirce states that these are Bocardo syllogisms, which are OAO syllogisms in the

(<i>Denial of Result</i>)	Enoch and Elijah are not mortal.	Few beans in this handful are white.
(<i>Case</i>)	<u>Enoch and Elijah were men.</u>	<u>These beans came from this bag.</u>
(<i>Denial of Rule</i>)	Some men are not mortal.	Probably, few beans in the bag are white.

However, like his previous examples, Peirce’s statements need to be reworded to make them fit the syllogism better:‡‡‡

(<i>Denial of Result</i>)	Enoch and Elijah are not mortal.	Some of these beans are not white.
(<i>Case</i>)	<u>Enoch and Elijah were men.</u>	<u>All these beans are beans from this bag.</u>
(<i>Denial of Rule</i>)	Some men are not mortal.	Some beans from this bag are not white.

Now to create abduction arguments (*Rule—Result—Case*), if one denies the conclusion (*result*) but admits the major premise (*rule*), then the minor premise (*case*) must also be denied:§§§

(<i>Denial of Result</i>)	Enoch and Elijah were not mortal.	Few beans of this handful are white.
-----------------------------	-----------------------------------	--------------------------------------

third figure. In other words, they look like this:

Some M are not P.
All M are S.
 Some S are not P.

‡‡‡ Using Enoch and Elijah in this example complicates things. In the *Denial of Result*, they are considered singularly (“some”) using Peirce’s Bocardo definition while being considered generally (“all”) in the *Case*. If both men are considered in the same general way in both premises, then the argument is an EAO syllogism in the third figure, also known as Felapton.

§§§ Peirce states that these are Baroco syllogisms, which are AOO syllogisms in the second figure. In other words, they look like this:

All P are M.
Some S are not M.
 Some S are not P.

(Rule) <u>All men are mortal.</u>	<u>Most beans in this bag are white.</u>
(Denial of Case) Enoch and Elijah were not men.	Probably, these beans were taken from another bag.

Again, rewording Peirce’s original statements and rearranging them to fit better his syllogism, it becomes:

(Rule) All men are mortal.	All the beans from this bag are white.
(Denial of Result) <u>Enoch and Elijah were not mortal.</u>	<u>Some of these beans are not white.</u>
(Denial of Case) Enoch and Elijah were not men.	Some of these beans are not beans from this bag.

Despite swapping lines around to derive the various argument forms, Peirce was not satisfied with this arrangement. He created other highly mathematical forms of abduction, but these examples, too, were later abandoned by Peirce.

Retroduction

In May 1903 when he was 63, a couple years before Peirce regularly began using the term “retroduction,” as part of his last Harvard lecture on pragmatism, he changed his form of abduction to better emphasize his ideas about pragmatism and working logically from effects to causes:²⁶

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.

The focus here is coming up with the hypothesis A that would best explain how C could be observed. No longer satisfied that he could simply swap premises and conclusions around to create an abductive argument, Peirce tried at this point to show a more general, normative form

to generate a valid hypothesis.

Problems

But there are problems with how Peirce tries to explain abduction.

Logical Fallacies

Beginning with Peirce's late-stage retroduction syllogism shown above, there are problems caused by this argument form that, perhaps, Peirce did not intend.

Deduction and induction are ways to justify how someone can arrive at a conclusion of belief given a set of premises. It incorporates ideas from epistemology and mathematical proof that ultimately evolved from Plato's three criteria of knowledge: justification, truth, and belief. It is "the stage of scientific inquiry . . . which [is] . . . concerned with the assessment of theories."²⁷ This is referred to as the *logic of justification*.

Deduction can positively verify that the conclusion of an argument is true or not based upon the truth-values of its premises. Induction can lead to a plausible conclusion based upon the strength of its premises. However, in Peirce's mind, abduction is supposed to generate guesses based upon the empirical facts.²⁸ But guesses carry little weight in terms of justifying any conclusion. Peirce states that "an abductive suggestion . . . is something whose truth can be questioned or even denied."²⁹ Or put another way, he also writes, "Deduction proves that something **must** be; Induction [sic] shows that something **actually is** operative; Abduction [sic] merely suggests that something **may be**. [The bolding is his.]"³⁰ If, as Peirce believes, abduction is a new mode of inference, it does not fit well in the logic of justification, like deduction and induction.

Because a hypothesis is simply a guess, the philosopher Norwood Hanson proposed in his book, *Patterns of Discovery*, that Peirce's notions of abduction fit better in a *logic of discovery*.³¹ It is the stage of scientific inquiry that focuses on "the act or process of conceiving new ideas. . . [because] conceiving a new idea is a non-rational process, a leap of insight that cannot be captured in specific instructions."³² Martin Potschka believes that this change from the context of justification to a context of discovery happened around 1898-1905, when Peirce focuses more on developing abduction as "the first step in a larger methodological process."³³

But this presents another huge dilemma: if the conclusion to an abduction process is a hypothesis, which is a guess created in a leap of insight and is therefore not rational, how can there ever be any logical rules to explain how one came up with the hypothesis?

A different problem with his retrodution syllogism is using the conclusion (the hypothesis A) in a conditional premise within the same argument. In order for the conditional premise to be true, one would need to already know the truth-value of the conclusion. Critics of Peirce clearly point this out. Referring to the known facts that form the premises of an abductive argument, the Finnish philosopher and logician Jaakko Hintikka writes:

The first pertinent question here is: Explanation of what facts? The merits of a theory or hypothesis include its ability to explain new, previously unknown facts. But these facts will be, if they are genuine new ones, unknown at the time of the abduction, and even more so must the auxiliary data which help to explain them be unknown. Hence these future, so far unknown explananda cannot be among the premises of an abductive inference.³⁴

To put it another way, the American philosopher Harry Frankfurt points out:

Clearly, if the new idea, or hypothesis, must appear in one father premisses[sic] of the abduction, it cannot be the case that it originates as the conclusion of such an inference; it must have been invented before the conclusion was drawn. Furthermore, the conclusion of the abduction is not the

hypothesis itself—as we had been led to believe by Peirce’s remark that a hypothesis “results from” abductive inference—but a statement that there is evidence for the hypothesis.³⁵

Peirce’s argument becomes a circular one, where the premise depends on the truth-value of the conclusion.

Adding to the confusion, even Peirce, in the same 1903 Harvard lecture on pragmatism that published this new form of retrodution, also mentioned that abduction “is very little hampered by logical rules.”³⁶ It seems Peirce realized the paradox of what he was trying to prove.

The Finnish philosopher and mathematician Ilkka Niiniluoto points out yet another problem with this syllogism:

The Peircean schema of abduction is not generally valid in the logical sense, since it is an instance of the well-known fallacy of affirming the consequent. However, Peirce was aware that in some cases inference from effect to cause may be irresistible or compelling: the abductive suggestion may come to us “like a flash.”³⁷

If the syllogism of retrodution leads to an inductive fallacy, has a hard time using logical rules to explain how to derive its conclusion from its premises, and does not share a common context of justification, like deduction and induction, then this strongly suggests that Peirce’s conception of retrodution/abduction fails to qualify as a legitimate mode of inference.

Suspicious Syllogism Analysis

Returning to Peirce’s earlier examples of deriving deductive, inductive, and abductive arguments, there are some other problems.

The first problem concerns the derivation of abduction from deduction. If the purpose of

abduction is to create a testable hypothesis, then the conclusion for an abductive syllogism could be either true or false—as he freely admitted³⁸—and it does not matter. That is where, according to Peirce, deduction and induction come in to test the validity of the hypothesis-conclusion. On the other hand, if the conclusion of an abductive inference is a hypothesis that may or may not be true, why would it matter about rearranging the statements into deductive and inductive forms? Because until the truth-value of the hypothesis is known, then the deductive and inductive arguments become a moot point.

There can be situations where the premises of an abductive argument are both true, but the abductive conclusion is false. Choosing a different example, here is the deductive argument:

(*Rule*) All birds that can fly have wings.
 (*Case*) All robins are birds that can fly.
 (*Result*) All robins have wings.

Swapping premises around, the inductive form

(*Result*) All robins have wings.
 (*Case*) All robins are birds that can fly.
 (*Rule*) All birds that can fly have wings.

and the abductive form both result in true conclusions.

(*Rule*) All birds that can fly have wings.
 (*Result*) All robins have wings.
 (*Case*) All robins are birds that can fly.

But by substituting a different species of bird in this example, the abductive form has a false conclusion:

(*Rule*) All birds that can fly have wings.

(Result) All ostriches have wings.

(Case) All ostriches are birds that can fly.

In this last case, if these statements were rearranged, the resulting arguments would not be sound—both deductively and inductively—given the fact that the premise “All ostriches are birds that can fly” would be false. If an abductive conclusion is false, and the truth-value apparently is not too important, what does that make the argument itself?

Recall the slightly modified beans argument when Peirce explains negating premises:

(Rule) Most of the beans in this bag are white.

(Case) This handful of beans are from this bag.

(Result) Probably, most of this handful of beans are white.

This is a big change to his argument: instead of staying with universal quantifiers like “all” or “none,” he switches to using particular quantifiers like “some,” “most,” or “few.” This completely changes the nature of the premises of the argument and violates the form of a Barbara syllogism, which requires universal quantifiers. Now in its new form, the argument is an IAI syllogism of the first figure and not considered a valid deduction. Peirce calls this a “probable deduction.”³⁹ A somewhat similar problem exists, as noted earlier, with his “Elijah and Enoch” denial example: in one premise the men are treated as singular instances, but in the other premise they are treated collectively in order to fit his Bocardo syllogism.

Despite having every intention to show that abduction is a new mode of inference, Peirce gives a poor explanation, and his examples fail to clearly show how this is true. By declaring that the truth-value of an abductive conclusion could be questioned and modifying his arguments to no longer fit the syllogistic forms he cited, it seems likely that his conviction that abduction could be formally proven lacked real evidence to support his claim.

Inference to the Best Explanation

The term abduction, however, is still being used today. As stated earlier, the modern philosophical definition of the word references the American philosopher Gilbert Harman's paper "Inference to the Best Explanation." Instead of claiming abduction as a new mode of inference, Harman clearly distances himself from several similar terms: "abduction," "the method of hypothesis," "hypothic inference," "the method of elimination," "eliminative induction," and "theoretical inference."⁴⁰ Harman, like Peirce, is committed to seeking a "hypothesis [which] is simpler, which is more plausible, which explains more, which is less *ad hoc*, and so forth" to entail the observed premises.⁴¹ But unlike Peirce, Harman does not concern himself with how one actually generates the hypothesis; he is only concerned that the hypothesis best explains the observed facts. Harman also points out that enumerate induction, whereby one infers a general rule after observing several instances where an inductive argument holds true, can be handled as a type of Inference to the Best Explanation (IBE). However, returning to Peirce's derivation of abduction from deductive argument, Harman argued that it is not always possible to infer a rule is indeed valid—for example, a situation where "someone is biasing the observed sample to make us think that" the rule is valid.⁴² Because Harman does not claim that IBE is a new mode of inference—it is just a different form of induction—there is no need to change the context of justification, and he also avoids the logical fallacy of affirming the consequent.

Conclusion

In conclusion, Charles Sanders Peirce attempted to establish a unified pragmatic

methodology that would capture an epistemological framework for scientific discovery and experimentation. Among his notable achievements, he attempted to articulate a new mode of inference but with limited success. Besides not being happy with the term abduction, he kept modifying what it was and what it was supposed to do. His explanations seemed to always come up short, and at times, seemed paradoxical and not well thought out. Unfortunately, because he did not publish any books and had to rely on the whims of scientific journal editors in his day, few people besides his students at Johns Hopkins University knew about his ideas. His legacy almost fell into obscurity until a renewed interest in his life and work began in the latter half of the twentieth century. He may have been onto something, but today, Peirce's concept of abduction is a relic of late-nineteenth century philosophical curiosity.

Notes

1. Joseph Brent, *Charles Sanders Peirce: A Life*, 2nd ed., (Bloomington, IN: Indiana University Press, 1998), 191-92, 217, 270, 318, 321, 337.
2. Ibid., 19–20, 53, 75, 245.
3. Ibid., 150-51, 368.
4. Ibid., 202.
5. Ibid., 18.
6. Paul Weiss, *Dictionary of American Biography*, vol. 14, O - P, s.v. "Peirce, Charles Sanders" (New York: Charles Scribners and Sons, 1934), 403, <https://archive.org/details/dictionaryofamer14amer/page/402>
7. Bertrand Russell, *Wisdom of the West*, (Garden City, NY: Doubleday, 1959), 276.
8. [C.S. Peirce], "A Boolean Algebra with One Constant (1880)", in *The Collected Papers of Charles Sanders Peirce*, vol. 4, *The Simplest Mathematics*, CP 4.12-21, ed. Charles Hartshorne and Paul Weiss (Cambridge, MA: Harvard University Press, 1933), 12-20.
9. Henry Maurice Sheffer, "A set of five independent postulates for Boolean algebras, with application to logical constants." *Transactions of the American Mathematical Society* 14, no. 4 (1913): 481-488, <https://doi.org/10.1090/S0002-9947-1913-1500960-1>.
10. Charles S. Peirce to Allan Marquand, December 30, 1886, in *Writings of Charles S. Peirce: A Chronological Edition*, vol. 5, 1884-1886. (Bloomington, IN: Indiana University Press, 1993), <https://muse.jhu.edu/chapter/1468597>.
11. C. S. Peirce, "A Quincuncial Projection of the Sphere," *American Journal of Mathematics* 2, no. 4 (December 1879): 394-96, <https://www.jstor.org/stable/pdf/2369491.pdf>.
12. Max H. Fisch, "Peirce as Scientist, Mathematician, Historian, Logician, and Philosopher," in *'Studies in Logic' by Members of the Johns Hopkins University, 1883*, ed. Charles S. Peirce. *Foundations of Semiotics* 1. (Amsterdam: John Benjamins Publishing, 1983), x, <https://doi.org/10.1075/fos.1.01fis>.
13. Richard S. Robin, *Annotated catalogue of the papers of Charles S. Peirce*. Amherst, MA: University of Massachusetts Press, 1967; "The manuscript material now (1997) comes to more than a hundred thousand pages. These contain many pages of no philosophical interest, but the number of pages on philosophy certainly number much more than half of that. Also, a significant but unknown number of manuscripts have been lost." Joseph Ransdell, "Some Leading Ideas of Peirce's Semiotic", end note 2, 1997, <http://www.iupui.edu/~arisbe/menu/library/aboutcsp/ransdell/LEADING.HTM>. "Light revision"

of version in *Semiotica* 19 (January 1977):157–78; Nathan Houser, "The Fortunes and Misfortunes of the Peirce Papers," paper presented at the 4th Congress of the IASS, Perpignan, France, 1989, *Signs of Humanity* 3 (1992): 1259–68.
<http://www.iupui.edu/~arisbe/menu/library/aboutcsp/houser/fortunes.htm>.

14. Weiss, *Dictionary of American Biography*, 399-400.

15. *Stanford Encyclopedia of Philosophy*, s.v. "Abduction,"
https://plato.stanford.edu/entries/abduction/#Bib_11/11/18.

16. Gilbert H. Harman, "The Inference to the Best Explanation," *The Philosophical Review* 74, No. 1 (Jan 1965), 88-95.

17. Martin Potschka, "Peirce's Concept of Abduction (Hypothesis Formation) across His Later Stages of Scholarly Life," *The Commens Working Papers* 8 (February 6, 2018): 2-3.
<http://www.commens.org/papers/paper/potschka-martin-2018-peirce%E2%80%99s-concept-abduction-hypothesis-formation-across-his-later>.

18. Ibid.

19. Ibid., 15.

20. *Merriam-Webster Dictionary*, s.v. "hypothesis," accessed November 14, 2018,
<https://www.merriam-webster.com/dictionary/hypothesis>.

21. Potschka, "Peirce's Concept of Abduction," 16.

22. Ibid., 30.

23. Ibid.

24. Potschka, "Peirce's Concept of Abduction," 17.

25. C. S. Peirce, "Illustrations of the Logic of Science," *Popular Science Monthly* 13 (August 1878): 470-482.

26. [Charles Sanders Peirce], "Pragmatism and Abduction," (lecture, Harvard University, Cambridge, MA, May 14, 1903), In *The Collected Papers of Charles Sanders Peirce*, vol. 5, *Pragmatism and Pragmaticism*, 180-212, ed. Charles Hartshorne and Paul Weiss, (Cambridge, MA: Harvard University Press, 1934); also [Charles Sanders Peirce], "The Three Stages of Inquiry," in *The Collected Papers of Charles Sanders Peirce*, vol. 6, *Scientific Metaphysics*, 468-474, CP 6.469, ed. Charles Hartshorne and Paul Weiss, (Cambridge, MA: Harvard University Press, 1934).

27. *Stanford Encyclopedia of Philosophy*, "Peirce on Abduction," s.v. "Abduction," supplement, <https://plato.stanford.edu/entries/abduction/peirce.html>.

28. [C.S. Peirce], "The Logic of Drawing History from Ancient Documents," from *The Collected Papers of Charles Sanders Peirce*, vol. 7, *Science and Philosophy*, ed. Arthur W. Burks, 218-223, CP 7.219 (Cambridge, MA: Harvard University Press, 1958).
29. [Charles Sanders Peirce], "Pragmatism and Abduction," (lecture, Harvard University, Cambridge, MA, May 14, 1903), In *The Collected Papers of Charles Sanders Peirce*, vol. 5, *Pragmatism and Pragmaticism*, 180-212, CP 5.186, ed. Charles Hartshorne and Paul Weiss, (Cambridge, MA: Harvard University Press, 1934).
30. Ibid., CP 5.171.
31. Norwood Russell Hanson, *Patterns of Discovery: An Inquiry into the Conceptual Foundations of Science*. (Cambridge, England: Cambridge University Press, 1958).
32. *Stanford Encyclopedia of Philosophy*, s.v. "Scientific Discovery," <https://plato.stanford.edu/entries/scientific-discovery/>.
33. Potschka, "Peirce's Concept of Abduction", 20.
34. Jaakko Hintikka, "What is Abduction? The Fundamental Problem of Contemporary Epistemology," *Transactions of the Charles S. Peirce Society* 34, No. 3 (Summer 1998): 507.
35. Harry G. Frankfurt, "Peirce's Notion of Abduction," *The Journal of Philosophy* 55, No. 14 (July 3, 1958): 594.
36. [Charles Sanders Peirce], "Pragmatism and Abduction," (lecture, Harvard University, Cambridge, MA, May 14, 1903), In *The Collected Papers of Charles Sanders Peirce*, vol. 5, *Pragmatism and Pragmaticism*, 180-212, CP 5.188, ed. Charles Hartshorne and Paul Weiss, (Cambridge, MA: Harvard University Press, 1934).
37. Ilkka Niiniluoto, "Defending Abduction," In "Proceedings of the 1998 Biennial Meetings of the Philosophy of Science Association Part I: Contributed Papers" *Philosophy of Science* 66 Supplement (September 1999): S436-S451.
38. "an abductive suggestion . . . Is something whose truth can be questioned or even denied." [Charles Sanders Peirce], "Pragmatism and Abduction," (lecture, Harvard University, Cambridge, MA, May 14, 1903), In *The Collected Papers of Charles Sanders Peirce*, vol. 5, *Pragmatism and Pragmaticism*, 180-212, CP 5.186, ed. Charles Hartshorne and Paul Weiss, (Cambridge, MA: Harvard University Press, 1934).
39. C. S. Peirce, "Illustrations of the Logic of Science," *Popular Science Monthly* 13 (August 1878): 470-482.
40. Gilbert H. Harman, "The Inference to the Best Explanation" *The Philosophical Review* 74, No. 1 (Jan 1965), 88-89.

41. *Ibid.*, 89.

42. *Ibid.*, 91.

Bibliography

- Brent, Joseph. *Charles Sanders Peirce: A Life*. 2nd ed. Bloomington, IN: Indiana University Press, 1998.
- Fisch, Max H. "Peirce as Scientist, Mathematician, Historian, Logician, and Philosopher," in *'Studies in Logic' by Members of the Johns Hopkins University, 1883*, ed. Charles S. Peirce. *Foundations of Semiotics* 1, vii-xxxii. Amsterdam: John Benjamins Publishing, 1983. <https://doi.org/10.1075/fos.1.01fis>.
- Frankfurt, Harry G. "Peirce's Notion of Abduction," *The Journal of Philosophy* 55, no. 14 (July 3, 1958): 593-97. <https://www.jstor.org/stable/2021966>.
- Hanson, Norwood Russell. *Patterns of Discovery: An Inquiry into the Conceptual Foundations of Science*. Cambridge, England: Cambridge University Press, 1958.
- Harman, Gilbert H. "The Inference to the Best Explanation." *The Philosophical Review* 74, no. 1 (Jan 1965): 88-95. <http://links.jstor.org/sici?sici=0031-8108%28196501%2974%3A1%3C88%3ATITTBE%3E2.0.CO%3B2-A>
- Hintikka, Jaakko. "What is Abduction? The Fundamental Problem of Contemporary Epistemology," *Transactions of the Charles S. Peirce Society* 34, no. 3 (Summer 1998): 503-33. <https://www.jstor.org/stable/40320712>.
- Houser, Nathan. "The Fortunes and Misfortunes of the Peirce Papers." Paper presented at the 4th Congress of the IASS, Perpignan, France, 1989. *Signs of Humanity* 3 (1992): 1259-68. <http://www.iupui.edu/~arisbe/menu/library/aboutcsp/houser/fortunes.htm>.
- Niiniluoto, Ilkka. "Defending Abduction," In "Proceedings of the 1998 Biennial Meetings of the Philosophy of Science Association Part I: Contributed Papers." *Philosophy of Science* 66 Supplement (September 1999): S436-S451. <https://www.jstor.org/stable/188790>.
- [Peirce, Charles Sanders]. "A Boolean Algebra with One Constant (1880)." In *The Collected Papers of Charles Sanders Peirce*. Vol. 4, *The Simplest Mathematics*, 12-20. Edited by Charles Hartshorne and Paul Weiss. Cambridge, MA: Harvard University Press, 1933.
- Peirce, C. S. "Illustrations of the Logic of Science," *Popular Science Monthly* 13 (August 1878): 470-482.
- [Peirce, Charles Sanders]. "Kinds of Reasoning." In *The Collected Papers of Charles Sanders Peirce*. Vol. 1, *Principles of Philosophy*, 65-75. Edited by Charles Hartshorne and Paul Weiss. Cambridge, MA: Harvard University Press, 1933.
- [Peirce, Charles Sanders]. "The Logic of Drawing History from Ancient Documents." In *The Collected Papers of Charles Sanders Peirce*. Vol. 7, *Science and Philosophy*, 218-223. Edited by Arthur W. Burks. Cambridge, MA: Harvard University Press, 1958.

[Peirce, Charles Sanders]. "On 'Illustrations of the Logic of Science.'" In *The Collected Papers of Charles Sanders Peirce*. Vol. 8, *Reviews, Correspondence, and Bibliography*, 214-238. Edited by Arthur W. Burks. Cambridge, MA: Harvard University Press, 1957.

[Peirce, Charles Sanders], "Pragmatism and Abduction." Lecture, Harvard University, Cambridge, MA, May 14, 1903. In *The Collected Papers of Charles Sanders Peirce*, Vol. 5, *Pragmatism and Pragmaticism* [sic], 180-212. Edited by Charles Hartshorne and Paul Weiss. Cambridge, MA: Harvard University Press, 1934.

Peirce, C. S. "A Quincuncial Projection of the Sphere." *American Journal of Mathematics* 2, no. 4 (December 1879): 394-96. <https://www.jstor.org/stable/pdf/2369491.pdf>.

[Charles Sanders Peirce], "The Three Stages of Inquiry." In *The Collected Papers of Charles Sanders Peirce*, Vol. 6, *Scientific Metaphysics*, 468-474. Edited by Charles Hartshorne and Paul Weiss. Cambridge, MA: Harvard University Press, 1935.

Peirce, Charles S. *Writings of Charles S. Peirce: A Chronological Edition*. Vol. 5, 1884-1886. Bloomington, IN: Indiana University Press, 1993. <https://muse.jhu.edu/chapter/1468597>.

Peirce Edition Project. Trustees of Indiana University, 2015, <http://www.peirce.iupui.edu/index.html>.

Peirce, James Mills. Quoted in "Note on the Pronunciation [sic] of 'Peirce'." *Peirce Project Newsletter* 1, no. 3 / 4 (December 1994). http://www.iupui.edu/~peirce/news/1_3/13_4x.htm.

Potschka, Martin. "Peirce's Concept of Abduction (Hypothesis Formation) across His Later Stages of Scholarly Life." *The Commens Working Papers* 8 (February 6, 2018). <http://www.commens.org/papers/paper/potschka-martin-2018-peirce%E2%80%99s-concept-abduction-hypothesis-formation-across-his-later>.

Ransdell, Joseph. "Some Leading Ideas of Peirce's Semiotic", end note 2, 1997. <http://www.iupui.edu/~arisbe/menu/library/aboutcsp/ransdell/LEADING.HTM>. "Light revision" of version in *Semiotica* 19 (January 1977): 157-78.

Richard S. Robin. *Annotated catalogue of the papers of Charles S. Peirce*. Amherst, MA: University of Massachusetts Press, 1967.

Russell, Bertrand. *Wisdom of the West*. Garden City, NY: Doubleday, 1959.

Sheffer, Henry Maurice. "A set of five independent postulates for Boolean algebras, with application to logical constants." *Transactions of the American Mathematical Society* 14, no. 4 (1913): 481-488. <https://doi.org/10.1090/S0002-9947-1913-1500960-1>.

Weiss, Paul. *Dictionary of American Biography*, edited by Dumas Malone. Vol. 14, *Oglethorpe - Platner*, 398-403. New York: Charles Scribner's Sons, 1934, <https://archive.org/details/dictionaryofamer14amer/page/398>.