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History and Philosophy in Peirce's Conception of Science

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History and Philosophy in Peirce's Conception of Science

by

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Abstract

This thesis examines the roles played by history in Charles Peirce's philosophy of science. History is seen to have two roles. First, it contributes to the philosophy of science: in examining the history of science we are able to learn about science and scientific progress. In this way, studying history can teach us about inquiry itself. Secondly, history is the subject of the philosophy of science. The methods of inquiry learned about and developed in the philosophy of science should be applied to historical inquiries. In this way, history contributes to philosophy of science, and historians (among other scientists) benefit from this contribution.

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To Jack Allford

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List of Abbreviations

I abbreviate citations to selected collections of Peirce's writings: "The Collected Papers of Charles Peirce", "The Writings of Charles S. Peirce: A Chronological Edition", and "Values in a Universe of Chance".

Citations of "The Collected Papers of Charles Peirce" will be given in the form: "CP, [Volume#].[Paragraph#]".

Citations of "The Writings of Charles S. Peirce: A Chronological Edition" will be given in the form: "W[Volume#], [Page#]".

Citations of "Values in a Universe of Chance" will be given in the form: "VUC, [Page#]".

Other abbreviations used are signaled in the text.

CHAPTER 1

"Each chief step in science has been a lesson in logic." – The Fixation of Belief

Charles Sanders Peirce was extraordinarily prolific and wide-ranging thinker. A polymath of prodigious dimensions, the breadth of his curiosity was matched by the depth of his competence. He worked intensely and minutely in a variety of fields, from philosophy to engineering, history to mathematics. He was educated as a chemist, but spent over thirty years working with the United States Coast and Geodetic Survey as a scientist working in geodetics and astronomy: his main work involved swinging pendulums to determine the shape of the earth. Further, he was involved in many prominent scientific groups[1] and contributed to many important scientific journals.[2] While conducting his geodetic work, Peirce also contributed to psychology and economics. He developed an extremely detailed theory of signs (the semeiotic) and his first publication was on Shakespearean pronunciation.[3] His philosophical interests were equally broad. Throughout his life he wrote on metaphysics, phenomenology (a version of which

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[1] "The American Academy of Arts and Sciences, the National Academy of Sciences, the American Association for the Advancement of Science, the American Metrological Society, the London Mathematical Society, and the New York (later the American) Mathematical Society".
Fisch, 1975, 146

[2] Such as "*American Journal of Science*, *Nature*, *the American Journal of Mathematics*, the *American Journal of Psychology*, and *Science*". Fisch, Max H. "Introduction: Peirce and the History of Science Society", *ibid*

[3] "Shakespearean Pronunciation", W1, 117

he founded: phaneroscopy), logic and epistemology, which seems to have been Peirce's primary concern. [4]

Peirce's philosophical writings frequently turn to discussions of the importance and methods of inquiry. He was impressed with scientists' ability to work and reason their way to the truth, and much of his study of inquiry explored this point. As such, much of Peirce's philosophical work can be understood as philosophy of science.

It is out of these wide-ranging interests that Peirce developed what came to be called pragmatism: a grand, tightly-knit philosophy, incorporating results and methods from each of his other areas of interest. Due to the influence of pragmatism, in the century since his death Peirce has come to be studied chiefly as a philosopher.[5] Many of those familiar with Peircean pragmatism are also aware that in his day Peirce was respected as a working scientist, and that his scientific work influenced his philosophical disposition. However, fewer seem to know that Peirce was equally well recognized as a historian—primarily a historian of science.[6]

The goal of my thesis is to examine the roles history plays in Peirce's philosophy of science. The roles are those of support and subject. Historical inquiry *supports* philosophy of science by helping us learn how to inquire. Inspection of the historical record shows numerous

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[4] We rarely find Peirce using the word "epistemology". As Susan Haack points out, it was relatively new at the time (coined in the 1850s by James Frederick Ferrier) and Peirce thought it to be "an atrocious translation of '*Erkenntnislehre*'". (Haack, 2014, 320; CP 5.496). As this thesis will later emphasize, he instead thought of epistemology as a branch of logic. The following is part of his lengthy definition of logic, coauthored with his student Christine Ladd-Franklin for Baldwin's Dictionary: "It is generally admitted that there is a doctrine which… considers, for example, in what sense and how there can be any true proposition and false proposition. … The common German word is Erkenntnisstheorie, sometimes translated EPISTEMOLOGY" Baldwin (Ed.), (1901)

[5] As well as a semiotician.

[6] Fisch, (1975), 145

cases of individual inquiries—each of which can be examined—as well as an overarching sense of scientific progress. History is the *subject* of philosophy of science because Peirce believes we ought to conduct historical inquiry using the same basic scientific principles that guide inquiry into any other subject. In this way, history contributes to the philosophy of science and philosophy of science informs historical and historiographical studies. This thesis analyzes both of these roles.

My work in this thesis approaches Peirce from a different angle than is usual. I look at his philosophy of science as understood in relation to the history of science. About Peirce on science there is lots of discussion, but on history there is very little.

The purpose of this chapter is to set the scene for discussing how history can contribute to the philosophy of science and *vice versa*, to orient the above questions within Peirce's commitment to the importance of philosophy, science and history. I do so by emphasizing Peirce's employment of the history of science in his two most influential papers, "The Fixation of Belief" and "How to Make our Ideas Clear".[7] These papers are the first to put forward Peirce's pragmatism, and their use of the history of science is not often noted.[8] In look at these papers from a historical point of view, I offer an original interpretation of Peirce's best known works, in order to highlight the role of history in Peirce's conception of science.

Chapter 2 considers the way in which Peirce understood history to contribute to the philosophy of science, and is centered around a brief piece on William Whewell, titled simply, "Whewell". "Whewell" is the published lecture notes from part of a series of lectures Peirce gave

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[7] The Fixation of Belief (Fixation), CP 5.358-387; How to Make our ideas Clear (How to), CP 5.388-410
[8] Though the roots of pragmatism can be found in earlier papers.

on British logicians, delivered at Harvard between December, 1869 and January, 1870. The notes are only eight pages long; the first two thirds or so are written out in prose, but the latter third of the lecture notes are just that—notes.

This lecture, while short, is extremely rich. In a matter of paragraphs, it brings our attention to a point around which the second chapter is centered: that the history of science contributes to the philosophy of science by way of revealing the ‘grand features’ of scientific progress. This chapter shows that Peirce really did believe history to be an important part of any well-constructed philosophy of science, and is, to my knowledge, the only analysis of the Whewell lecture. Because of the value of Peirce’s discussion around this point, the tiny manuscript provides the context in which the third and final chapter is to be understood.

Chapter 3 describes how historical inquiry can be approached as a science in its own right. It is centered around Peirce’s very substantial paper, “On the Logic of Drawing History from Ancient Documents especially from Testimonies”. This is the full title of a paper Peirce wrote in 1901. At its full length, the monograph is 263 written pages long.[9] In this paper Peirce puts forward his account of inquiry and explains how it ought to be applied to the study of history. To my knowledge there is only one other work on “On the Logic”.[10]

My thesis considers these two papers, which are brought into dialogue to achieve a common goal: understanding the way in which the history of science contributes to the philosophy of science and *vice versa*.

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[9] As noted in the Robin Catalogues, entry #690.
[10] Brunson (2010)

> "We have, hitherto, not crossed the threshold of scientific logic… the secret of which the history of science affords some hints." – How to Make Our Ideas Clear

SCIENTIFIC INQUIRY

Peirce's two most famous papers are found in a series he wrote for *Popular Science Monthly* called "Illustrations of the Logic of Science". These papers, "The Fixation of Belief" and "How to Make Our Ideas Clear", outline some of the central principles of what was later called pragmatism (first called so by William James). They are usually studied together as part of an introduction to Peirce or pragmatism.

"The Fixation of Belief" ("Fixation") deals with how one ought to settle their beliefs. When we have a belief, for Peirce, the belief informs habits of action. For example, my belief that the fridge is cold is the part of the reason why I store food inside of it. However, beleifs can be upset by surprises. A light not turning on as expected when a switch is flicked raises the question as to why; a surprising experimental result can upset a belief in a scientific theory; a surprising score on a chemistry test can raise doubts about your understanding of chemistry, and so on. Peirce notices that such doubts are uncomfortable, and so once surprised out of a belief we try and find a way back into one. We can believe our landlord's claim that the power went out, perform another experiment related to the theory—we can even just choose to believe defiantly that we know our chemistry despite the outcome of the test. For Peirce, any attempt to re-establish belief is a form of inquiry.[11] Peirce lists four methods of inquiry in total: the methods of

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[11] Though he says, "it must be admitted that this is sometimes not a very apt designation.". Fixation, CP 5.374

tenacity, authority, a priority, and science.[12] In “Fixation” he urges that science is the preferable method for settling beliefs. This is because a scientifically settled belief is less likely to be upset in the future.

The point he is at pains to make is that inquiry, if *properly* pursued, tends towards the truth. Part of the advantage of science is that it forces the scientist to continually adapt their beliefs to the surprises upsetting them. Further, the other methods are those which cannot be practiced incorrectly. It is a feature of tenacity, authority and apriority that they concede to the biases or preconceptions of those following them. However, learning whether you are properly following the scientific method is itself a question open to study—it is not determined by how strongly you feel. “This is the only one of the four methods which presents any distinction of a right and a wrong way.”[13] It is one thing to look for an answer to a question that is troubling you, but it is another thing to do so effectively. To do so effectively is, in the broad sense, to reason well about the questions with which you are concerned.

What is special about science is that it is a method of inquiry that *can* be properly (or improperly) pursued. This is part of what makes it valuable. It is something we have to work at, something that can be improved, and for that reason is *worth* working at.

This sentiment is set out from the first sentence of “Fixation”. Peirce notes that few people think they need to study logic, as they are already satisfied with their ability to draw inferences correctly. However, Peirce argues that correct reasoning does not work this way. It

[12] I discuss these further in Chapter 2.
[13] Fixation, CP 5.385

has to be carefully studied and cultivated. It "is not so much a natural gift as *a long and difficult art*."[14]

Having made this point in the opening lines, "Fixation" immediately illustrates it by taking us through an abbreviated history of science. Peirce shows how our ability to reason has developed—from the schoolmen, through Roger and Francis Bacon, through Kepler and Lavoisier, our ability to reason has grown stronger and stronger. The point I would like to draw here from "Fixation" is not just that we can best learn about the world by employing science, but, that, for this reason scientific inquiry is itself something which repays close study.

The second paper in the "Illustrations of the Logic of Science" series, "How to Make Our Ideas Clear" ("How to") establishes a need for a new grade of clarity in relation to historical grades of clarity. In it, Peirce provides a way to clarify an idea to a level beyond the 'clear and distinct' ideas of Descartes and the abstract definitions of Leibniz. The rule Peirce gives us for reaching the third level of clarity is the famous pragmatic maxim: "Consider what effects, that 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."[15]

My focus here is not on the maxim, but on the reason for which Peirce thought it important. He desired a new, sharpened grade of clarity—due to the potential dangers of the others. Descartes' clarity doesn't distinguish itself from a *feeling* of clarity; Leibniz's abstract definitions define words in terms of other words and do not allow for empirical input or intervention.

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[14] Fixation, CP 5.359, my emphasis
[15] How to, CP 5.402

Peirce again appeals to history to explain the importance of a truly clear idea. He says, "To know what we think, to be masters of our own meaning, will make a solid foundation for great and weighty thought."[16] A clear idea is a catalyst for valuable thoughts. While the opposite is also true: "a single unclear idea, a single formula without meaning, lurking in a young man's head, will sometimes act like an obstruction of inert matter in an artery, hindering the nutrition of the brain."[17] Peirce also points out that, at the societal level, this 'malnourished' thought is responsible for stunted scientific development.

As such, Peirce emphasizes that it is part of the purpose of logic to teach us how to clarify our ideas. A clear idea is valuable for expediting the creation of valuable thoughts, and presumably, a society infused with clear ideas would have greater opportunity for scientific progress.

It will take some teasing-out to explain what I mean by progress here, a notion which I examine more fully in Chapter 2. Peirce believes the purpose of thought (clear or otherwise) is primarily the production of belief. A belief, for Peirce, is that which establishes a habit. "Fixation" taught us inquiry is the struggle from doubt to belief, and so stops when a belief is settled. However, he is also clear that such a struggle provides new starting-place for the next inquiry. Progress must work from this starting-place. Someone who is tenacious makes no progress because they are continually returning to their starting-place—they insist their keys are in their pocket, even though at every inspection their pocket is empty. One who follows the

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[16] How to, CP 5.393
[17] How to, CP 5.393

scientific method progresses because their starting place is always updating. Are the keys in their pocket? No. On the dresser? No. On the shelf? Etc.

I summarize this position (clear ideas facilitating progress) because Peirce indicates it also plays a role in our understanding of science itself—and that this progress ought to be informed by the history of science.

At the end of the penultimate paragraph of "How to", Peirce says that one value of the pragmatic account of meaning is in how "beautifully… [it] can be applied to the ascertainment of the rules of scientific reasoning."[18] In the final sentence of the paper, he suggests that the discussion thus far has not "crossed the threshold of scientific logic" insofar as it has not told us how to generate those ideas most useful for the progression of science. Such "is an art not yet reduced to rules, but of the secret of which *the history of science affords some hints.*"[19]

These two articles exemplify the importance of the growth of science in Peirce's thought, and that the history of science plays a central role in such growth. Indeed, Peirce's famous papers are bookended by the history of science. On one end, it is used to show that our ability to reason well has been developing, and that we need to work in order to improve that development. On the other end, the history of science is offered as a place to look in order to better understand how to facilitate this development.

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[18] How to, CP 5.410

[19] How to, CP 5.410, my emphasis. Following suit, the next paper in the series ("The Doctrine of Chances") begins with a historical observation ("It is a common observation that a science first begins to be exact when it is quantitatively treated."), immediately backed up with an example (Lavoisier's influence in bringing quantitative methods to chemistry).

This gives us some insight into how Peirce understood the first role of the history of science. He echoes the idea fifteen years later, when he prefaces his draft of a book on the history of science with the following:

> "For my part, I am quite sure that, however it may be with the rank and file of the great army of general readers, those who come here will be interested in the history of science not as a mere Wonder Book, but as an instance, a specimen, of how the laws of growth apply to the human mind."[20]

Peirce's conception of scientific progress is related to his understanding of science. A scientist himself, it is perhaps because of his intimate familiarity with the life of a scientist that Peirce places an unusual emphasis on the importance of the attitude of a scientist.[21] This emphasis is unusual in that science was typically thought of as a sort of systematized, structured body of knowledge. Peirce insists, "Science and philosophy ['the love of wisdom'] seem to have been changed in their cradles. For it is not knowing, but the love of learning, that characterizes the scientific man; while the 'philosopher' is a man with a system which he thinks embodies all that is best worth knowing."[22]

This definition of science in terms of the 'scientific man' lines up with the characterization of science from "Fixation". The scientific attitude requires the inquirer to pursue truth with no other motive. They are not acting out of want of fame or money, but only with the hope that their actions will help pave the road to truth. In Peirce's words, the scientific man

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[20] CP. 7.267n7
[21] We find him saying: "Since I was brought up in intimacy with almost all the chief men of science in the United States during those years and was always attentive to their conversation, I think it hardly supposable that I should have mistaken what they meant by that word… [that is, as] inquiries to which they are so devoted as to be drawn to every person who is pursuing similar inquiries," Robin Catalogues, entry #655
[22] CP 1.44

inquires “without any sort of axe to grind, nor for the sake of the delight of contemplating it, but from an impulse to penetrate into the reason of things.”[23] Recall that in “Fixation” science was—at least in part—that form of inquiry which separated the inquirer from their own desires regarding their beliefs. One with this attitude also takes seriously the task of studying science—of learning how to best inquire and facilitate progress.

Peirce’s characterization of science in terms of the scientific attitude is constant.[24] And as the attitude is one that must be embodied by living inquirers, so to can science as a whole be seen as something ‘living’. That is, science is understood, generally, for Peirce as those *actions* undertaken by a community which shares a “love of truth” and inquires accordingly. The definition is widened, into science, as “a living *historic* entity”; it is the activity of those engaged in “diligent inquiry into truth for truth's sake” for as long as that sort of activity has been engaged in.[25]

INQUIRY INTO THE PAST

Peirce has a long background in history. He wrote his first historical piece in 1850, when, at age 11, he composed a history of chemistry.[26] Later in life, Peirce translated Fibonacci’s “The Epistle of Petrus Peregrinus on the Lode Stone” into English, did extensive research into Pythagoras, Kepler, Egyptian mathematics and engineering, the dating of Plato’s works and the

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[23] CP 1.44
[24] See, for example each entry under “Science” in the online Peirce Commens Dictionary: http://www.commens.org/dictionary/term/science
[25] CP 1.44, my emphasis
[26] VUC: xxv

passing on of Aristotle's written manuscripts.[27] These are some of his specific studies, but one finds evidence of his historical proficiency throughout his philosophical writings. One example of this proficiency comes from his doctor, G. Alto Pobe, who, attending to Peirce in the later years of his life recalls:

> "Peirce knew more about medicine than I did. When I went to see him I would stay with him a half-hour to an hour at a time. It did you good to talk to him. When I arrived he would often tell me all of his symptoms and diagnose his illness. Then he would tell me the whole history of the medical treatment for this illness. Then he would tell me what should be prescribed for him now. He was never wrong. He said he had to ask me to write out the prescriptions since he did not have an M.D. degree."[28]

The two main sources of Peirce's historical writings are a set of lectures and book draft, both entitled "The History of Science". The twelve lectures were delivered in Lowell between November 28th, 1892 and January 5th, 1893. Later, in 1898, Peirce was asked to write a book on the history of science. Peirce described his plan for it as "a good History of Science to replace Whewell, and of the same instructive and intellectual kind".[29] He initially planned to have it finished within a year, as William James expressed interest in using it as a textbook for classes.[30] At his point in his life Peirce was making little money and the thought of a lucrative textbook was enticing. He produced detailed plans for the book, which was to be 100,000 words long and stretch from the earliest recorded history up until 1848.[31] Peirce worked on the draft sporadically until his death in 1914. Unfortunately, due to his poor finances and secluded location he was unable to spend much time in a library. This proved to be "the hitch" with the manuscript for

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[27] Eisele, 1975; CP 7.240-255 (The end of "On the Logic of Drawing History from Ancient Documents")
[28] Quoted from Sebeok, T, Sebeok, J.U., (1981)
[29] Eisele (1985), 301
[30] Eisele (1985), 301
[31] Eisele (1985), 404

“The History of Science”, as he instead chose to work on projects for which he did not need help from the library. Unfortunately, due to this hitch, the manuscript was never completed.

In 1985, Carolyn Eisele published the lectures, the book manuscript and the correspondence leading up to them (among much else) in the two volume “Historical Perspectives on Peirce's Logic of Science: A History of Science.”[32] The lectures total 123 typed pages while the work on the book totals 89. And from the first sentence of the book and the lectures Peirce pushes the same contrast between systematized knowledge and the actions of devoted inquirers.[33] He was looking for the scientific attitude within history, and thought it should be used to investigate history also.

At the beginning “The History of Science” Peirce explains quite grandly, "that which the author had at heart throughout his studies of the history of science was to gain an understanding of the whole logic of every pathway to the truth."[34] He wanted to look at every way throughout history in which people were able to arrive at stable, true beliefs. Each of these methods properly called “science”.

When speaking about how to approach the history of science Peirce makes another such grand claim about the purpose of science. It reminds us of “Fixation”, and like the above, it speaks to science’s scope: “Science seeks to discover whatever there may be that is true … every truth which will prevent a future fact of perception from surprising us, which will give the means

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[32] Eisele (1985)
[33] Eisele (1985), 307
[34] CP 7.267n8

of predicting it, or the means of conditionally predicting what would be perceived were anybody to be in a situation to perceive it, this it is, beyond doubt, that which science values."[35]

This last line is from a paper written in 1901, twenty-three years after the "Illustrations in the Logic of Science" series. Mentioned above, it is called "On the Logic of Drawing History from Ancient Documents, Especially Testimonies" ("On the Logic").[36] In this paper Peirce notes the role history can play in the philosophy of science. However, the primary goal of the paper is to instruct would-be historians.

The structure of the paper is quite clear. He begins by giving a quick set of arguments against how he believes history is commonly inquired into. He then gives an extremely lengthy and detailed account of his philosophy of science. He covers, quite in-depth: types of inference and how inquirers ought to best allocate their resources. This exposition is provided to show why science is successful. He then, to conclude the first half of the paper, distills this into six rules for the historical inquirer. The second half of the paper is Peirce applying these methods to three case studies.

It may seem odd that history should be considered a science. However, Peirce had reason for thinking all sciences—though carefully separated into different types—operated under the same principles. This made his account of science broad enough to range from mathematics to linguistics to goldsmithing.

Part of Peirce's argument for why history in particular deserves to be called a science is that its hypotheses are, more or less, open to verifiability. A historical hypothesis implies "a

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[35] CP 7.186
[36] CP 7.162-255

ligament of numberless possible predictions concerning future experience, so that, if they fail, it fails."[37] One example Peirce uses here is the historical hypothesis of the city of Troy. If Troy were to exist, as told in the stories of the Trojan War, then excavations of a particular city should match some descriptions given in the Iliad. Further, those discoveries would continue the "ligament of possible predictions", as they ought to be comparable to other such archeological finds of other relevant areas in and around Greece.[38]

Peirce also thought it was important that historical hypotheses are open to tests from future evidence. Even if a particular hypothesis is not currently testable, this does necessitate that it will remain so. Historians must hope that a test we be conceived. Peirce calls a theory which is not sensitive to future discoveries "metaphysical gabble", while one that relies on them wholly is a "mere piece of fortune telling."[39]

In a similar vein, Peirce urges us to recognize that there may be some forms of evidence that we are not yet sensitive to or have not yet considered. For example, there might be a large, perfectly placed mirror-like surface hundreds of light-years away, on which we could watch our own history unfold. Alternatively, historical facts could have been recorded in a way that we are not now sensitive to.[40] The idea is not that we hold out for any one of these unlikely ideas. The point is only that historical hypotheses could very well become testable due to future developments. This helps support history's position as a science in Peirce's eyes. More will be said on this subject in Chapter 3 where I discuss "On the Logic" more fully.

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[37] CP 5.597
[38] CP 5.597
[39] CP 5.541
[40] CP 2.642

Peirce believed the history of science had a role to play in the philosophy of science. In the next chapter I look further into Peirce’s philosophical views regarding that role. Peirce’s comments on the work of William Whewell offer a rich look into exactly what Peirce believed the role of the history of science to be within the philosophy of science. The manuscript shows that studying history is a wonderful lens into the features of scientific progress. The following chapter, Chapter 3, looks at the role philosophy plays for the historical inquirer. It discusses how and why Peirce conceived of history as a science, and deals with questions arising from that classification. The history of science helps us understand what science is—and brings out the great features of scientific progress—and that very history, like all history as a serious inquiry, is best pursued scientifically in Peirce's broad sense.

CHAPTER 2

> "Whewell described the reasoning just as it appeared to a man deeply conversant with several branches of science as only a genuine researcher can know them, and adding to that knowledge a full acquaintance with the history of science. These results, as might be expected, are of the highest value" –Lessons from the History of Science[41]

WHEWELL

I here examine Peirce's lecture on William Whewell in order to explain the way in which history contributes to the philosophy of science: by revealing the features of scientific progress. Peirce's lecture on Whewell does not take long to emphasize the importance of the grand features of scientific progress. The grand features (as I may refer to them hereafter) are mentioned on only the third page. Peirce says, "A theory of science which is thus founded on the history of science in a truly scientific spirit and by a genuine inductive method…must be true to the grand features of scientific progress…" Much more about these grand features is included in this sentence (which is a trying 110 words long), and even more so in the paragraph it begins, but this excerpt does a nice job of setting the scene. It draws our focus to three main points. First, Peirce is talking about using the history of science as an important contribution to a 'theory' (or philosophy) of science. Second, Peirce emphasizes that the history must be applied to the theory in a "truly scientific spirit". As we see below, this scientific spirit plays a much larger role, not only guiding the application of historical facts to philosophical theories, but as essential to the

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[41] CP 1.70

historian as well. Lastly, a properly conducted history of science is seen to contribute to the philosophy of science by way of revealing the grand features of scientific progress.

In order to fully understand the grand features, it is important to understand the context in which Peirce is mentioning them and within his wider philosophy of science. In this chapter I look at both.

In the paragraphs preceding his mention of the grand features, Peirce discusses three main things: the difference between the scientific and literary approaches to learning, that Whewell was a properly scientific investigator, and that historical inquiry ought not to be biased by a philosophical view. The grand features of scientific progress show up here, argued to be the inevitable result of an unbiased scientific inquiry.

It is important to discuss the context leading up to the grand features for two reasons in particular. First, as just noted, the grand features are the inherent result of an unbiased, properly scientific inquiry into history. Understanding what this sort of inquiry is, and why it is important, will be central for understanding what Peirce means by scientific progress. Secondly, it can be argued from looking into the early pages of "Whewell" that Peirce sees the history of science here as having a particular *purpose* as regards the philosophy of science. Namely, the purpose of the history of science in "Whewell" is to contribute to a *theory* or *philosophy* of science. The grand features of scientific progress are a major part of this contribution, and so are best understood if put into context. In the next section I discuss these two points, first discussing the scientific attitude and why it was important for Peirce that Whewell held it—both as a historian and philosopher of science. This leads into textual reasons for supposing that Peirce understood the role of the history of science as that of contributing to a proper philosophical theory of science.

THE SCIENTIFIC ATTITUDE

From the very first sentence of the Whewell manuscript Peirce is concerned with showing the difference between two approaches to understanding, the ‘scientific’ and the ‘literary’, and explaining the importance of the former for scientific inquiry. In this article, the scientific approach is argued to be important for historians as well as scientists, especially those who mean to use history as a means to enhance their philosophy of science. These are to be understood as compatible yet contrasting modes of thought. [42] Each is a different approach to understanding: a person who adopts the literary mode approaches understanding very broadly—believing that we cannot understand something *properly* until it has been looked at from all angles, incorporating every facet of human nature.[43] The scientific approach is different. A scientific person thinks something needs to be studied very closely and narrowly. Furthermore, a ‘scientific’ study must not be influenced by passion or emotion.[44]

This distinction sets an important tone for the rest of the manuscript, including discussion of the grand features. Peirce is clear that the scientific mode is essential for someone who wishes to “understand science well”.[45] Further, having introduced this as a criterion for understanding science, Peirce then commends Whewell’s qualifications as a ‘scientific man’—one especially fit for the “treating of science”.[46]

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[42] W3, 337, “…the contrast not to say contradiction between two modes of thought.”
[43] W3, 337 “We cannot regard things as they ought to be regarded unless we look at them broadly and from the entirety of human nature”
[44] W3, 337
[45] W3, 337
[46] W3, 337

The distinction between scientific and literary also serves as the starting point for my interpretation of Peirce's understanding of the *purpose* of history in this article. I take it that, in "Whewell", Peirce is speaking about the history of science as something which can contribute to the philosophy of science (as opposed to as history for its own sake, for the sake of other historians, for telling a good story, for finding lost treasures, etc.). I support this interpretation in the next subsection by analyzing Peirce's discussion of Whewell as a scientific man. It becomes clear that Peirce is insisting that Whewell have a scientific attitude because such an attitude is essential for one who wishes to understand science. To understand why, it is important first to understand the scientific attitude. As such, my discussion on this topic comes after discussing the scientific approach.

In the beginning of "Whewell", the literary and scientific are set out to contrast between *broad* and *narrow* approaches to understanding. However, this is not how Peirce usually uses the terms. Usually, "scientific" is used to denote a certain level of genuine concern for discovering the truth—motivating an inquirer to be rigorously truth seeking and forward looking; "literary" is used in various ways, but usually to indicate that someone has a motive other than uncovering the truth. Given this, Peirce's use of the terms in "Whewell" has two main differences: (1) literary man described in "Whewell" is still concerned with the truth, but happens to think inquiry is best done from an extraordinarily holistic perspective. (2) The scientific approach described in "Whewell" advocates for narrow scrutiny, but "with the entire exclusion of the passions and emotional sensibilities".[47] To help us better understand these differences, I look at both of them in turn.

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[47] W3, 337

First, Peirce's characterization of 'scientific' in his lecture on Whewell has an uncharacteristic aspect. Namely, in addition to being narrow, it should be practiced "to the entire exclusion of the passions and emotional sensibilities."[48] I bring this up because it suggests a rather robotic understanding of scientists, one that can be assuaged by looking at Peirce's more usual usage of the term. Rather than dispassionate, Peirce's regular scientific person is one who:

- …has "a *great desire* to learn the truth"[49];
- …has a "searching thoroughness … [consisting in adopting a theory and] devot[ing] their whole energies and lives in putting it to test … [in order to satisfy] their restless insatiable impulse [to test]."[50];
- …"*burns* to learn"[51] and has a "*love* of truth"[52]

These quotations are representative of Peirce's regular characterization of the scientific attitude. What they show is that the scientific person must be passionate about discovering the truth.

The sort of passion Peirce is decrying in his lecture is any which *distracts* from the pursuit of truth. One sort might be a scientist who is "wedded to a conclusion".[53] This would be someone who studies with some sort of emotional attachment to an outcome of that study. Alternatively, or in addition to being wedded to a conclusion, one could be motivated by some passion other than the pursuit of truth (e.g., to write a work that will make them famous, to exemplify a certain style, etc.).[54] While the description in the "Whewell" lecture exorcises all

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[48] W3, 337
[49] CP 1.235, my emphasis
[50] CP 1.33
[51] CP 1.44, my emphasis
[52] CP 1.49, my emphasis
[53] CP 1.635
[54] CP 7.387

passion, it should be understood in conjunction with the above context praising passion *for* science.

Second, I would like to demonstrate how Peirce usually uses “literary”. He usually uses the term in two ways: [55]

- To denote merely verbal decoration (a “spangle of glitter” for a proof; “[clothing] philosophical ideas in fresh and modern phraseology”).
- To denote inquirers with certain motivations (e.g. prolonging a debate rather than solving a problem; fuelling a sense of satisfaction, etc.).

The general theme is that literary people tend to either misrepresent or intentionally obfuscate an idea. This sort of “studying in a literary spirit” is often contrasted with the scientific approach, as it is in “Whewell”.[56] The literary man is more interested in, say, creating an interesting narrative out of historical events than in determining the truth. As mentioned above, the scientific approach tends to be characterized not by its narrowness, but by its focus on discovering the truth (as discussed further, below). This is the usual contrast between the two modes of thought.

Despite the focus on broad and narrow investigation in the “Whewell” lecture, I do not think this characterization of the literary and scientific approaches is actually so different from their usual depiction in Peirce. Some of Peirce’s characterizations of the literary show how their

[55] “…not such as shall merely add a new spangle to the glitter of their proofs.” CP 1.33
“A positive discovery which takes a favorite subject out of the arena of literary debate is met with ill-concealed dislike.” CP 5.396
“But at present, the word begins to be met with occasionally in the literary journals, where it gets abused in the merciless way that words have to expect when they fall into literary clutches.” CP5.414
“But Hume was a literary man, and one of the characteristics of his philosophical style was that he was continually endeavouring to clothe philosophical ideas in fresh and modern phraseology.” CP 6.541
[56] CP 1.33

broadness is a disadvantage to inquiry. At one point, after making a characteristically careful linguistic distinction, Peirce tells us he does so in order to "rescue the good ship Philosophy for the service of Science from the lawless rovers of the sea of literature."[57]

My focus here is on the term “lawless rovers”. This term paints a literary study as one in which the literary man wanders around the sea of literature looking for treasure—a shiny spangle of glitter for their proof, or a controversial passage to reanimate a debate. They are looking for anything which might achieve these ends, and have no preordained goal nor method for reaching it. This is contrasted with the scientific inquirer, who has a definite goal (arriving at true beliefs) and—due to the intense desire to reach this goal—puts considerable thought into their methods. We have to learn how to inquire, just as we have to learn how to sail. Even the best “intellect will ofttimes lose his orientation and waste his efforts in directions which bring him no nearer to his goal, or even carry him entirely astray. He is like a ship in the open sea, with no one on board who understands the rules of navigation. *And in such a case some general study of the guiding principles of reasoning would be sure to be found useful*.”[58] The scientific person is motivated by discovering the truth, and for this reason has to do their best to learn how to do so.

Now, in the lecture, Peirce has given the literary inquirers something like a goal and a method: they are attempting to understand their subject from every possible angle. Their goal is understanding, and their method is holistic interpretation. However, how useful is this for actually learning about a subject? If we want to know why Cicero acted as he did during the Second Catilinarian conspiracy, what use is it to write a paper on how a Shakespearean character

[57] CP 5.449. For an excellent discussion on this topic, see Haack (1996).
[58] Fixation, CP 5.368, my emphasis.

might have acted? It might be interesting, but even after exhausting all of Shakespeare's characters we are no closer to actually knowing about Cicero's actions.[59]

This is contrasted with a careful, purposeful, and indeed narrow scientific approach. It is not enough for a scientific man to want to discover the truth, they should also have reason to believe their method of uncovering that truth is a good one. This emphasis on a "well-considered method" is important because it disqualifies the broad 'gather everything' approach of the literary "inquirer" of the Whewell lecture.[60]

Further, Peirce believes the proper method will arise only from the genuine motivation to discover the truth. "If this desire is not pure, but is mingled with a desire to prove the truth of a definite opinion, or of a general mode of conceiving of things, it will almost inevitably lead to the adoption of a faulty method."[61] Peirce advocates for a method only when there seems to be some reason to think the method will result in the truth. In this way the scientific attitude is *more* than just a desire to reach the truth; it also inspires the inquirer to consider carefully how to best approach their goal. (As I describe below, this involves more than just individual actions: one motivated by the scientific attitude ought to recognize the importance of community for science as well.) For Peirce, "science consists in actually drawing the bow upon truth with intentness in the eye, with energy in the arm;" with a narrow *focus,* not a broad net.[62]

[59] A more targeted example of a literary writer might be Ralph Waldo Emerson. Peirce grew up with Emerson occasionally in his home (VUC, 416) and Emerson's writings on history seem to exemplify the literary style as described here; he ends his essay "History" buy stating that we must write our annals "[b]roader and deeper…if we would trulier express our central and wide-related nature". Emerson, Mikics (Ed.) (2012), 138-160.
[60] CP 1.235
[61] CP 1.235
[62] CP 1.235

It is of interest to us here that Peirce uses the scientific approach twice on the first page of the manuscript, and that these mentions occur in different contexts. These contexts split the usefulness of the scientific approach into two types—one general: the scientific approach is generally to be preferred when seriously trying to understand any aspect of the world—and one particular: the scientific approach is *necessary* for one wishing to understand *science*.

The first mention of the scientific approach in "Whewell" is the one discussed at length above. It is saying that in order to understand something well it must be studied closely and with scrutiny. This claim, as applied to history, suggests that the proper historian of science ought to approach their topic by looking closely at cases or episodes from history (as opposed to trying to understand a historic episode from every angle).

In the second mention of the scientific approach, just slightly further on down the page, Peirce makes a much more specific claim: that in order to understand *science* well you must have access to someone with "an interior view of science", someone who has used the above scientific approach to solve a scientific problem.

This gives us two criteria for the scientific historian. First, they must approach their subject narrowly, with a desire to uncover the truth. Secondly, they must have recourse to someone (possibly themselves) with an interior view of science. Understanding the way in which Whewell fulfills these criteria leads us to understand the purpose of historical studies for Peirce in his Whewell lecture. It shows us that Peirce is thinking of history being studied in the most useful way for informing a theory or philosophy of science. One way it is able to do so is by revealing the grand features of scientific progress.

THE CONTRIBUTION OF HISTORY

I argue that in "Whewell" Peirce takes the purpose of the history of science to be to inform a philosophy of science. I make this point by looking into why Peirce would need to qualify Whewell as a scientific man in order to conduct a historical inquiry, as well as through a close analysis of some of the text leading up to the discussion of the grand features.

Peirce believes Whewell had the right sort of scientific background to write a good history of science. Whewell was a widely successful scientist, recognized today for significant work on the tides, mechanics, geology, astronomy, and economics. Peirce lists all of these areas, adding conic sections, engineering, meteorology, optics, and chemistry.[63]

Further, Whewell has since been called the grandfather of historiography of science, and may well have been the first person to undertake a broad, systematic survey of the whole history of science.[64] Peirce seems aware of this too, distinguishing Whewell even further as an ideal candidate for investigating the nature of science in virtue of his historical studies. Peirce mentions two of Whewell's historical works, "The History of Inductive Science" and "The History of Scientific Ideas", which served as a precursor to his philosophical work, "The Philosophy of the Inductive Sciences, Founded upon Their History". Peirce gives these works the highest praise, and further praises Whewell for founding his (philosophical) understanding of science on its history.[65]

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[63] W3, 338
[64] Cohen (1994), 27.
[65] At a glance, it looks as though Peirce has made possible a chronological error here. *The Philosophy of the Inductive Sciences* was published in 1840, while the historical volumes were published in 1837 and 1858, respectively. However, Whewell tells us that *The History of Scientific Ideas* is a collection of historical chapters that

The above discussion of the nature of the scientific approach provides two criteria for a good historian of science. The first is that the historian approaches the history in a narrow, scrutinizing way. Evidence for whether Whewell has met this standard is found by looking Whewell's historical case studies. The second criterion is that the historian of science has some access to a narrow 'interior view' of science. Evidence here is found by looking at Whewell's own scientific achievements or, lacking that, whether he consulted with a scientist in completing his history.

The second claim is the easier to support. This is because, as mentioned above, we know that Whewell was "an eminent scientific investigator", to use Peirce's words. His wide range of scientific work makes him seem qualified to a modern reader, and, importantly, clearly impressed Peirce. Whewell seems to have been in agreement with Peirce regarding the historian of science's need to have practiced science. He says himself, "I knew that my life had been principally spent in those studies which were most requisite to enable me to understand what had thus been done [in the history of science]".[66] And if we doubted his own achievements, on top of this, while writing the histories Whewell apparently sent his manuscripts to other scientists to ensure that he was accurate.[67]

Now, for the first point, Peirce gives no indication in his lecture as to whether Whewell's histories are themselves "narrow, scrutinizing" studies. For this we have to look elsewhere.

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were either originally published in *The Philosophy of the Inductive Sciences,* or historical chapters that he didn't feel suited that work. As such, *The History of Scientific Ideas* is aptly chosen as a historical foundation for Whewell's mentioned philosophical work despite its later publication date.

[66] Whewell (1837), Preface, x-xi

[67] Snyder (2012). And in his own words: "I had been in habits of intercourse with several of the most eminent men of science of our time, both in our own and in other countries … I did not, therefore, turn aside from the responsibility which the character of the Historian of Science imposed upon me." (Whewell (1837), Preface, xi)

There is evidence to suggest that Whewell was careful and narrow in the way Peirce suggests. First of all, when Whewell describes his own approach he says, “the historian of science [works] in reference to subjects which demand a far intenser [sic] and more methodical study than the historian of practical life gives to the actions of which he treats.”[68] This suggests Whewell would be in line with Peirce’s understanding of the scientific approach, one requiring a special level of scrutiny.

There is also a sense in which Whewell has narrowed his inquiry. He is conducting a history of science, but confines himself to the physical sciences; he further narrows his view by splitting up those sciences.[69]

The above tells us three things about Whewell’s approach. First, he seems to have spent an appropriate amount of time as a scientific investigator to have an ‘interior view’ of science (as well as taking necessary steps to double check with other scientists). Secondly, Whewell seems to share Peirce’s idea that there is some special level of scrutiny required for a good inquiry into the history of science. Lastly, it is unclear whether Whewell’s approach is narrow in the way Peirce might intend a scientific approach to be. It seems to be. Above, the narrow aspect of the scientific approach was seen to plausibly relate with focus or purposeful attention to the method and questions of this inquiry.

With this in mind, we have enough information to decide whether Whewell meets Peirce’s criteria for a scientific historian of science. The two criteria are (1) that the historian be

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[68] Whewell (1837), Preface, x

[69] They are split up such that “if [he has] satisfied the competent Judges in each science…the scheme of the work must be of permanent value, however imperfect may be the execution of any of its portions.” This suggests at least some weight being given to a narrow focus rather than the larger, overall picture. (Whewell (1837), Preface, xiv)

properly narrow and scrutinizing and (2) that they have recourse to an interior view of science. The second criterion is clearly met, as shown above. The first seems clearly met in terms of scrutiny—Whewell is clear that he takes the history of science to require intense careful study. But, without looking further it is unclear whether Whewell is sufficiently narrow. I take it that he is, however, because later in the manuscript Peirce praises Whewell's historical writings. Given that Peirce is the one insisting on narrowness, his word should be sufficient for clarifying this uncertainty. The above is enough to conclude that Whewell's approach to history is suitably scientific, in Peirce's sense.

The importance of the scientific attitude for researching the history of science will be discussed in the next chapter, but for now it is worth asking: why would someone need to be a specialist (have an interior view of science) in order to understand something generally (the proceeding and logic *of science*)? Recall that Peirce's wider writings on the scientific approach emphasize the passion required for science. This passion is emphasized because Peirce assures us that a scientific life is difficult and tedious, so one has to have passion for the truth in order to undertake such a life. I think this suggests a reason for why Peirce would require the interior view of science.

Peirce emphasizes in his own writings on the history of science that he is particularly interested in "that particular psychical ingredient[, of the scientific man, that is] needful for the success of their researches."[70] In the very next sentence he credits Whewell with having shown conclusively that different people will learn different things from the same observations

[70] Eisele (1985), 311

"depending upon what ideas already acquired [they] bring to the study of them."[71] Peirce is making this point to show that the historic scientific man will likely be the most productive and have the most fruitful ideas. However, the point applies here too. Someone who has an interior view of science will be able to see things in the history of science that are otherwise invisible.

It is in this way that a specialization allows one to reach more general conclusions. There is an important difference here between looking for the general *features* of science and looking to understand science from the generalist's *perspective*. Peirce is interested in learning about the general (or 'grand') features of scientific progress, but thinks you must do so from the perspective of a scientist or specialist. One must use their knowledge of the working of science to help identify those features which are essential to it. This is different from approaching the study of science in a general (or 'literary') way.

Despite these credentials, Peirce insists that we also have to ask whether Whewell was biased in conducting his histories. Here I take it that Peirce is aware that Whewell undertook his histories in part to inform his philosophy of science.[72] His worry, here, is that Whewell may have used his histories to give credence to a previously held philosophical view (as opposed to using them to ground or inform a later developed philosophical view).

Two questions immediately arise regarding this critique: (1) why does Peirce think it is important and (2) does Peirce think Whewell is successful in avoiding philosophical bias, and for what reasons? I begin by addressing the first question.

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[71] Eisele (1985), 311
[72] Snyder, 2012

Peirce is clear that being free from bias is of chief importance, comparing it to a rule given on high from the Saviour.[73] Peirce is here talking about lack of philosophical bias being important for the historian of science (in the same way that the scientific approach was important). Peirce is simply praising an unbiased approach for "deriv[ing] theories from… facts". However, Peirce's reasons for *supporting* this approach are conditional. When he gives his support, Peirce talks about the way in which such a history is beneficial for informing a philosophy of science.

This lends support to the idea that the manuscript is written with an eye to answering the question "how ought we to best understand science?" We find Peirce saying that a historical account free from philosophical bias is essential if one wants that historical account to help inform an account of science.[74] I only stress this point because this need not be the case. Generally, I'd imagine, a lack of bias would be seen as advantageous because it minimizes distortion or cherry picking, which in turn preserves accuracy. While Peirce might have these factors in mind as reasons for *why* an unbiased account is beneficial for developing a philosophy of science, they are not his focus.

Another reason for suspecting that Peirce is primarily concerned with using history to understand science is that he only mentions *philosophical* bias. He does not here express concern for, say, a cultural bias or a bias towards one type of science over another. The issue is only that one's historical account may be tailored to an already held philosophical account. If Peirce's chief concern were merely the accuracy of the account, then any other type of bias should be

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[73] W3, 338
[74] W3, 339

equally problematic. What is special about philosophical tailoring is that such gerrymandering would obviously affect—in addition to the general accuracy—the account's ability to inform philosophy.

This point is further supported when we focus on Peirce's early mentions of Whewell. He is first brought up to ensure that he has suitable "qualifications for treating of science"[75] This is not a question about being qualified to examine the *history* of science, but science itself. As we see in the first paragraph, Peirce is concerned with the "proceeding and logic" of science.[76] However, to the above Peirce quickly adds: "Whewell was not the man to write upon the Logic of Science solely on the basis of *general* qualifications. He prepared himself for his task by an exhaustive study of the history [of science]".[77] This suggests that Peirce took Whewell to be interested in establishing a 'theory of science', that he was qualified to do so, and that he further recognized the need for that theory to be informed by history. Peirce praises Whewell's historical works for their ability to inform science (and Whewell is praised for applying them without bias).[78] This suggests the role of history within the Whewell lecture is to contribute to the philosophy of science.

This contribution, as it is mentioned in the manuscript, is to reveal the grand features of scientific progress. These features are spelled out in one dense paragraph, which explains the benefits of an unbiased historical account to a philosophy of science. It begins, "A theory of science which is thus founded on the history of science in a truly scientific spirit…" and goes on

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[75] W3, 337
[76] W3, 337
[77] W3, 338
[78] W3, 338

to make on central point. Namely, that a history of science free from philosophical bias "must be true to the grand features of scientific progress".[79]

THE GRAND FEATURES OF SCIENTIFIC PROGRESS

Peirce characterizes a 'grand feature' in two ways, both of them in this single paragraph in "Whewell". First, a grand feature of scientific progress is a "character of scientific investigation which leaves its mark upon [the history of science]".[80] Secondly, a grand feature is a "representative condition of the success of scientific thought".[81]

Below these two loose definitions of the grand features of scientific progress, Peirce offers the following about scientific progress itself. Scientific progress, he says:

(1) "Belongs to the community of scientific men of the same department,"

(2) Arrives at unanimous conclusions,

(3) Gives "no private interpretations of nature" and so

(4) Those interpretations must be published in such a way that allows the rest of the world to adopt them.

I will look at the grand features of scientific progress within a larger discussion of Peirce's idea of scientific progress itself. I take the grand features of scientific progress to be that scientific inquiry is: (1) done in a community (2) of investigators with the scientific attitude (3) in a self-controlled way. Or:

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[79] W3, 339
[80] W3, 339
[81] W3, 339

(1) That inquiry is communal

(2) That the community of inquiry has the scientific attitude described above and,

(3) That inquiry is *self-controlled*.

In the following three subsections I look at these features of scientific progress, but not in the order presented above. First, I discuss what Peirce means by scientific progress. Afterwards I again discuss the importance of the scientific attitude. This is because it leads to each of the other features. In considering methods which lead to truth one is engaging in self-control; and such considerations will lead to recognizing the importance of community for scientific progress.

Scientific Progress

The following is a discussion of Peirce's philosophy of science geared towards his notion of scientific progress. This sketch of the philosophy of science is aimed particularly at illuminating the importance of the grand features of scientific progress outlined above.

"Progress" implies that science is moving towards something. Peirce takes science to be progressing towards the truth. But it is important to understand what is meant by 'the truth' for Peirce. Truth is "the opinion which is fated to be ultimately agreed to by all who investigate."[82]

First, it is important to know that this notion of truth is bound up with the idea that there is a mind-independent reality. Peirce describes reality as such: "a mode of being by virtue of which the real thing is as it is, irrespectively of what any mind or any definite collection of minds

[82] CP 5.407

may represent it to be."[83] There is a world out there, at least some elements and aspects of which are not influenced by how we may think of them.

How does this idea of reality complement truth? Peirce gives a succinct answer:

> "There are Real things, whose characters are entirely independent of our opinions about them; those Reals affect our senses according to regular laws, and, though our sensations are as different as are our relations to the objects, yet, by taking advantage of the laws of perception, we can ascertain by reasoning how things really and truly are; and any man, if he have sufficient experience and he reason enough about it, will be led to the one True conclusion."[84]

This can be understood in terms of Peirce's doubt-belief theory of inquiry. Recall that a belief, for Peirce, is a proposition or mental state which, in virtue of being believed, leads the believer to certain habits, both "in fancy as well as… in action."[85] So, one's belief that coffee is invigorating plays a part in their making a cup when tired; A belief in the afterlife may cause one to sacrifice their life to a religious cause; a belief in the position of one's furniture and floorplan lets them navigate their way to the bathroom in the dark, etc. Beliefs are tied to action in this way.

You can think of a belief as implying a set of predictions. The belief that a diamond is very hard means that you predict it would scratch all sorts of other surfaces if brought to the test. This can be thought of as a list of predictive conditionals: "Were I to rub a diamond against copper, the copper would scratch; Were I to rub a diamond against chalk, the chalk would scratch; Were I…" and so on. So to with a belief about your floor plan: "Were I to take another

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[83] CP 5.565
[84] Fixation, CP 5.384
[85] CP 3.160

step north I would hit a wall; Were I to swing my left arm I would break a lamp." etc. These predictions are used to guide action within the world.

However, since the world is independent of how we think of it, our predictions can be wrong. If I forget the renovations made to my home, it does not matter how strongly I hold the belief in the old floor plan: when I get up in the night I will run into the newly placed wall or recently moved sofa. The world is not determined by our beliefs, and so our beliefs can conflict with the world.

It is when our predictions are wrong and we 'bump into' the world that we are forced into a state of Peircean doubt. One is in a state of doubt when one of their beliefs is upset by experience, and not otherwise.[86] One who is doubting is at a loss for how to act. This is an uncomfortable state, and so the person attempts to settle a new belief. As I mentioned in Chapter 1, this movement from doubt to belief is what Peirce calls inquiry. And we are forced to inquire into nature insofar as we 'bump into' the natural world in surprising ways. Peirce describes this as experience teaching us by way of "practical jokes, mostly cruel. … [Experience] says, Open your mouth and shut your eyes And I'll give you something to make you wise; and thereupon she keeps her promise, and seems to take her pay in the fun of tormenting us."[87] We are given the opportunity to learn by way of often uncomfortable surprises.

Scientific inquiry was also mentioned in the first chapter. It is a method of moving from doubt to belief (a method of inquiry) that focuses on ensuring the new belief is compatible with

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[86] This is part of Peirce's answer to the sceptic. He does not bother to justify his belief in the world existing because there has been no actual doubt on the matter. The sceptic can show that it is logically possible that the world does not exist as we imagine it to, but they have never actually doubted its existence in the Peircean sense. They have never had an experience to the contrary.
[87] CP 5.51

the surprising experience. It is contrasted with methods of inquiry that fail to update in this way: tenacity (maintaining a belief despite experience to the contrary), authority (using an authority to determine your beliefs—this is untenable because eventually you will be met with contradictory authority), and a priority (deciding your beliefs based what is “agreeable to reason”, which is untenable because it is, Peirce argues, is a matter of taste).[88]

The next chapter covers the particular way in which the scientific method works, and how it is able to update an inquirer’s beliefs in a way that accords with the surprising experience. For present purposes I will use the simple example from earlier. If you are wandering to the bathroom at night and bump into a couch, your mental floorplan will be thrown into doubt. The scientific method of belief formation would have you incorporate a new piece of furniture into this place in your floor plan.

The tenacious inquirer would note the bump, forget it, and continue trying to make their way to the washroom. The question of what they bumped into does not even need to arise: they are not looking to change their beliefs. From this angle, authority and *a priority* can be seen as species of tenacity. If my beliefs are settled relative to an authority, then I do not worry about bumping into something unless the authority has pronounced on it. Further, I might not be able to think of a good reason for there to be a couch in you path to the bathroom, and so not worry about it.[89]

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[88] Fixation, CP 5.391

[89] The a priori method may seem silly here, but much in the history of philosophy and science has been decided upon on the basis that it is agreeable to reason. Peirce gives the example of Plato deciding that the distance of the planets should be proportionate to the distance between harmonies on a vibrating string. This sort of thinking, as it is really used in the history of thought, is what Peirce is arguing against in criticizing the a priori method.

It is because the scientific method updates beliefs to conform with new experience that it is to be favoured. The next time you walk through your house, you will know there is a couch in the hall. This means you will be able to get to the bathroom without the inconvenience of doubt. The others will have to struggle every evening.

In this context we can see how scientific inquiry is that which tends towards the truth. There is a world that imposes itself upon us through experience in certain, generalizable ways. A true belief is one that is never upset by experience, no matter how it is tested or how many times, in however many contexts. A true belief is one that survives the long run without any need for revision. The goal of scientific inquiry is to settle upon these true beliefs, and we do so by updating our beliefs when we are surprised by experience. Eventually, if we are subject to enough experience, our beliefs will be so updated to be true. And so, inquiry *progresses* insofar as it moves us closer to the truth.

However, notice that the scientific method as described here only goes part of the way to reaching the above proclamation—being fated to arrive at the truth. One would update all those beliefs which they had opportunity to doubt in the course of regular life, *but no more*. If we take seriously the idea that beliefs are guides to action, then an inquirer will only have opportunity to scientifically fix those beliefs related to everyday life. They will be fated to true beliefs, but only a small, practically useful subset of all true beliefs. The composition of the distant starts will not be discovered because no action is based upon that information. However, there is a truth about the composition of the stars, one the current formulation scientific inquiry is not fated to discover. This sort of inquiry is not fated to arrive at all truths because not all truths are vital to everyday action.

The sort of science Peirce is referring to when he says that scientific investigation is fated to arrive at the truth is essentially the type of scientific inquiry described above but *conducted by those with the scientific attitude*. This small addition is significant. The importance of the scientific attitude is that it implores the inquirer to *seek out* doubt. This sort of inquiry is fated to arrive at the truth because, given enough time, it promises to settle belief about everything that can in fact be brought to the test. The analogy in our simple example would be the person who makes an effort to *improve* their mental picture of their floorplan. He will run his hands along the floor and knock on the walls, looking for an experience that would surprise him. His curiosity leads to eventually building a complete mental floorplan. The less curious night-walker will only know the route from the bedroom to the bathroom.

THE SCIENTIFIC ATTITUDE AGAIN

There is a question as to how one can properly doubt things that they seemingly did not hold beliefs about before. Doubt is a surprise that upsets a belief; If I have no knowledge of the studs within my walls how can my knocking on the wall bring about a surprise, and so, an inquiry? Peirce gives an answer to this sort of question, and it marks an important point in his philosophy of science, for two reasons. First, it offers a way to move from this 'everyday' sort of scientific inquiry to proper scientific inquiry, the sort that is fated to arrive at the truth. Second, this answer acts as an introduction to what has come to be called Peirce's 'no-belief-in-science' thesis—the thought that scientists treat the content of their scientific work and discoveries as 'mere opinions' and not full beliefs. A brief description of this thesis will be helpful for filling out the sketch of Peirce's philosophy of science as well as the other two grand features of scientific progress.

There are certain beliefs which we do not find reason to doubt in our everyday lives. Peirce describes these as more or less like instincts. For example, that food eases hunger or that the rustling in the bushes might indicate danger. These beliefs "arise from a strong … involuntary experience of a suggestive nature".[90] Similar to these instinctual beliefs would be our 'common-sense' beliefs. Some of these we are unable to properly doubt ("the world exists") and others have perhaps not yet been offered an opportunity for doubt ("there is no world beyond the sea").

Some of these beliefs naturally get called into question over time. Perhaps one notices animals that seem to be coming from the sea. This could invite the conjecture "there might be a place beyond the sea". Or, if a particular medicine works, the question as to why it works may arise if it ceases to be effective. For example, a medieval Anglo-Saxon, named Bald, wrote a 'Leechbook', a book of medicine with several ointments, herbal preparations, methods and reasons for bloodletting, etc. One entry, described as "the best of leechdoms" was used to treat eye infections. It has recently been shown that this recipe was in fact an early antibiotic.[91] As such, like modern antibiotics, it will have become less effective over time. The failure of the medicine would cause a (perhaps painful) surprise, which in turn might invite questioning. This would have been an opportunity for science to begin.

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[90] CP 5.480

[91] This was discovered as a side project between an English professor and a microbiologist at the University of Nottingham. The story and interview from which I took the quote can be found here: http://www.nottingham.ac.uk/news/pressreleases/2015/march/ancientbiotics---a-medieval-remedy-for-modern-day-superbugs.aspx

However, other times the inquirers have to create this opportunity for themselves. Peirce gives an example of a "primitive man" in one of these situations. It is worth quoting in full:

> "Thus, the primitive man must have been sometimes asked by his son whether the sun that rose in the morning was the same as the one that set the previous evening; and he may have replied, "I do not know, my boy; but I think that if I could put my brand on the evening sun, I should be able to see it on the morning sun again."[92]

The primitive man in this example is attaching a potential action to an otherwise unquestioned part of his everyday life. He does this by way of conjecture. "Do not forget" Peirce reminds us "that every conjecture is equivalent to, or is expressive of, such a habit that having a certain desire one *might* accomplish it if one *could* perform a certain act."[93] He is here showing how we can attach these non-vital questions to our experience. By wondering about *potential* effects of potential actions, a conjecture can be made relevant. And, further, when speaking of scientific concepts, Peirce says the following: "Every concept, every general proposition of the great edifice of science, first came to us as a conjecture."[94]

The primitive man is then coming up with a potential way to answer the question posed to him: "Were I able to mark the sun, then I could determine whether it is the same as yesterday's". He is thinking about forming a potential belief—not one that he will actually ever use in his day-to-day life, but one founded on a fanciful conditional. The first step in this process, however, is brought about by the man's son. In asking whether the sun is the same every day, the son is inviting the opportunity for conjecture.

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[92] CP 4.480
[93] CP 5.480, my emphasis.
[94] CP 5.480

An inquirer who has the scientific sprit discussed in the first part of this chapter creates the opportunity for conjecture themselves:

> "[The inquirer] invents a plan for attaining to doubt, elaborates it in detail, and then puts it into practice, although this may involve a solid month of hard work; and it is only after having gone through such an examination that he will pronounce a belief to be indubitable. Moreover, he fully acknowledges that even then it may be that some of his indubitable beliefs may be proved false."[95]

Putting a mark on the sun may take more than a solid month's hard work. But the idea is the same. The scientific inquirer will do their best to question all that they can. Scientific curiosity allows people to work to discover surprises. Newton was not the first person to notice a falling apple, but only the first to wonder how it compared to the orbit of the moon. It is in this way that science is the development of our natural instincts.

The idea that a scientific inquirer is also ready to have their beliefs proved false leads us into discussion of the importance of community and the no-belief-in-science thesis.

COMMUNITY

An inquirer with the scientific attitude will also recognize the importance of community in the pursuit of truth. The above section showed that the scientific attitude will have one separate their scientific interests from their practical ones. Part of this is the recognition that a given investigation may not be finished within a particular inquirer's lifetime; it must be carried

[95] CP 5.451

on by the next generation. This does not lower the scientific person's commitment to that investigation. It gives sciences a progressivist spirit. Science will be forward-looking as long as there is more to discover, and given that a scientific person is always ready to be proven wrong, there task never ends. Members of a scientific community are those imbued with this notion, defined by the fact that they are actuated by this attitude.

This exhibits the importance of future communities of inquirers. They are important for two reasons. First, it is likely to be a future community (not our own) that arrives at or near the fated final opinion. This fact ought to keep the current community humble. Second, one genuinely concerned with the truth would recognize that the final opinion is a long way off, and so do their best to set up the future for success.

The present community of scientific inquirers is just as important. This community has the role of verifying and blending scientific ideas. Verification is important because it removes results which depend on a particular inquirer or lab. Blending of ideas is important because it allows "scientific men of the same department" to be exposed to different methods which may be of use, as well as different facts from other fields which may be surprising to them. Both of these factors spur scientific progress.

A fuller, better understanding of these ideas is helped by a discussion of Peirce's notorious no-belief-in-science thesis: that, properly speaking, scientists do not *believe* the results of their inquiry, but hold them as *mere opinions*. I am making use of this thesis, but do not here defend it. It is plausible enough that it can be used to help me make my point, that scientific inquiry continues to distance itself from practical action.[96]

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[96] For a useful overview and defense of the thesis, see Migotti (2005).

A belief is a habit that guides action. In the above discussion, we saw that in order to expand inquiry beyond our everyday lives we need to be curious about the world outside of those everyday lives. The no-belief-in-science thesis furthers this separation.

Recall that the purpose of science, for Peirce, is "to discover *whatever* there may be that is true."[97] Truth, as we have seen, is certainly tied to potential experience and action. There can be no truth about a matter that does not potentially affect experience. This is a result of the famous pragmatic maxim mentioned in Chapter 1.[98] This means that the goal of science is to tell us all that could be subject to potential experience. One way to think about it is as follows. Recall that a belief produces a list of conditionals: "If I were to X then Y", "If I were to X_1 then Y_1", etc. Science can be seen as endeavouring to fill out *each possible conditional*. As Peirce says, "*every* truth which affords the means of predicting what would be perceived under any conceivable conditions is scientifically interesting; and nothing which has not conceivable bearing upon practice is so."[99] In this sense, science is tightly tied to practice (and so, to belief), but notice that it is *conceivable practice* (and so, *conceivable* belief).[100] A scientific hypothesis, even if confirmed, does not play the role that a belief plays. Its purpose is not to guide practical action, but to be tested.

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[97] CP 7.186, my emphasis. Going further: "Every truth which will prevent a future fact of perception from surprising us, which will give the means of predicting it, or the means of conditionally predicting what would be perceived were anybody to be in a situation to perceive it, this it is, beyond doubt, that which science values."

[98] For an example of this sort of reasoning in action: "If our hope is vain; if in respect to some question — say that of the freedom of the will — no matter how long the discussion goes on, no matter how scientific our methods may become, there never will be a time when we can fully satisfy ourselves either that the question has no meaning, or that one answer or the other explains the facts, then in regard to that question there certainly is no *truth*." CP 5.565

[99] CP 7.186, my emphasis.

[100] Note that this isn't to say that people cannot have beliefs about things which cannot be investigated. Such beliefs simply cannot be determined to be a true, and so are not a matter for science. Short (unpublished) argues that such propositions are still Peircean beliefs, noting that Peirce himself uses the example of the assassin jumping to his death in accordance with religious belief. This belief cannot be investigated (in this life) and so it may not be worth asking if it is true, but it is certainly a belief.

Of course, if a scientist is put in a situation where their scientific training can be of immediate use, then in that context they are justified in relying on it.[101] A chemist could pass a chemistry test. However, qua inquirers, a scientist cannot believe their hypothesis. This is because they must be ready to abandon a hypothesis if evidence comes up to the contrary. For practical purposes, every scientific position is like the primitive man and the mark on the sun. It is speculation, not to be settled until subject to the tests of innumerable future generations.

If the results of this speculation prove to be useful for immediate action in other areas of life, this is fine. But it is not the aim of science to produce these useful effects. Its purpose is to arrive at true beliefs. Here it is worth quoting Peirce at length:

> "The value of Facts to [science], lies only in this, that they belong to Nature; and Nature is something great, and beautiful, and sacred, and eternal, and real — the object of its worship and its aspiration. It therein takes an entirely different attitude toward facts from that which Practice takes. For Practice, facts are the arbitrary forces with which it has to reckon and to wrestle. Science, when it comes to understand itself, regards facts as merely the vehicle of eternal truth, while for Practice they remain the obstacles which it has to turn, the enemy of which it is determined to get the better. Science, feeling that there is an arbitrary element in its theories, still continues its studies, confident that so it will gradually become more and more purified from the dross of subjectivity; but practice requires something to go upon, and it will be no consolation to it to know that it is on the path to objective truth."[102]

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[101] So to is the general public justified in relying on scientific conclusions. To quote Peirce: "After a while, as Science progresses, it comes upon more solid ground. It is now entitled to reflect: this ground has held a long time without showing signs of yielding. I may hope that it will continue to hold for a great while longer. This reflection, however, is quite aside from the purpose of science. It does not modify its procedure in the least degree. It is extra-scientific." CP 5.589

[102] CP 5.589.
This makes it sound as though something like cancer research is in fact not scientific (as it has a practical goal), and in a sense, that is correct. Of course, cancer researchers are part of the scientific community. But, if a community's *entire* end purpose was to have everyone healthy, fed, and happy (for example) then once succeeding in those goals the community would cease to inquire. This would leave facts outside the scope of those goals undiscovered.

We are now able to see how scientific inquiry is fated to arrive at the truth. To finish the quote on the nature of reality from the beginning the discussion on scientific progress and truth:

> "Reality is that mode of being by virtue of which the real thing is as it is, irrespectively of what any mind or any definite collection of minds may represent it to be. The truth of the proposition that Caesar crossed the Rubicon consists in the fact that the further we push our archaeological and other studies, the more strongly will that conclusion force itself on our minds forever — or would do so, if study were to go on forever."[103]

These points (that inquirers need to be ready to revise their beliefs and that that truth is approached asymptotically) lead into the discussion of community. There are two points to be made about community, one looking to the present and one looking to the future. First, the present community is important as a fact-checker. A hypothesis, if true, is true "despite the vagaries of you and me."[104] By subjecting a hypothesis to verification by a community, those hypotheses that rely on the quirks of individuals are weeded out. What is left is, hopefully, a representation of mind-independent reality. This is one simple reason why community is necessary.

It is also important to note that the community consists of those scientifically minded individuals. In this way, they each have the same end—trying to discover the truth. This common end is what makes a group of inquirers into a community: "Investigators, instead of contemning each the work of most of the others as misdirected from beginning to end, cooperate, stand upon

[103] CP 5.565. See also CP 5.407
[104] CP 5.311

one another's shoulders."[105] However, the call for cooperation does not diminish from an individual's duty to scrutinize other inquirers' work. Even if the hypotheses is cherished by one or more members of the scientific community, if it is proved wrong "the scientific man will be glad to have got rid of an error."[106]As Migotti points out, this is not to say that, on the whole, the investigator will be happy that his life's work has been shown false; only that, insofar as his goal is to discover truth (as it must be if he holds the scientific attitude) then getting rid of a false hypothesis is worth being happy about, as it moves the community closer to the truth.[107]

As mentioned, future communities also have an important role to play in scientific progress. Recall that the ideal goal of science is an 'endpoint' of inquiry, which we approach asymptotically. And it is for this reason, in part, that scientists do not regard scientific hypotheses, ideas or theories to be *beliefs*. Beliefs are to guide immediate action. The truth at which science aims "is nothing to you or me, to our children, or to our remoter posterity. What concern have we with the universe, or with the course of ages? No more than my dog has in the book I am writing."[108]

This emphasizes the importance of future communities. Truth is an opinion to be approached in the future. Recall that a true opinion is one that survives any test of experience without resulting in surprise. No matter how many times we check that the earth is orbiting the sun, and no matter if we check from here or from a spacecraft, or with infra-red or ultra-violet instruments, we will find the result unsurprising. That tests are repeatable indefinitely is what

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[105] CP 5.413
[106] CP 1.635
[107] Migotti (2005), 51
[108] CP 1.237

makes the 'end point' of inquiry only asymptotically approachable.[109] However, this also has the effect of always pushing the truth into the future.

Since science is aiming at some future point, an inquirer motivated by discovering the truth will not be focused on present, practical benefits. In Peirce's words, "logicality inexorably requires that our interests shall not be limited. They must not stop at our own fate, but must embrace the whole community. This community, again, must not be limited...It must reach, however vaguely, beyond this geological epoch, beyond all bounds." [110]

It is for this reason that a scientific community ought to do their best to set up future communities for the most fruitful inquiry. Peirce claims that "progress in science depends upon the observation of the right facts by minds *furnished with appropriate ideas.*"[111] This is one way to understand the duty a past community has upon a future one: to furnish them with appropriate ideas.

There are two points to be made about this duty. The first has been hinted at. People with different backgrounds will likely give different interpretations of information. This is why it was so important to Peirce that Whewell had "an interior view of science". The same is true for a community of inquirers. If your intellectual precursors believe the distance between planets

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[109] An aspect of self controlled inquiry (discussed below) that I would like to touch on here is what Peirce called the Economics of Research. This is the idea, briefly, that the resources needed for inquiry (time, money, mental effort, etc.) are scarce and so should be allocated thoughtfully. This is important when we remember that Peirce thinks that inquiry into any question whatever is never truly over. The Economics of Research suggests that we investigate those questions most likely to further our knowledge of the world, those most likely to bring about surprises. Because, Of course, there are some tests that do not seem worth doing again and again. For example, checking that 1+1=2, or that rocks fall to earth. See CP 1.122-125, 7.139-57 for more on the Economics of Research.
[110] CP 2.654
[111] CP 6.604

should correspond to the distance between harmonics on a vibrating string, it is harder for you to arrive at the proper distances. Your intellectual background will affect your experience, and so, the way in which you are able to work with that experience in progressing science.

Secondly, a community must pass down ideas that encourage further inquiry. It is no help for a scientific community to declare that this that or the other is unknowable, inexplicable, or, the opposite: perfectly known and absolutely certain.[112] These sorts of claims "block the way of inquiry" because they remove the impetus to investigate certain questions.

These are ways in which a community must be forward thinking. Inquirers must recognize that inquiry is an ongoing endeavour and strive to investigate the world in a way that not only brings themselves closer to the truth but also sets the infrastructure for future generations to thrive in and build upon. "[I]n storming the stronghold of truth," Peirce tells us, "one mounts upon the shoulders of another who has to ordinary apprehension failed, but has in truth succeeded by virtue of the lessons of his failure. This is the veritable essence of science."[113]

Error is sifted out as scientific communities build on the results of previous ones. Such is an indefinite advance towards the truth. This connects future communities with the fallibilism touched on in the last section: it is precisely because we do not know everything that we must be open to widely accepted ideas being shown false. It is because of the importance of this humility

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[112] See Haack, (2014) and CP 1.128, 1.137,1.138 and 1.139. Note also that this sentiment comes directly from the scientific attitude. In Peirce's words: "Upon this first, and in one sense this sole, rule of reason, that in order to learn you must desire to learn, and in so desiring not be satisfied with what you already incline to think [(this is the scientific attitude)], there follows one corollary which itself deserves to be inscribed upon every wall of the city of philosophy: Do not block the way of inquiry" CP 1.135

[113] CP 7.51

and future-directedness that Peirce thinks it important to say that scientists do not even *believe* the results of their conclusions.

Scientific communities can also be beneficial in providing a host of different ways to try and solve scientific problems. Peirce thinks it important that inquirers learn how to adopt methods used by others when investigating their own problems. He gives a quick list of examples, stating that the combination of different ideas is what is responsible for the most scientific progress in the generation before his own.[114] So too are "the higher places in science in the coming years are for those who succeed in adapting the methods of one science to the investigation of another."[115] Different scientific communities provide the different methods; learning how to merge them in an effective way is the result of studying "logic", in Peirce's idiosyncratically broad meaning of the term: It is to study inquiry itself. This is to have your inquiry become self-controlled.

SELF-CONTROL

In illuminating the first two grand features of scientific progress, enough ground has been covered to touch on the third without much further exegesis.

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[114] CP 7.66 "That is what the greatest progress of the passing generation has consisted in. Darwin adapted to biology the methods of Malthus and the economists; Maxwell adapted to the theory of gases the methods of the doctrine of chances, and to electricity the methods of hydrodynamics. Wundt adapts to psychology the methods of physiology; Galton adapts to the same study the methods of the theory of errors; Morgan adapted to history a method from biology; Cournot adapted to political economy the calculus of variations. The philologists have adapted to their science the methods of the decipherers of dispatches. The astronomers have learned the methods of chemistry; radiant heat is investigated with an ear trumpet; the mental temperament is read off on a vernier."
[115] CP 7.66

Inquiry becomes self-controlled due to the scientific attitude. An inquirer desires to get to the truth, and as we saw above, is responsible for determining a reasonable method for attaining it. In this way, the scientific method is critical of itself. And, just as many different scientists would be destined to arrive at the same conclusions regarding some physical phenomena, Peirce thinks it to be the case that self-controlled inquirers will arrive at his methods of investigation, as laid out in this chapter and the next.

Of course, this too is up for revision in light of contrary evidence. The openness to revision we saw in the last section also applies to the method itself, with the same upshot. As Peirce says "Now control may itself be controlled, criticism itself subjected to criticism; and ideally there is no obvious definite limit to the sequence."[116] In this way, the scientific method may be improved.

The idea is that the scientific method is also something about which there is truth, and so it too is something to be investigated into and improved upon. It can be done badly. Peirce believes that "To say that any thinking is deliberate is to imply that it is controlled with a view to making it conform to a purpose or ideal."[117] As we know, the ideal for science is arriving at true beliefs; inquiry is deliberate thought with this goal in mind.

Self-control plays a primary role in distinguishing *scientific* progress from *undirected* progress. It is conceivable that people not interested in science, given enough time, would nevertheless 'bump up' against experience in enough ways to arrive at the whole truth. Peirce indeed thinks this to be the case.[118] However, progress can be greatly sped up when people

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[116] CP 5.442
[117] CP 1.573
[118] CP 7.78: "It will infallibly be reached sooner or later, if favorable conditions continue; but man having a short life, and even mankind not a very long one, the question is urgent, How soon? And the answer is, as soon as a sane

recognize that certain methods are more amenable to arriving at the truth than others. This is a self controlled inquiry. [119]

T.L. Short nicely sums up why we need self-controlled inquiry at the end of his book, *Peirce's Theory of Signs*:

> "…we have no knowledge a priori of how to inquire—there can never be a time when we will know, for sure, that we are proceeding in the right way or even that there is a right way to proceed. We can only go by the evidence we have so far acquired, in faith that there is an impersonal truth, that is, a final opinion toward which an ideal inquiry would tend. The evidence that supports that faith is extensive and compelling and yet conceivably erroneous. It is shot through with uncertainty, unanswered questions, unresolved problems, and vague formulations."[120]

To sum up, I took the grand features of scientific progress to be:

(1) That inquiry is done in a community;

(2) That the community of inquiry has the scientific attitude described above;

(3) That inquiry is *self controlled*.

The scientific attitude discussed at length in the first half of this chapter is shown to be the most important of these grand features, as plays a role in developing the other two. One who wants to learn will come to a self-controlled inquiry, trying to do all they can to improve their

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logic has had time to control conclusions. Everything thus depends upon rational methods of inquiry. They will make that result as speedy as possible, which otherwise would have kicked its heels in the anteroom of chance."

[119] For more on the importance of self control see: CP 1.107, 1.43, 2.144, 2.204, 2.209, 4.476, 4.540, 5.130, 5.461, 7.276, 7.277 and 7.346, among others.

[120] Short (2009), 347.

methods. (History is, of course, a vast source of methods of inquiry.) In this effort, the self-controlled inquirer will recognize the benefit and necessity of inquiring as a community.

The importance of inquiring as a community is hard to overstate. Truth is something to be attained in the long run, not necessarily in the lifetime of any given individual inquirer. For this reason, each inquirer is trusting in future inquirers to carry on their work. A scientific community has a responsibility to future communities to provide ideas which are most susceptible to growth. Growth here is synonymous with progress, and can take on a number of forms. The history of science provides a choice window into the passing of the torch from one generation of inquirer to the next.

The grand features of scientific progress are a self-controlled generation, articulation and examination of scientific hypotheses, theories and ideas, undertaken by a community determined to discover the truth and to help future communities do so.

We have seen some of the motivations behind Peirce’s philosophy of science, and that history is an important component of a well-informed philosophy of science because it reveals the grand features of scientific progress. The next chapter examines how to use Peirce’s philosophy of science to excavate truths from the past and of how to find the features of scientific progress in a historical study, looking to Peirce’s writings on history and historiography to do so.

CHAPTER 3

"The use we should desire to make of ancient history is to learn from the study of it, and not to carry our preconceived notions into it."

–On the Logic of Drawing History from Ancient Documents

In this chapter I discuss Peirce's scientific approach to historical inquiry. This discussion draws largely from the 1901 paper, "On the Logic of Drawing History from Ancient Documents, Especially Testimonies". "On the Logic" has a history of its own, as it developed out of multiple drafts of a paper requested by the Smithsonian Institute, written in April and May of 1901.[121]

Peirce originally asked S.P. Langley, the Secretary of the Smithsonian Institute, if he could write an article for them on the nature of scientific reasoning. Langley requested that Peirce instead write on how the idea of laws of nature had changed since the time of Hume. Langley believed Hume's essay "Of Miracles" caused a great change in how laws of nature were understood and wanted Peirce to connect Hume's essay on Miracles to the understating of laws of nature since that time (1748).[122] Peirce, though "far from charmed with the subject" completed a draft in under a week.[123]

Langley was unhappy with this draft, and requested that Peirce include a history of how the term "Law of Nature" was understood by the common person since the time of Hume. Peirce incorporated this history, also discussing what he called Hume's "theory of balancing

[121] The account of this history is taken from Peirce's correspondence with S.P. Langley, in VUC, 275-289
[122] Hume (1748), Section 10.
[123] VUC, 277, 281

likelihoods", taking it to be the theory Hume was making use of in his essay on miracles. Peirce critiqued Hume's approach, contrasting it with his own "logic of hypotheses" (likely the theory of scientific reasoning he initially wanted to write on). This critique emphasized the importance of three types of inference he viewed as essential to science: Abduction, Deduction and Induction. This draft, entitled "The Proper Treatment of Hypotheses" was dismissed as being too difficult to read.

Peirce tried a final time to complete the article requested of him, writing "Hume on Miracles and Laws of Nature". However, he had a hard time writing it as, to his understanding, "*Hume's argument has nothing to do with the Laws of Nature*. That is the difficulty".[124] Peirce took this to be the case because Hume's argument rests on balancing the probabilities of testimonies, as opposed to any metaphysical notion of laws of nature (which is what Langley was interested in). Langley disagreed, and published his own "Laws of Nature" instead of any of the drafts provided by Peirce.

However, Peirce's work on the topic laid the groundwork for "On the Logic of Drawing History from Ancient Documents". The paper is 150 typed pages, and covers: a critique of Hume's "theory of balancing likelihoods"; a critique of contemporary historical critics, who used the same basic approach as Hume; a sustained, detailed account of his own logic of hypotheses as a more scientific approach to studying history; and finally, three case studies of his own method being put to use.

In this chapter I illustrate Peirce's approach to historical inquiry, defending the idea that history can be approached as a science. I begin by showing that Peirce really did think of history

[124] VUC 286, original emphasis.

as a science. This is made clear by the inclusion of History within Peirce's classification of the sciences, the Architectonic. I then go over the "logic of history" as described in "On the Logic", as well as explaining Peirce's critiques of his contemporary historical critics.

HISTORY AS A SCIENCE

After Langley's "Laws of Nature" appeared in the Smithsonian Review, Peirce wrote him again, requesting "employment for a few months" to write on his architectonic classification of the sciences.[125] It is with a brief overview of this classification that I begin this chapter, as it shows that Peirce believed history should be studied as a science.

THE ARCHITECTONIC

The Architectonic is a way of organizing different pursuits of knowledge in a way that shows their relation to one another. It is important to once again note that these pursuits of knowledge are understood as activities, not systems of facts or theories. As Peirce viewed science as a living thing, growing with the inquiries that composed it, so too was the architectonic supposed to grow as science advanced. Peirce expresses his hopes for the architectonic in a rather grandiose passage: "for a long time to come, the entire work of human reason, in philosophy of every school and kind, in mathematics, in psychology, in physical

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[125] VUC, 287

science, in history, in sociology, and in whatever other department there may be, shall appear as the filling up of its details."

These 'pursuits of knowledge' whose details will be filled out are defined first broadly and then specifically. Broadly, they are divided up by how they advance science. Peirce divides them into the Sciences of Discovery (the most closely tied to inquiry and progress), the Sciences of Review and the Practical Sciences (the least). The Sciences of Discovery take the forefront in the pursuit of knowledge, trying to learn new things about the world. The Sciences of Review are those "in the business of … arranging the results of discovery."[126] The Practical Sciences are things like gold-smiting or navigation.[127] Peirce puts very little emphasis on these sciences. For, as we have seen above, pursuing practical ends will arrive at truths, but only a limited set of them.

These groups are further subdivided by their subject matter. For example, math involves inquiring into the nature of purely hypothetical objects; philosophy involves inquiring into general experience of the world; the subsequent sciences require special sorts of observation and this determines their subject matter (astronomy looks at stars and botany looks at plants, etc.). This is what separates types of inquiry. The physical sciences (physics, chemistry and biology) have a different subject matter than the psychic ones (linguistics, sociology and history), etc.

These divisions are *organized* by the way in which they loosely depend on one another. For example, the reasoning in math is quite general, and depended on universally, so it has the

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[126] CP 1.182. Building the Architectonic belongs to this grouping, as does the Philosophy of Science.
[127] Peirce gave a very long list of practical sciences, which the editors of CP abbreviated down into "pedagogics, gold-beating, etiquette, pigeon-fancying, vulgar arithmetic, horology, surveying, navigation, telegraphy, printing, bookbinding, paper-making, deciphering, ink-making, librarian's work, engraving, etc." CP 1.243. I am personally glad that the editors left "pigeon-fancying" on the list.

most fundamental position. Logic is close behind. Further, since one cannot make a specific observation without having general experience, all of the physical and psychical sciences depend on philosophy. The sciences of review classify and sort the discoveries of the sciences of discovery, and so are less fundamental. Etc.

The Architectonic is very rich, and a full review of its motivations and structure is beyond the scope of this thesis.[128] I want to give just enough of a sketch of it to understand where history fits within it and the implications of this position. History is one of the Sciences of Discovery; particualrly, it is of the third type of Science of Discovery, Idioscopy (Peirce's word for 'special science'). Idioscopy has two wings, the Physical and the Psychical. History is one of the Pyschical, Idiosopic sciences.

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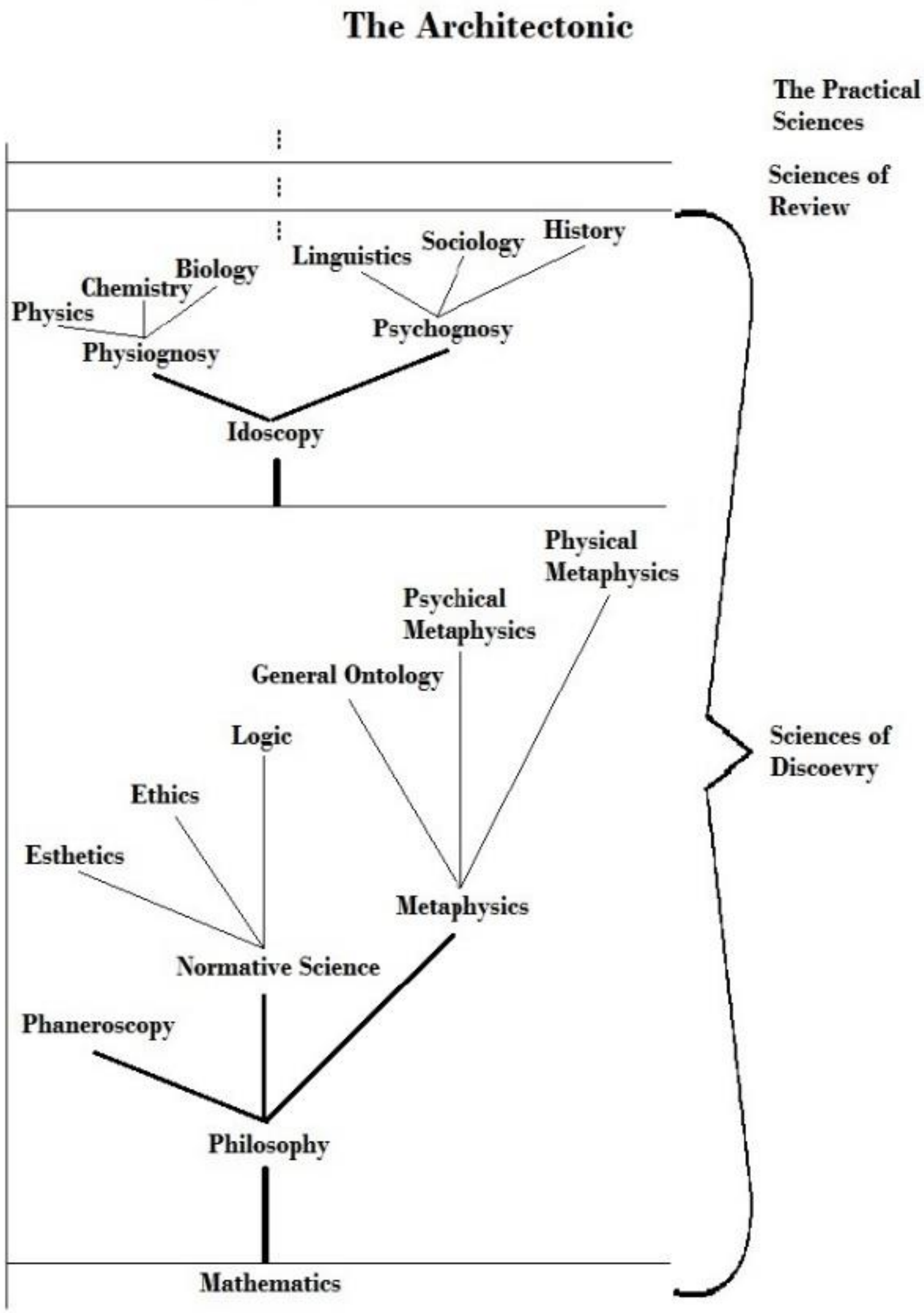
[128] Inspired by Louis Agassiz's biological classification, Peirce further divides sciences into Branch, Class, Order, Family, Genus, Species and Variety. CP 1.229-230.



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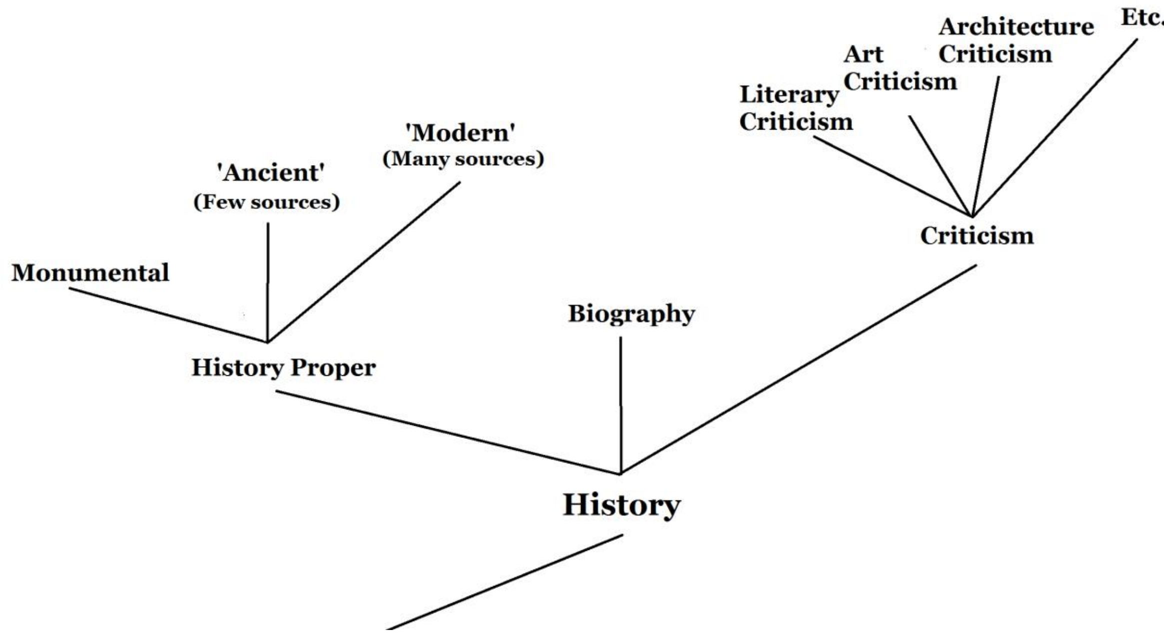
129 This chart is somewhat simplified. The architectonic developed in complexity throughout Peirce's life, with revisions coming as late as 1911, three years before his death.

History itself is split up into three types: History Proper, Biography and Criticism. History Proper is split up according to the type or amount of evidence available for investigation. Namely, Monumental, History with Few Sources (which tends to be ancient) and History with Many Sources (which tends to be more modern).[130] These are the types of historical evidence Peirce discusses in "On the Logic", and which I look at below.



Finally, (for my purposes) each of the methods of History Proper is divided by the subject it might study. Those subjects are: Political History, History of the Different Sciences, and History of Social Developments.[131]

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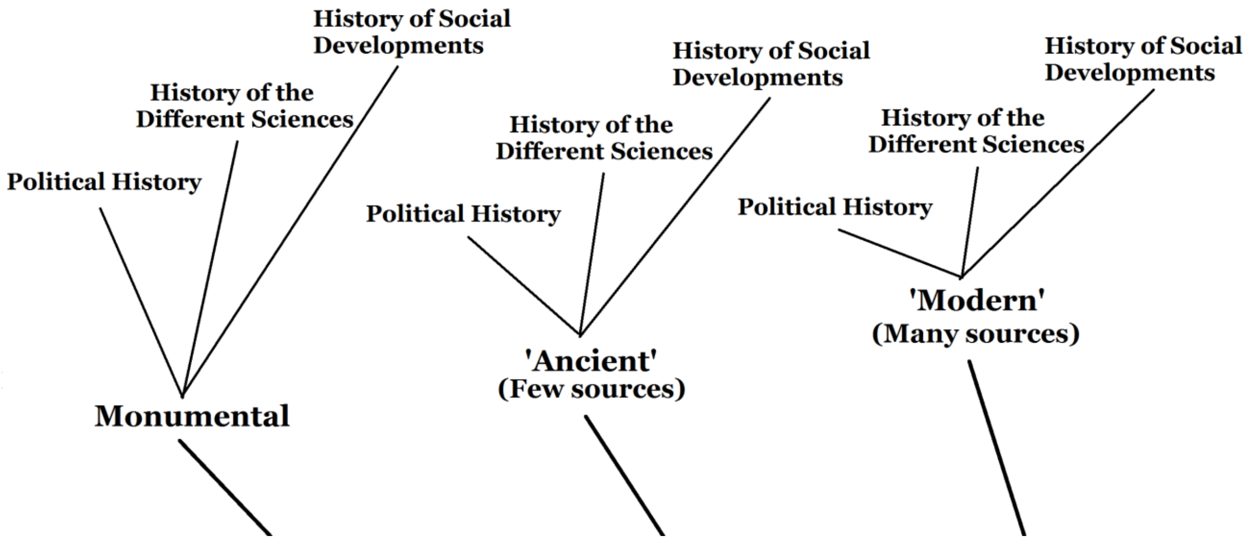
[130] CP 1.201. Monumental history works together with testimonial history. Reference to monuments ought to appear in relevant texts, and if a text mentions monuments, those monuments should leave some archeological record. Monumental history is concerned with "hypothesis [which] would render the present existence of a monument probable, or would result in giving a known monument a certain character; that if… true, certain ancient documents [would] contain some allusion to it." CP 7.231
[131] CP 1.201



As such, we have located the position of the History of Science on the architectonic. First of all, it is one of the Sciences of Discovery. Secondly, it is less fundamental than Sociology, Linguistics, Psychology, and the Physical Idioscopic sciences. Further, it relies on principles from Philosophy and Mathematics.[132] While it informs the less fundamental sciences, those of Review and the Practical Sciences.[133] It is also separate from Biography and Criticism.

For my purposes, that positioning tells us the following about how history might be investigated into. It will use the methods of science. Namely, Abduction, Deduction and Induction, inference forms developed under Logic and discussed below. These methods are to be applied to extracting historical information from either monuments or testimonies, discovering something about the world. Further, it is separate from but close to developments in political or

[132] "The whole business of deriving ancient history from documents that are always insufficient and, even when not conflicting, frequently pretty obviously false, must be carried on under the supervision of logic, or else be badly done." CP 1.250

[133] For example, "the natural classification of science must be based on the study of the history of science" CP 1.268

social history. However, it is an entirely different endeavour from Biography or the various Criticisms.

It might seem strange not only that *history* should be considered a science, but that activities ranging from mathematics and logic to goldsmithing and ink-making are also included. I will give a quick explanation of why Peirce has such a wide conception of science before focusing on history specifically.

As we have seen, Peirce's primary interest is in investigating those practices which lead to true beliefs. In a word, this explains why his notion of science is so broad. However, he also thinks the sciences share the same *general*, self-controlled inferential procedure, which I discuss in the next section. Every science, from mathematics to the practical sciences, follows this procedure.

In mathematics, one makes inferences based on observed diagrams.[134] Interestingly, these observations do not have to be external: imagining a proof or doing mental sums count as observing diagrams. The method also applies to the practical sciences. Take a mechanic. They are confronted with the fact (presumably surprising to the customer) that a car will not start. They then begin their diagnostic by way of observation and simple hypothesis testing. Is the problem electric? If so the other electric systems will be impacted, but they work normally. Is the problem mechanical? If so the mechanism engaged by the turn of the key might be malfunctioning somewhere along the line. They can check the components of this mechanism to

[134] Symbols (like those comprising an equation) also count as diagrams for Peirce. For a discussion of Peirce's notion and use of diagrams see Shin (1995) and Shin (2002).

find the problem and then use the same way of thinking to fix it. As such the practical sciences still make use of the general inferential procedure of science.[135]

The following section describes the way in which history functions as a science in the same way as others named in the Architectonic. Namely, by making use of the three forms of inference Peirce thought essential to science, abduction, deduction and induction.

THE LOGIC OF HISTORY

Peirce believed any scientific work had to proceed through three stages of inference: abduction, deduction and induction. These stages of inquiry comprise the method Peirce believed to best lead us toward the truth. As such, in examining Peirce's logic of history, I begin with the first of the grand features of scientific progress, self-controlled inference.

I focus on the importance of abduction. Abduction is the form of inference that is responsible for the formation of hypotheses, the purpose of which is to explain away a surprising experience. As such, the next subsection looks at what makes an experience surprising, and when such a surprising experience calls for explanation.

In answering these questions, we are brought again to the grand features. It is not enough to engage in a lone, self-controlled inquiry. I argue that community has a vital role to play in determining when a given experience is worthy of explanation. What surprises one person might

[135] In Chapter 2, science was separated from practical benefits because pursuing only practical benefits will discover only practical truths, but science is interested in finding *every* truth. The practical sciences have a place on the Architectonic because of course practical truths are still truths, and so belong to the content of science.

not surprise another; what Peirce is most interested in is the experience of an individual which is surprising from the standpoint of a scientific community. The following section discusses how history *makes use* of historical hypotheses. I show that, similar to any other science, historical hypotheses make predictions, to be supported or refuted by future evidence.

INFERENCE AND EXPLANATION

Peirce defines three types of inference, all logically distinct and important for science. They are abduction, deduction and induction. The majority of this section will be about explaining Peirce's idea of abduction, as it has the primary role to play in explanation. Put simply, abduction is the proposing of a hypothesis; we use deduction to clarify that hypothesis and to trace its consequences in the world; then, finally, we use induction to test for those consequences. (In a historical context, these consequences will be related to historical monuments or testimonies.)[136]

To be more specific, abduction is the first step in scientific inquiry. Once a surprising observation has been made the inquirer tries to come up with hypotheses that would explain it. There is a discussion on explanation below, but essentially, the goal of a hypothesis is to put forward a proposition that, if accepted as true, would render the surprising fact unsurprising. Once this hypothesis has been put forward, the inquirer makes use of deduction to clarify exactly what is meant by the hypothesis and to determine what its consequences upon the world ought to

[136] CP 7.85

be. The final stage of inquiry makes use of induction. The inquirer uses induction to test the world for those consequences predicted by their deduction.

Logically, the three forms of inference can be explained as rearrangements of the Barbara syllogism.[137] Deduction is just the standard form of Barbara. There is a general rule, and in noting an individual case that fits under this rule, we can deduce that the result follows necessarily:

Rule	All the Beans from bag A are white.
Case	These beans here are from bag A.
Result	∴ These beans here are white.

Induction makes use of an individual case (or sampling of cases) as well as a rule to try and predict a result:

Case	These beans here are from bag A.
Result	Those same beans are white.
Rule	∴All of the beans from bag A are white.

[137] The following examples are from W3, 325-26. Peirce's interest in the Barbara as a paradigm case seems to have two main sources. The first is that he believed all other forms of syllogism could be rearranged into Barbara (W1, 308). The second is that Peirce had a standing interest in statistics and chance (one which grew to define a major aspect of his mature philosophy—tychism), and in rearranging forms of Barbara, one could infer from or to conclusions about samples of populations.

Abduction is different still. Staying within the language of Barbara, it takes a Result and a Rule and tries to guess at a case that makes sense of them. The conclusion here does not follow from the premises; it is something added to the premises in order to connect them:

Rule	All of the beans from bag A are white.
Result	Those same beans are white.
Case	These beans here are from bag A.

I focus on abduction here, as it has the primary role to play in explanation. I say that abduction has the *primary* role to play in explanation because, for Peirce, an explanation is just a hypothesis that would account for whatever it is that needs explaining. In Peirce's words, abduction is just "the operation of adopting an explanatory hypothesis."[138]

To understand what makes a hypothesis explanatory we have to recall when a hypothesis is called for in the first place. To put it simply, an explanatory hypothesis is called for when we are surprised. However, not every surprise calls for an explanation. The need for an explanation depends on two things: (1) an inquirer should be surprised at a fact *within a relevant network of facts*. And, (2) it is not the extent to which an inquirer is surprised that determines the need for explanation, but whether that inquirer's experience would surprise the wider scientific community. I will explain these points in turn. But first, it is helpful to explain the emphasis Peirce puts on *regularity* when discussing these points.

[138] CP 5.189

Regularity plays a crucial role in whether something calls for an explanation. Recall that the purpose of science is to discover what is regular about the world, to get our expectations to align with the way the world regularly works.[139] We have no need to explain the irregular. This is because we only desire an explanation when our beliefs (or scientific opinions) are shown by experience to be incorrect; and as it is we can only expect regularities. Peirce gives a quick illustration of the life that might result were we to try and expect irregularities: "In what a state of amazement should I pass my life, if I were to wonder why there was no regularity connecting days upon which I receive an even number of letters by mail and nights on which I notice an even number of shooting stars!"[140]

As such, the only cases where we call for explanation are (1) when there more regularity than we expect (10 coin flips in a row come up heads—perhaps the coin is rigged) or (2) when there is less (this tree produced fruit for the last few decades, why has it not produced any this year?).

What *never* calls for explanation is irregularity itself. We do not need an explanation for why there is no pattern in 100 die throws. Or, for example, consider the arrangement of trees in a growing forest. It turns out that as a forest grows the new trees do not adhere to a pattern (aside from being within a certain distance of the parent tree). So, "if [I] were to expect that an attentive observation of a forest would show something like a pattern, then there is nothing to explain except the singular fact that we… anticipated something that has not been realized."[141] There is

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[139] Recall from Chapter 2 that the meaning of beliefs (and scientific opinions) is a predictive conditional that makes a claim about something acting regularly.
[140] CP 7.189
[141] CP 7.195

no need to explain why a forest grows without a pattern. There is nothing to explain about the *forest itself*, but we might have to explain why I thought there would be a pattern.[142]

To the first point, above, we also do not ask for an explanation of a fact in isolation.[143] Contrary to this, Peirce argues that something calls for explanation only when connected to other facts—namely, only when connected to other facts that, taken together, would lead you to expect the contrary of the fact in question.[144] For example, the fact "My car is in my driveway" does not need explanation. But, if you also know "I leant my car to Mary last week", "Mary is on a trip to Edmonton", and "Mary's trip is scheduled to last three weeks", then your car in your driveway is surprising, and demands explanation.

This raises the second point, that Peirce should *not* "be understood [as making] the strength of an emotion of surprise the measure of a logical need for explanation."[145] A surprise signals that there *may* be need for explanation, but what *determines* that need is by asking "in what way explanation subserves the purpose of science."[146]

The goal here, the purpose of science, is to render the surprising phenomenon predictable.[147] Again, "an explanation is positively called for, [in] the case in which a

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[142] CP 7.195 "In such a case we straightway commence reviewing our logic to find how our error is to be explained." If we had good reason to expect that the forest would grow into a pattern, then the discovery of its irregularity can call our reasoning into doubt. But it does not ask us to "explain" the irregularity of the forest.
[143] CP 7.198
[144] CP 7.198

[145] CP 7.190
[146] CP 7.192. Notice that this is in line with the need for science to separate itself from practical life, explained in Chapter 2. Things that are very familiar can call for scientific explanation. Peirce talks of "cognitive surprise." For example, given all you know about geometry, it may "cognitively surprising" that space is three-dimensional, even though you have never had an experience to the contrary. CP 7.197: "In this last case [of three-dimensional space], the emotion of surprise is not felt, because the cognitive part of the mind must be uppermost in order to recognize the rarity of the phenomenon."
[147] And, with the scientific attitude, to render potentially surprising phenomena predictable as well.

phenomenon presents itself which, without some special explanation, there would be reason to expect would *not* present itself; and the logical demand for an explanation is the greater, the stronger the reason for expecting it not to occur was."[148]

Surprise, then, serves as a signal that investigation might be necessary, but not in every case. For example, it might seem *prima facie* improbable that Gaius appointed his horse to be a Roman Consul, and so testimonies claiming such would be surprising. But whether this surprise ought to spur an investigation depends on the background facts which *make it* surprising. If a testimony about Gaius surprises you as a Gaius scholar, with all you know about his life and Roman history, then your surprise is likely based on facts logically connected to the testimony. The testimony is thus unexpected and worthy of investigation. If your knowledge of Gaius suggests the otherwise surprising fact (say, that he loved horses, was mentally unstable, and gave power to his friends) then the testimony is rendered unsurprising and the need for investigation into the testimony is lessened. Also, if you find the testimony surprising given a set of logically unrelated facts, say that you never knew a horse elected to Canadian government, then the need for investigation is slight.[149]

The point here is that the progress of science is not concerned with every surprise; it need not be concerned with what surprises the uninformed inquirer. Instead science moves forward when a phenomenon is surprising given the current state of scientific knowledge. And this knowledge is held by a community as a whole, not by any one scientist. In this way, community is shown to be essential for explanation. And it is for this reason that the scientific attitude

[148] CP 7.194
[149] It is the role of deduction to decide how a given hypothesis (abduction) logically relates to other facts. In this way, if the critics do try and explain rather than dismiss a surprising fact they will be making perfectly good abductions. However, upon analysis they will likely be shown to be irrelevant.

requires one to recognize the importance of community in their conception of science. Such a conception is *designed* to root out unconscious influences of inquirers, "the vagaries of you and me". As celebrated Peirce scholar Max Fisch puts the point:

> "[Objectivity] is guaranteed not by the psychology or logic of the individual historian, but by the institutions of historical scholarship themselves, by the orderly procedures of review in the journals, by the ethics of bibliographic citation, by indexes, catalogues, bibliographies, reference works of all sorts, which protect the historian against involuntarily ignoring anything relevant to this undertaking, and provide ready means for calling him to account when he does." [150]

This brings us to a final point on this topic. Namely, that a historian has to try and explain *all* the facts they are presented with. Part of this requires the historian to begin by assuming that testimonies are true. Something calls for explanation if it is out of place given those facts logically related to it. If we do not begin by *accepting* historical testimonies, then there is little else to compare them to. And if a testimony seems odd, even to the point of being prima facie incredible, that invites investigation, not outright dismissal. "It is not sufficient to say that testimony is not true, it is our business to explain how it came to be such as it is."[151] As Peirce puts it:

> "Underlying all such principles [that guide us in choosing a hypothesis] there is a fundamental and primary abduction, a hypothesis which we must embrace at the outset, however destitute of evidentiary support it may be. That hypothesis is that the facts in hand admit of rationalization, and of rationalization by us."[152]

[150] From Fisch (1959), 167-168. Reprinted in Tursman, (Ed.) (1970).
[151] CP 7.225
[152] CP 7.219

Predicting Historical Evidences

History observes monuments, testimonies or other historical texts, and examining these sources raises questions for the historian: for example: “Did Gaius really grant his horse a seat in the Roman government?” As discussed above, the way to try and answer these questions is with a hypothesis that would explain whatever it was that was curious in the source. The way to test a hypothesis is by determining its consequences and testing for them. How do we do this in history?

The predictions of a historical hypothesis can be supported either by way of fitting with other historical evidence or by making predictions that we can attempt to verify now or in the future. For example, if Shakespeare is said to have been married at Stratford-upon-Avon, then we ought to be able to find a marriage license in the historical record. Secondly, if a testimony gives clues to the location of a lost city we could now or later go and check for evidence of such a city. In Peirce’s words: “hypotheses in history are able to meet the general conditions for verifiability”, namely, that they imply "a ligament of numberless possible predictions concerning future experience, so that, if they fail, it fails."[153]

This raises a question. An early formulation of Peirce’s pragmatic maxim implied that a diamond was not hard unless scratched;[154] Is it similarly true that a historical episode did not happen unless it can be brought to the test? It goes without saying that there are historical episodes that were not recorded by those taking part in them; or that there were buildings built

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[153] CP 5.597
[154] How to, CP 5.403

that we cannot detect. How does Peirce's philosophy of science deal with these, as he called them, "buried secrets"?

The answer to this question concerns the "ligament of numberless possible predictions" mentioned above, as well as the role of hope in science. The thought is, first of all, any past occurrence will impact the world in an unlimited number of ways, most of which we are probably not currently sensitive to; but just because we are not currently able to detect certain historical events does not mean that we will never be able to. This is where hope is a relevant factor. "History would not have the character of a true science if it were not permissible to hope that further evidences may be forthcoming in the future by which the hypotheses of the [historians] may be tested." [155] The scientific attitude requires inquirers to hope that they or their intellectual ancestors will someday be able to find and make use of all the evidence which is possible to find. Thus, we have hope that the buried secrets will be uncovered. Peirce gives the following example:

> "Now, the facts which serve as grounds for our belief in the historic reality of Napoleon are not by any means necessarily the only kind of facts which are explained by his existence. It may be that, at the time of his career, events were being recorded in some way not now dreamed of, that some ingenious creature on a neighboring planet was photographing the earth, and that these pictures on a sufficiently large scale may some time come into our possession, or that some mirror upon a distant star will, when the light reaches it, reflect the whole story back to earth. Never mind how improbable these suppositions are; everything which happens is infinitely improbable. I am not saying that these things are likely to occur, but that some effect of Napoleon's existence which now seems impossible is certain nevertheless to be brought about."[156]

[155] CP 5.597. I changed the word "critics" to "historians" to follow how I use the terms below, when discussing the high critics.
[156] CP 2.642

The idea of a potential space-mirror is a fanciful, but the point it makes is important. I would like to offer the following example of a development in historical inquiry in order to (literally) bring Peirce's point down to earth. This example is found in recent studies of ancient Roman history. Mary Beard outlines how we are able to learn things about ancient Roman economics that were previously thought to be lost to history by re-examining a form of evidence we have had access to for millennia.[157] Namely, how we can look at Roman coins to learn something new about the ebb and flow of the Roman economy.

Roman coins were made by hammering a die (an impression made of some hardened bronze or iron) into a heated piece of softer metal (often bronze or silver); this would imprint the image on the die into the coin. As the dies take the bludgeoning of creating many coins, the image produced by the die will become less and less crisp. Scholars are able to estimate how many coins a die could create before becoming too blunt to use. And, due to the differences between the individual dies, we can also determine how many dies were used in a given year. This, in combination with the store of coins we have today, can give estimates of how many coins were cast in a given period. This gives a view of the Roman economy as a whole that was otherwise invisible unless records were kept. As such, this new method of looking at long-held evidence can offer insight into an aspect of historical life that was previously very difficult to access. Susan Haack gives another example of ingenuity leading to new historical discoveries.[158] Namely, that ancient historians have started to use a breast cancer detection device in order to read "postcards" written by Roman soldiers.

[157] Beard (2015), 45
[158] Haack (2003), 109.

This brings us to a peculiarity of Peirce's scientific approach to history. Namely, that history must be forward-looking.[159] Of course, the evidence used by historians makes its way to us from the past, but insofar as they are hopeful that their hypotheses may be confirmed they must look forward:

> "As for that part of the Past that lies beyond memory, the Pragmaticist doctrine is that the meaning of its being believed to be in connection with the Past consists in the acceptance as truth of the conception that we ought to conduct ourselves according to it (like the meaning of any other belief). Thus, a belief that Christopher Columbus discovered America really refers to the Future."[160]

The above sections describe the way in which Peirce believes we ought to inquire into history. In noting when an observation is surprising to the historical community as a whole, historians can start formulating hypotheses that would explain that surprise. Then, the predictions made by that hypothesis can be tested for in the present day (and days yet to come). Peirce distilled his method into six rules for the historian:

1. That a hypothesis should try to explain all the related facts (even if they appear improbable). (Abduction)
2. You should start from the hypothesis that the historical testimony is true. You need a good reason to hypothesize that a testimony is false. (the "fundamental and primary abduction".)
3. You can make appeal to probabilities that are both objective and of a high degree of certainty, but not otherwise.[161]

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[159] For discussion on this topic, see Brunson (2010). Brunson also looks at "On the Logic" and we draw similar conclusions, but have done so independently.
[160] VUC, 222
[161] "Let it be clearly understood, then, that what I attack is the method of deciding questions of fact by weighing, that is by algebraically adding, the feelings of approval produced in the mind by the different testimonies and other

4. You should split a hypothesis up into as many items as possible so as to test each one separately. (Deduction)
5. If you don't know which of two hypotheses to choose from, you should enlarge the field of facts which they are to explain and see if that gives precedence to either. (Abduction and Deduction)
6. If you have to test hypothesis A in order to test hypothesis B, then all other things being equal, we should prefer hypothesis A to some third hypothesis, C, that would require extra work in order to test. (Induction, and the Economy of Research, mentioned above.)

It is with these rules in mind that I turn to Peirce's critiques of the German "High Critics" of his day, inspired (as Peirce took them to be) by the Humean "theory of balancing likelihoods". We see that the main issue with how they inquired into history is that they were too subjective. In lacking the scientific attitude, they also neglected the importance of community and self-controlled inquiry.

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arguments pertinent to the case. I acknowledge that this method is supported, under abstract conditions, by the doctrine of chances, and that there are cases in which it is useful. But I maintain that these conditions are not often even roughly fulfilled in questions of ancient history; so that in those investigations it commonly has no value worth consideration." CP 7.170

MIRACLES AND MATH

This section covers Peirce's critique of the theory of balancing likelihoods presented in the beginning of "On the Logic". In the introduction to this chapter I went over the history of "On the Logic", emphasizing that it was in part borne out of a critique of Hume's "Of Miracles". It is important to note this context because, of course, there is no philosopher who has better claim to also be a historian than Hume.[162] The Hume characterized here by Peirce seems to be framed by his theory of miracles, not his wider historical works. This should be kept in mind through discussions of the theory of balancing likelihoods. [163]

A basic rehashing of the theory of balancing likelihoods is as follows: When a historian encounters a testimony that seems improbable to them, they consider all the arguments they can think of for and against the truth of that testimony, assign them each a probability. Then, having done the math, decide whether 'true' or 'false' has more credence. This is a form of pseudo-scientific reasoning that Peirce believes is likely to occur when one gets their hands on a small bit of scientific machinery (in this case, a weak understanding of probability).[164]

Peirce believes some of his contemporaries, the German 'high critics', used this general approach as well. However, their case is complicated by the fact that they are also interested in proving historical certainties. They try to conduct their historical inquiry "with the necessity of a mathematical demonstration".[165] Peirce also describes these critics in a way that looks like he is

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[162] It is interesting to note that Hume here is an interesting contrast from Peirce. While Peirce insist that history and philosophy support one another, Hume's best-selling historical work seems to be separated entirely from his philosophy.
[163] I do not here assess whether this theory is actually accurately attributable to Hume.
[164] CP 7.177
[165] CP 7.167

accusing them of studying in the literary spirit, as discussed in Chapter 2. Namely, they claim to prefer the less probable explanation (as it is less likely to have been invented by the historical figure), however they still reserve the right to veto a reading which is not certain enough for them. As such, “They are thus provided with two defences against historical testimony. If the story told appears to them in any degree unlikely, they reject it without scruple; while if there is no taint of improbability in it, it will fall under the heavier accusation of being too probable; and in this way, they preserve a noble freedom in manufacturing history to suit their subjective impressions.”[166]

Peirce offers six criticisms of this view. However, I want to focus on the one just mentioned: that the theory of balancing likelihoods relies too heavily on *subjective impressions*.[167] As we have seen, a historical criticism begins when a critic encounters something which they believe to be unlikely. They then assign probabilities to arguments for and against this occurrence and do the math. If the conclusion comes out certain enough for them they accept it, if not, it is rejected.

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[166] CP 7.167

[167] I list the six here. I am focusing on the third, but they are not sharply divided.

1.) It's not natural. People naturally are satisfied with a testimony until proven otherwise.

2.) Testimonies are not independent, from each other or the likelihood of the story told. But the theory of balancing likelihoods requires independence.

3.) People don't know what probabilities are in the full scientific sense. They take a probability more to be what agrees with their preconceived notions. In this sense the approach is literary.

4.) It doesn't matter if a person has a history of giving false accounts, he only gives the account once, and so his history does not bear on the truth of a given testimony. (Peirce has a view of the uselessness of using probability for events that only happen once. See CP 2.652)

5.) Further to (3): The scientific sense of reasoning with probabilities is mathematical, and math is about reasoning with known facts. It cannot amplify knowledge.

6.) We don't have any good laws of psychology where math can help us (like it can with our laws of physics helping astronomy).

This is obviously problematic. And for Peirce, it is detrimentally so, as it is looking to history with the entirely wrong aims. As he puts it: “the use we should desire to make of ancient history is to learn from the study of it, and not to carry our preconceived notions into it, until they can be put upon a much more scientific basis than at present they can."[168] The theory of balancing likelihoods is problematically subjective at three stages: (1) It is subjective what some critic will find unlikely, (2) the probabilities the critic assigns to the argument do not seem to have any objective foundation, and (3) it is up to the critic to decide if the math comes out to a high enough level of certainty for them to accept the testimony. By “probability” we ought not to mean “the degree to which a hypothesis … recommends itself to a professor in a German university town” for if we do “then there is no mathematical theory of probabilities which will withstand the artillery of modern mathematical criticism.”[169]

As such, the theory of balancing likelihoods is pseudo-scientific, as it combines a scientific tool (mathematics) with an unscientific approach.[170] As Peirce puts it: “The theory of probabilities has been called the logic of the modern exact sciences; … and therefore when a literary man learns that the method which he has been pursuing has the sanction of such a great mathematical doctrine, he begins to feel that he is a very scientific person.” His claim is that by using probability theory a literary inquirer allows themselves to feel legitimately scientific.

A further issue is that these critics somehow also feel as though they should be discovering historical certainties, and try to use mathematics—a form of inquiry that can result in

[168] CP 7.181
[169] CP 7.177. See also CP 6.536: “[A]lthough we can have no knowledge of ancient history independent of Greek (and Latin) authors, yet the critics do not hesitate utterly to reject narratives attested sometimes by as many as a dozen ancient authorities—all the testimony there is, at any rate—because the events narrated do not seem to persons living in modern Germany to be likely.”
[170] CP 7.177. “Pseudo-scientific” is my term, not Peirce’s.

certainty—to bolster their claims. There are two problems here. The first is that it is part of their "two defences against historical testimony" mentioned above. The second is that this is an improper use of mathematics, as Peirce makes clear with an analogy between history and astronomy.

The analogy is as follows. Astronomy is the science that looks deep into the physical past, by looking at far off stellar bodies. History is analogous as it looks deep into the mental past (since by looking at testimonies of writers we are engaging with their thoughts). However, Peirce claims that even when you look at the role of mathematics in astronomy, you find that it still does not allow astronomers to make demonstrative conclusions. This is despite the fact that astronomy is largely connected with physics, a well-developed science where many laws are known with some accuracy. History, insofar as we are looking at how credible the testimonies of individuals, is governed by psychology. And psychology is not nearly as well developed as (that is to say, does not have as many laws as) astronomy. And so, contra the critics of his day, we should not expect to be able to use math for demonstrative conclusions in history.

Some Examples

In this section I look at a few examples of the bad reasoning of the high critics. I begin with two from "On the Logic" which remind us that we ought to take testimonies seriously. And even when a testimony is incredible, we must at least explain why such incredible testimonies are being made. I then turn to some examples from Peirce's writings on history. These concern a series of bad hypotheses made about the Great Pyramid of Giza. The hypotheses are bad not only because they are easily refutable, but also because the facts they are intended to explain do not call for explanation.

In “On the Logic” Peirce gives two examples of critics rejecting testimony off hand. The first is the testimony that Pythagoras had a golden thigh. The second is that Thales fell into a well while looking at the stars. Peirce’s rules for historical inquiry require us to try and take these stories seriously.

For the case of Pythagoras’s thigh, Peirce remarks that we could dismiss it, had the testimony claimed “that the thigh of Pythagoras was a metallic gold to the centre while his lower leg and foot were solid flesh”. In that case, the testimony is too incredible to be considered as true. However, it is still the task of the historian to explain *why* such a testimony is made, and by so many sources, for “—It is asserted by Aristotle, of all possible authorities the highest, by both Porphyry and Jamblichus after Nicomachus, by Herodotus, by Plutarch, Diogenes Laertius, Aelian, Apollonius, etc.”[171]

Peirce attempts an explanation turning on a possible second meaning of “golden”. He says, “Nobody can think that the golden thigh was treated as a modern assayer would treat a gold brick. It was probably flexible and therefore its golden appearance was superficial. One of these days, we may find out something about the ancient Persians, Chorasmians, or Brahmins which may make this story significant.”[172] Here Peirce is both attempting to explain why such a testimony was made as well as reminding us that the future may cause us to see the story in a different light. For example, if we found the ancient Persians often describing athletes as

[171] CP 1.88
[172] CP 1.90

“golden” this would support Peirce’s hypothesis that Pythagoras’s thigh was called golden because it was desirably flexible.

Peirce’s second example of dismissed testimony from “On the Logic” is that of Thales falling into a well while stargazing. Peirce notes that this too is rejected by the high critics, because it is “utterly incredible that Thales should have been such an impracticable theorist”.[173] However, Peirce notes that the Greeks considered Thales “the first of the wise men”, and that eccentricity was “essential to the character of a philosopher”.[174] With these two other observations, Thales’s falling into a well seems rather unsurprising. And as such, we need neither ignore it nor be particularly concerned to explain it further.

Peirce’s writings on the history of science are also full of examples of deconstructing the reasoning of the ‘high critics’. Some of the best examples of this come from an early section, of both his lectures and his book draft, concerning writings on ancient Egypt, especially the Great Pyramid.

The Great Pyramid was a popular topic to write on at the time, but Peirce thought all but three of the works on the pyramid were prime examples of bad reasoning. As Peirce put it, “more learned foolishness has been written in recent about the great pyramid then upon all other subjects”.[175] I here look at four examples of this ‘high critic’ style of hypothesizing.

The first hypothesis is that the Great Pyramid was built for some purpose aside from that of a tomb. While it is possible that the Pyramid had other functions, the critics do not cite any

[173] CP 7.176
[174] CP 7.176
[175] Eisele (1985), 152. And, remarking on one of the theories about the Pyramid: “I should be somewhat tempted to pronounce this the absurdist theory ever broached, were not the same author’s other hypotheses about the pyramid instances to the contrary.” *Ibid.*

reason for supposing so. Peirce makes his view clear: “there is not the slightest reason to think that any astronomical, geodetical, physical, meterological or other scientific idea governed the construction of the whole or any portion of [the Great Pyramid].”[176] Further, given what we know about the Egyptian beliefs in the afterlife, and the importance of a tomb therein, the grandeur of a ruler’s tomb is to be expected.

The second hypothesis is that that the Pyramid was constructed to be placed at 30 degrees latitude. This is apparently hypothesized because the Pyramid lies nearly on that line of latitude. Peirce replies to this hypothesis in similar way. First, there is no reason to think any Egyptian was at all concerned with such a location. Secondly, as a different scholar noted, “It is certainly the finest site for miles on either side of it”.[177] Peirce adds, it was “very near the capital city of Memphis, on good solid ground, and with a convenient hill to build over.”[178] This is a more likely hypothesis. Again, once we know that the pyramid was built on a site that appears to be quite ideal for building a pyramid, the coincidence that such a site also happens to be near a line of latitude becomes unremarkable.

A third hypothesis that Peirce denies is that the entranceway to the pyramid is set up with a stellar goal. The basic premise he opposes is that the entranceway is set up so that, while standing in it, you can see the pole star during the daytime.[179] Peirce begins by studying whether you can see a star during the day time in virtue of being deep in a dark tunnel. To this end he visits Professor William Watson at the observatory of Wisconsin, Madison, who had dug a long

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[176] Eisele (1985), 320
[177] Eisele (1985), 320
[178] Eisele (1985), 320
[179] At the time, the pole star was not *Polaris*, but *Draconis*.

tunnel to attempt to view *Polaris*. Peirce could not see the star from the tunnel, and in discussion with Professor Watson he learned that no one ever had.

This is a blow to the hypothesis, but Peirce continues. When asked why the Egyptians would want to observe their pole star this manner, the critics answer that doing so would be useful for determining the azimuth. However, Peirce notes that such an observation would be quite useless for determining the azimuth unless the Egyptians also had a clock. He then provides an alternate hypothesis for how the Egyptians might have determined the azimuth. The details of Peirce's explanation are complex, and are not worth drawing out for such a small point.

Peirce's discussion of this hypothesis brings up a more general point, which is reinforced by Peirce's final discussion of the pyramid. Namely, when there is enough data you are bound to find coincidences. These coincidences should not be taken too seriously. It might seem remarkable that the pole star should be shining down the entrance of the Great Pyramid at the time it was built. But, when you consider that it could not be seen or made use of, this coincidence appears to be merely a coincidence. Peirce offers a simpler explanation for the slope of the entranceway: it was 1:2, which is very easy to build and transport a sarcophagus through. "What further explanation would any man of good sense have?"[180]

We now come to the fourth and final hypothesis about the Great Pyramid, another hypothesis from coincidence. The coincidence criticized is, that since certain ratios of angles on the pyramid can be related mathematically to produce a value close to π, the Egyptians must have built the Pyramid with knowledge of π.

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[180] Eisele (1985), 322

The support given for this idea is that the slopes on the pyramid are 51˚ 50′ and 51˚ 54′. If you take the cotangent of these slopes, you get the values 0.7860 and 0.7841. The average of these values is 0.7851. Now, it just so happens that $\frac{1}{4}\pi$ is equal to around 0.7854—a very similar value. The inference that Peirce wants to avoid is that, since we have derived a number very close to π from the Egyptians' results, the Egyptians must have been aware of this number.

This is bad reasoning, Peirce tells us, because it is always possible to find *some* relation between two numbers. He then immediately demonstrates this by deriving an important mathematical number (the Naperian base, 2.7182818…) from some relations between dimensions of the building.[181]

The first two hypotheses about the pyramid are rejected because they offer an incredible solution to a non-problem. Though it seems unlikely that the Pyramid's entrance lined up with the pole star's daytime position, this alone does not require an explanation. When we learn that the star could not be seen or used by the Egyptians, the hypothesis seems empty. The last two hypotheses are rejected for a similar reason. They are put forward to explain an unlikely coincidence that does not need explaining. The hypotheses of the high critics are made because they seem interesting or shocking, not because they solve a problem or even call for an explanation. This focus on what is interesting is a symptom of the literary style of inquiry. So too is the dismissal of those testimonies which do not seem plausible.

It is the task of the historian to explain historical evidence. Even if implausible, it should be accounted for. When a piece of historical evidence is surprising, that should signal to the

[181] Eisele, (1895), 152-153. In particular, he notices that the height of the pyramid divided by the height of the pyramid minus the semi-diagonal base is 5 times the Naperian base.

historian that it might be in need of investigation, not that it should be dismissed. However, not every surprise warrants investigation. The historian must check the surprising piece of evidence against what else is known at the time in order to determine the need for investigation. A community of historical inquirers making predictions and checking against one another and borrowing from other scientific disciplines allows history to grow and progress as a science, alongside each other science in the march towards the end of inquiry.

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Peirce's main philosophical work is centered around understanding inquiry, its methods and its aims, its expected results and possible limitations. This project is informed by the wide array of intellectual endeavours in which Peirce immersed himself—not least of which were logic, mathematics, various special sciences, and history.

Peirce's attempt to learn about how we learn about the truth provided him with a method to be employed and tested in every branch of inquiry, including history itself. We should approach learning about the past in the same general way we approach learning about the truths of anything else. A historical inquiry is a focused attempt to solve a particular problem, arising from surprising evidence. Predictions made in an attempt to explain surprising evidence can be tested against future experience, such that history is future-looking and constantly updating. Historians engaged in their own inquiries rely upon and critique each other, forming a community of inquirers focused on the same end.

These minute historical inquiries taken together form a mosaic. Especially regarding the history of science, a careful inquirer can examine this mosaic in an attempt to read off the curve of scientific progress. These features are not uncovered from a single case study, but rather are the results of Peirce's close examination of historical attempts at reasoning, trying to figure out what works. "That which [he] had at heart throughout his studies of the history of science was to gain an understanding of the whole logic of every pathway to the truth".[182]

We approach the truth so long as "favorable conditions continue; but man having a short life, and even mankind not a very long one, the question is urgent, How soon? And the answer is, as soon as a sane logic has had time to control conclusions. Everything thus depends upon rational methods of inquiry. They will make that result as speedy as possible, which otherwise would have kicked its heels in the anteroom of chance. Let us remember, then, that the precise practical service of sound theory of logic is to abbreviate the time of waiting to know the truth, to expedite the predestined result."[183]

Self-controlled, scientific study of history contributes to our understanding of the "rational methods of inquiry" and polishes the path of inquiry. As such, history plays a two-part role in Peirce's project. First of all, the history of science contains a wealth of historical inquiries from which we can learn. Peirce, like Whewell before him, conducts his history of science with this aim, in an attempt to learn about inquiry by examining and critiquing episodes from the history of science. Informed by history (as well as other investigations) Peirce is able to construct a general theory of inquiry, which itself can be applied to future historical investigations; we can again learn from these investigations and update our understanding of inquiry. And so on, science progresses.

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[182] CP 7.27n8
[183] CP 7.78

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