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## CHAPTER XX

### The Sources of Mill’s View of Ratiocination and Induction

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#### I. Introduction

By 1800, at least in the British Isles, logic in the old Scholastic sense was, as a scholarly discipline, nearly dead. Only at Oxford was it still a meaningful part of the curriculum but even there scholarship was slight and examinations were cursory.<sup>1</sup> Edward Copleston thought the decline had gone far enough when there was a move just after 1809 to replace Henry Aldrich’s already skeletal thirty-seven-page *Artis Logicae Compendium* (Aldrich, 1691) with Henry Kett’s new *Logic Made Easy* (Kett, 1809). Copleston and a few others complained not only about the shallowness of studies in traditional logic but also about the wholesale replacement of that topic with Baconian and Lockean epistemologies.<sup>2</sup> Copleston and his collaborators, especially his student Richard Whately, successfully revived a scholarly interest in logic in the early nineteenth century.<sup>3</sup> John Stuart Mill’s *A System of Logic: Ratiocinative and Inductive* (1843) was, as we will see, a part of the sweeping revival.

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Copleston and colleagues had to address two major challenges. One was an assault on the syllogism. In the seventeenth century, most notably in Francis Bacon's *Novum Organum* (1620),<sup>4</sup> there were criticisms that syllogistic logic was about words and not things and therefore hollow and corrupt. In the late eighteenth century there was increasing criticism that the syllogism committed the fallacy of *petitio principii*. The *petitio principii* charge states that the syllogism is fallacious because knowledge of the major "contains" or "presupposes" that of the conclusion.<sup>5</sup> Opponents also complained that the syllogism cannot lead to new knowledge.

The second challenge was that the widely admired Baconian induction simply did not fit into the slot allocated for induction in the Scholastic topology. In that topology, induction was, with the enthymeme and example, a minor sort of propositional inference, to be dealt with in a few sentences that showed how the inference was made valid by conversion to a first-figure syllogism. But Baconian induction was not as much a kind of propositional inference as a logic for identifying causal definitions and classifying thereby. A few logicians of the late nineteenth century tried to argue that Baconian induction and Aristotelian logic could be reconciled,<sup>6</sup> but to successfully do so would have required driving a wedge between a true Aristotelianism and Aristotle as the Scholastics understood him. The attempted reconciliation did not get far and mainstream English-language epistemology, as that of Thomas Reid and Dugald Stewart,<sup>7</sup> remained committed to Baconian induction as against Scholastic.

Richard Whately's *Elements of Logic*, published first in 1823 as two volumes in the *Encyclopaedia Metropolitana* then as a standalone volume in 1826, addressed both these challenges and more. The book went through fourteen editions. In the 1844 edition, Whately felt justified in taking credit for "[t]he revival of a study which had for a long time been regarded as an obsolete absurdity."<sup>8</sup> In the ninth edition, of 1854, Whately said—probably

without exaggeration—that the revival he attempted must have looked like trying to restore a fossil to life but that now the book was used in every one of the colleges in the United States.<sup>9</sup> In 1860 Auguste De Morgan said Whately deserved to be called the “restorer of logical study in England.”<sup>10</sup> In Mill's *Autobiography*, he reports having studied several works on logic.<sup>11</sup> Only Whately's was less than a hundred years old. Mill wrote a fifteen-thousand-word review of Whately's “excellent treatise” in the *Westminster Review* in 1828.<sup>12</sup>

In *A System of Logic* Mill provided an empiricist explication of two types of reasoning, “popularly said”:<sup>13</sup> the syllogism (or ratiocination), which is treated in Book II, and induction, which is dealt with in Book III. In the early 1830s Mill began composing an early tract on logic that would evolve into *A System of Logic*. Although the exact dates of this early manuscript remain tentative, three phases of its composition can be distinguished.<sup>14</sup> In the first phase (ca. 1830–1832), Mill drafted what became in the first edition the general introduction, Book I, Chapters i–vi (on names and propositions), and Book II, Chapters i–iii (on reasoning and the syllogism). In the second stage (ca. 1834), he rewrote and expanded what became Book I, Chapter vi (on verbal propositions), composed what became Book I, Chapters vii and viii (on classification and definition) and composed material that resulted in Book III, Chapters ii and iii (on induction). The difficulties which Mill experienced when dealing with induction brought him to a halt, which he says lasted until 1837.<sup>15</sup> In the third stage (ca. 1837), he composed what became Book II, Chapters iv–vi (on trains of reasoning and necessary truths). By 1838 he completed the first draft of Book III and by 1840 he finished the entire draft. From 1841 to 1843 he worked on the press-copy manuscript, in which he reworked the early version, considerably expanded Book III (on induction), and composed Books IV (on operations subsidiary to induction), V (on fallacies), and VI (on the logic of the moral sciences).<sup>16</sup>

In what follows, we will discuss the sources on which Mill drew when formulating his views on ratiocination and induction proper and analyze their significance for his ideas on these matters.

## II. Ratiocination

Two works were of vital importance for the development of Mill's views on the syllogism: Richard Whately's *Elements of Logic* (1826) and the second volume of Dugald Stewart's *Elements of the Philosophy of the Human Mind* (1814). Mill, as will be shown, was not a slavish follower of their work. Instead, he subjected their work to critical examination and in the course of doing so he arrived at an idiosyncratic account of the syllogism that challenged more than two thousand years of orthodoxy regarding logic.

In his early twenties Mill was a member of what Ethel E. Ellis dubbed the "Society of Students of Mental Philosophy." It met twice a week at George Grote's house in London between 1825 until early 1828 and then again in 1829.<sup>17</sup> Its members were particularly interested in logic and at their meetings they discussed books on the subject.<sup>18</sup> It was in this context that the group dealt with Richard Whately's *Elements*, in which one "will find stated with philosophical precision, and explained with remarkable perspicuity, the whole of the common doctrine of the syllogism," as Mill later stated in *A System of Logic*.<sup>19</sup> Whately's work was the only contemporary textbook which Mill and his friends discussed – all other textbooks, which were predominantly scholastic, date back to the seventeenth century. In early 1828, Mill's review of Whately's *Elements* appeared in the *Westminster Review*.<sup>20</sup> Whately's *Elements* was the source on which Mill based his study of the syllogism.<sup>21</sup> At least two particular features of Whately's *Elements* were important for the development of Mill's views on deductive reasoning. First, Mill endorsed Whately's line of thought according to which the syllogism—or, as the latter referred to it, the "Grammar of Reasoning"—provides

“a test to try the validity of any argument,” because it is “the form to which *all* correct reasoning may be ultimately reduced.”<sup>22</sup> Second, Mill scrutinized and ultimately rejected Whately's claim that one could neutralize the charge that the syllogism, insofar as it is considered a process to establish new truths, involves a *petitio principii*.<sup>23</sup>

Although several opponents of Aristotelian logic had accused the syllogism of committing the logical fallacy of *petitio principii*, most of them were not crystal clear on what the fallacy actually involved.<sup>24</sup> George Campbell seems to have been the first to clearly formulate the *petitio principii* charge.<sup>25</sup> In his *Philosophy of Rhetoric* (1776) he argued that the syllogism is epistemologically wanting because it assumes “in the proof the very opinion or principle proposed to be proved.”<sup>26</sup> The *petitio principii* charge states, in other words, that the syllogism is fallacious because knowledge of the major “presupposes” that of the conclusion.<sup>27</sup> According to proponents of the inductive philosophy, the syllogism begs the question because, in the order of knowing, the major is epistemologically posterior to its conclusion. In other words, their criticism of the syllogism was tied up with their view on how knowledge is acquired. In their view, knowledge is acquired from particular facts to general principles and not the other way round. A different charge that frequently accompanied the *petitio principii* charge complained that, since the syllogism only renders explicit what is contained in its general principle, it cannot lead to new knowledge. Although both charges are distinct, they were frequently confounded by defenders and opponents of the syllogism alike.

In his characterization of the *petitio principii* charge, Whately was blending the *petitio principii* charge and the charge that the syllogism cannot lead to new knowledge. To nullify the *petitio principii* charge against the syllogism Whately distinguished between physical and logical discoveries. Physical discoveries refer to the establishment of matters of fact, which “were, before they were discovered, *absolutely* unknown, being not implied by anything we

previously knew.”<sup>28</sup> Logical discoveries, by contrast, refer to the mere deducing and unfolding of “the assertions wrapt up, as it were, and implied in those with which we set out, and to bring a person to perceive and acknowledge the full force of that which he has admitted; to contemplate it in various points of view; to admit in one shape what he has already admitted in another, and to give up and disallow whatever is inconsistent with it.”<sup>29</sup> With the above distinction at hand, Whately argued that syllogistic reasoning establishes logical discoveries only and that the criticism that syllogism involves a *petitio principii* insofar as it is considered as a reasoning process that establishes new truths rests on the mistaken assumption that the aim of syllogistic reasoning is to establish physical discoveries.<sup>30</sup> In his review on Whately’s rebuttal of the *petitio principii* charge, Mill commented, “he refutes this imputation most triumphantly, and his ideas on the entire subject are philosophical and just.”<sup>31</sup> Mill observed that, although Whately did not fully explain how “mankind may correctly apprehend and fully assent to a general proposition, yet remain for ages ignorant of myriads of truths which are embodied in it,” he was correct in claiming that ratiocination establishes unforeseen (logical) truths. “Of this fact the whole science of mathematics is a perpetual proof,” he added.<sup>32</sup> When he composed his review of Whately’s *Elements*, Mill still believed that ratiocination consists in reasoning from premises.<sup>33</sup>

Although the exact details are lacking, a couple of years later Mill began to doubt whether the syllogism leads to new (logical) truths and whether it is a form of reasoning from premises.<sup>34</sup> When he began to commit his views on logic to paper in the early 1830s, he began to perceive a difficulty in Whately’s treatment of the syllogism, and it was in Dugald Stewart’s writings that he, according to his own testimony, found a clue as to how to resolve it:

As to the fact there could be no doubt; as little could it be doubted, that all reasoning was resolvable into syllogisms and that in every syllogism the conclusion is actually

contained and implied in the premisses. How being so contained and implied, it could be new truth, and how the theorems of geometry [...] could be all contained in them, was a difficulty which no one, I thought, had sufficiently felt, and which at all events no one had succeeded in clearing up. The attempts at explanation by Whately and others seemed rather explainings away; and though they might give a temporary satisfaction, always left a mist still hanging over the subject. At last, when reading for the second or third time the chapters on Reasoning in the second volume of Dugald Stewart, interrogating myself on every point and following out the various topics of thought which the book suggested, I came to an idea of his about the use of axioms in ratiocination, which [...] seemed to me to be not only true of axioms but of all general propositions whatever, and to lead to the true solution of my perplexity. From this germ grew the theory of the syllogism propounded in the second book of the Logic: which I immediately made safe by writing it out.<sup>35</sup>

Mill now became convinced that “in every syllogism, *considered as an argument to prove the conclusion*, there is a *petitio principii*.”<sup>36</sup> Syllogistic arguments in his view beg the question because the conclusion is required in the proof of the major premise.<sup>37</sup> His argumentation ran as follows:

When we say,

All men are mortal,

Socrates is a man,

therefore

Socrates is mortal;

it is unanswerably urged by the adversaries of the syllogistic theory, that the proposition, Socrates is mortal, is presupposed in the more general assumption, All

men are mortal: that we cannot be assured of the mortality of all men, unless we are already certain of the mortality of every individual man: that if it be still doubtful whether Socrates, or any other individual we choose to name, be mortal or not, the same degree of uncertainty must hang over the assertion, All men are mortal: *that the general principle, instead of being given as evidence of the particular case, cannot itself be taken for true without exception, until every shadow of doubt which could affect any case comprised with it, is dispelled by evidence aliundè; and then what remains for the syllogism to prove? That, in short, no reasoning from generals to particulars can, as such, prove anything: since from a general principle we cannot infer any particulars, but those which the principle itself assumes as known.*<sup>38</sup>

Note that Mill's rendering of the *petitio principii* charge against the syllogism is based on the interconnected presuppositions that the major premise is but "an aggregate of particular truths,"<sup>39</sup> that the relation between a premise-set and its conclusion is essentially that which holds between a major premise and its instances,<sup>40</sup> and that, accordingly, the truth of a major premise requires the truth of all its instances. It is only under these (debatable) assumptions that the *petitio principii* charge emerges.

Having set up the problem, Mill criticized Whately, as follows:

When you admitted the major premise, you asserted the conclusion; but, says Archbishop Whately, you asserted it by implication merely: this, however, can here only mean that you asserted it unconsciously; that you did not know you were asserting it; but, if so, the difficulty revives in this shape – Ought you not to have known? *Were you warranted in asserting the general proposition without having satisfied yourself of the truth of everything which it fairly includes?*<sup>41</sup>



Mill became equally convinced that the only way to steer out of the *petitio principii* problem was to make a quite idiosyncratic move: *to deny that the syllogism involves inference.*<sup>42</sup> As he pointed out in *An Examination of William Hamilton's Philosophy* (1865):

Nor is its refutation [of the *petitio principii* charge], I conceive, possible, on any theory but that which considers the Syllogism not as a process of Inference, but as the mere interpretation of the record of a previous process; the major premise as simply a formula for making particular inferences; and the conclusions of ratiocination as not inferences from the formula, but inferences drawn according to the formula.<sup>43</sup>

Inference properly conceived of involves “a progress from the known to the unknown: a means of coming to a knowledge of something which we did not know before”<sup>44</sup> and, as we will see, only induction fills that bill.

If syllogistic arguments do not involve inference, then what is their function? The chapters on mathematical axioms and deductive reasoning in the second volume of Dugald Stewart's *Elements of the Philosophy of the Human Mind* (1814), which Mill's father, James Mill, reviewed,<sup>45</sup> served as an important source of inspiration for Mill's treatment of the function of the syllogism.<sup>46</sup>

In the second volume of his *Elements*, Stewart launched a rather vague criticism of the status of mathematical axioms as principles of reasoning. Traditionally, mathematical axioms are seen as the founding premises *from which* a myriad of mathematical truths *are deduced*. Taking a clue from Locke's denial that general maxims are useful in the establishment of knowledge,<sup>47</sup> Stewart observed that “it cannot with any propriety be said, that the axioms are the foundation on which the science rests; or the *first principles from which* its more recondite *truths are deduced.*”<sup>48</sup> The true principles of reasoning in mathematics are the definitions: “the principles of mathematical science are, *not* the axioms but the *definitions*;

[...]. From what principle are the various properties of the circle derived, but from the definition of a circle? From what principle the properties of the parabola or ellipse, but from the definitions of these curves? A similar observation may be extended to all the other theorems which the mathematician demonstrates: [...].”<sup>49</sup> Instead, Stewart argued that “although they [i.e. mathematical axioms] are not the principles of our reasoning, either in arithmetic or in geometry, *their truth is supposed or implied in all our reasonings in both; and, if it were called in question, our further progress would be impossible.*”<sup>50</sup> Moreover, Stewart urged that the “idea that all demonstrative science must rest ultimately on axioms, has been borrowed, with many other erroneous maxims, from the logic of Aristotle.”<sup>51</sup>

That Stewart served as a source of inspiration can be seen from the content of *A System of Logic*, Book II, Chapter iii, in which Mill addressed the functions of the syllogism. There Mill pointed out that:

It is justly remarked by Dugald Stewart, that though the reasonings in mathematics depend entirely on the axioms, it is by no means necessary to our seeing the conclusiveness of the proof, that the axioms should be expressly adverted to. [...] This remark of Stewart, consistently followed out, *goes to the root, as I conceive, of the philosophy of ratiocination*; and it is to be regretted that he himself stopt short at a much more limited application of it. He saw that *the general propositions on which a reasoning is said to depend, may, in certain cases, be altogether omitted, without impairing its probative force.* But he imagined this to be a peculiarity belonging to axioms; and argued from it, that axioms are not the foundations or first principles of geometry, from which all the other truths of the science are synthetically deduced [...]; but are *merely necessary assumptions, self-evident indeed, and the denial of which would annihilate all demonstration, but from which, as premises, nothing can be demonstrated.* [...] [H]e contended that axioms are in

their nature barren of consequences, and that the really fruitful truths, the real first principles of geometry, are the definitions; [...]. Yet all that he had asserted respecting the function to which the axioms are confined in the demonstrations of geometry, holds equally true of the definitions.<sup>52</sup>

According to Mill, Stewart's analysis of the role of mathematical axioms in mathematical demonstration applies to all major premises in syllogistic argumentation. Correspondingly, he argued that the proposition "the Duke of Wellington is mortal" is "not an inference drawn *from* the formula ['all men are mortal'], but an inference drawn *according to* the formula: the real logical antecedent, or premise, being the particular facts from which the general proposition was collected by induction."<sup>53</sup> This quotation reveals an important feature of Mill's views on logic: namely, he believed that *logical antecedents* ought to correspond to *evidential antecedents* that are grounded in particular facts.<sup>54</sup> In Mill's view, the general major premise "all men are mortal" does not have probative force in itself, it serves as an *aide mémoire* only: "The proposition, All men are mortal [...] shows that we have had experience from which we thought it followed that the attributes connoted by the term man, are a mark of mortality. But when we conclude that the Duke of Wellington is mortal, we do not infer this from the memorandum, but from the former experience. All that we infer from the memorandum is our own previous belief [...] concerning the inferences which that former experience would warrant."<sup>55</sup> The real inference, Mill contends, is finished once we have established the inductive generalization "all men are mortal"; the descent from the major to "the Duke of Wellington is mortal" is "not a process of inference, but a process of interpretation."<sup>56</sup> The proper form of the major premise, according to Mill, is therefore the following:

In the argument, then, which proves that Socrates is mortal, one indispensable part of the premises will be as follows: "My father, and my father's father, A, B, C, and

an indefinite number of other persons, were mortal;” which is only an expression in different words of the observed fact that they have died. This is the major premise divested of the *petitio principii*, and *cut down to as much as is really known by direct evidence*.<sup>57</sup>

Although the syllogism is not a process of inference, it is not entirely useless, for it “furnishes a test of the validity of reasonings, by supplying forms of expression into which all reasonings may be translated if valid, and which, if they are invalid, will detect the hidden flaw.”<sup>58</sup> In view of his analysis of the syllogism, Mill concluded that all inference is “from particulars to particulars,”<sup>59</sup> and that “all processes of thought in which the ultimate premises are particulars, whether we conclude from particulars to a general formulae, or from particulars to other particulars according to that formula, are equally Induction.”<sup>60</sup>

### III. Induction

The philosophical background important to Mill’s theory of induction has two major components: Richard Whately’s introduction of the uniformity principle into inductive inference and the loss of the idea of formal cause.

Surprisingly, David Hume (1711–1776) is of little importance here. Hume was not associated with induction in his own day, in Whately’s, or in Mill’s. The association was not made until the 1920s.<sup>61</sup> In the early nineteenth century, the philosopher considered most important for induction was still Francis Bacon. Even those writers criticizing Bacon or his inductive method acknowledged his pervasive influence. Richard Whately was one such critic.<sup>62</sup>

Whately’s project was to reverse the trends wrought by Bacon, John Locke, and especially their followers. But to do so, Whately could not simply return to Scholasticism, at least not regarding induction. He made a proposal that has been so successfully revolutionary,

we now take it for granted. To understand it and then Mill's framework, we need to have a sense of the Scholastic and then Baconian conceptions of induction.<sup>63</sup>

In Scholastic logic, induction is a kind of propositional inference made good by complete enumeration (actual or presumed). The inference is valid because the induction can be converted into a syllogism. A common example was "This, that, and the other magnet attract iron; therefore all magnets attract iron." It was claimed that this could be rendered—and would gain inferential force by being rendered—as a syllogism, which is done by supplying the missing (minor) premise "all magnets are this, that, and the other." If the list was not fully enumerated but could be treated as if it were, "et cetera" could be added to both premises.

Renaissance humanists reading Aristotle's *Topics*, Cicero's works, and other ancient texts discovered another conception of induction, one that justified universal statements not by converting an argument into a syllogism but by identifying the essential features that make something the kind of thing it is, that is, by identifying the "formal cause" or "form" of something. Because of associations with Socrates' search for universal definitions, this kind of induction was in the ancient world and then again in the Renaissance called "Socratic induction." Francis Bacon's project was to codify and systematize Socratic induction.<sup>64</sup>

In the seventeenth century, the Baconian/Socratic conception of induction supplanted the Scholastic, and adherents of the new conception were typically also the thinkers losing interest in syllogistic logic. That logic seemed to them concerned only with words in debates and not with things in the world. Bacon said the first distemper of learning is "when men study words and not matter."<sup>65</sup> His followers in the Royal Society adopted *nullius in verba* as its motto. Philosophers' attention turned from formal logic to how the human mind processes sense experience, how it forms universal concepts, how it judges, and what the relation is between the judgments, concepts, and experiences, and the objects and attributes in reality. The major epistemological works were no longer commentaries on Aristotelian logic but

works on “human understanding” or “intellectual powers.” By the early nineteenth century, the stock way to describe this change was that “mental philosophy” had replaced “formal logic.”

Whately’s project was to revive formal logic. But since Baconian induction had become so widely considered the foundation of successful experimental science, Whately could not simply return to a cursory treatment of induction. He also recognized the shortcomings of the Scholastic conception. He needed something new, and he got it from his teacher and colleague Edward Copleston (Copleston, 1809). It came packaged in the technical vocabulary of Scholastic logic.

What we nowadays would call an induction justified by complete enumeration was called by Scholastics “an enthymeme in Barbara with the minor premise suppressed.” That is, it is a syllogism such as this:

(major) Father, Son, and Holy Ghost are eternal.

(minor) [God is Father, Son, and Holy Ghost.]

(concl.) Therefore, God is eternal.

Whately claimed this was the wrong way to understand induction. Induction is not, he said, an enthymeme (or syllogism) with the *minor* premise suppressed, “as Aldrich represents it,”<sup>66</sup> but a syllogism with the *major* premise suppressed. Of course, it was not just Aldrich who thought this.<sup>67</sup> Whately was overturning the whole history of induction.<sup>68</sup>

Whately was also reversing a fundamental principle of logic. Normally, the minor term is the subject of the conclusion and the major term is the predicate. And subject and predicate are meant ontologically, not grammatically. Whether one says, “tyrannies are short-lived,” “being short-lived is a property of tyrannies,” or “the property of short-lived belongs to tyrannies,” the content of the proposition does not change and if this is the conclusion of a syllogism, the minor term is “tyrannies” and the major term is “short-lived.” But for Whately,

as for Copleston, and as against the Baconians, logic is just a grammar. It is not about things in the world. It is about how we put words together. So which is subject and which is predicate, that is, which is the minor and which is the major term, is determined by the form of the sentence. So Whately can then form the inductive syllogism he wants, an enthymeme in Barbara with the major premise suppressed:

(major) [A property of the examined tyrannies is a property of all tyrannies.]

(minor) The property of being short-lived is a property of the examined tyrannies.

(concl.) Therefore, the property of being short-lived is a property of all tyrannies.

(concl.) That is, all tyrannies are short-lived.

This is the introduction of the uniformity principle into induction theory.

To serious students of logic, the import of Whately's new syllogism was readily apparent. William Hamilton called Whately's move destructive, "palpably suicidal."<sup>69</sup> An anonymous reviewer of Whately's *Elements of Logic*, writing in the *Westminster Review* in early 1828, had the opposite view. He applauded the good effect Whately's book was already having on the study of logic at Oxford and in England generally. The reviewer said not only that Whately's new view of induction was "original" and "extremely important" but also that this "one remark [about major and minor] would have sufficed to correct the erroneous notion the ancients had of induction, and to which Lord Bacon justly ascribes the gross errors they committed in the investigation of nature. They in fact mistook altogether the inductive syllogism, completing it by the addition of a *minor*, instead of a *major*."<sup>70</sup> The reviewer was suggesting that the whole Baconian era could have been avoided had someone identified the Scholastic error before Bacon advanced his alternative. The reviewer was 21-year-old John Stuart Mill.

Mill began work on [A System of Logic](#) soon afterward. And he made good progress on Book 1 (on name and propositions) and Book 2 (on ratiocination), drawing heavily on his

readings of Aldrich and other authors in the Scholastic tradition. For Book 3 (on induction) he wrote a few pages, “Of Induction in General,” “Of the Various Grounds of Induction,” and “Of the Uniformity in the Course of Nature.” Whately’s new syllogism was central.

Archbishop Whately remarks, that every Induction is an imperfect Syllogism, with the major premiss omitted. The remark is just; [...]. [T]he principle which we are now considering, that of the uniformity of the course of nature, will come forth as the invariable major premiss, immediately or remotely of all inductive argumentations.<sup>71</sup>

But Mill then hit an impasse, “stopped and brought to a halt on the threshold of induction.”<sup>72</sup>

His last words in the draft were these:

Why is a single instance in one case sufficient for a complete Induction, while in another myriads of concurring instances without a single exception known or presumed, goes so slight a way towards establishing a general proposition? Whoever can solve this question, knows more of the Philosophy of Logic, than the wisest of the ancients, and has solved the great problem of Induction.<sup>73</sup>

Mill said he could go no further without a “comprehensive and [...] accurate view of the whole circle of physical science.”<sup>74</sup> In 1837, he found what he needed in William Whewell’s *History of the Inductive Sciences*, published early that year. He then reread *A Preliminary Discourse on the Study of Natural Philosophy* by Whewell’s friend John F. W. Herschel, and by autumn of 1837 Mill had “substantially completed” his theory of induction.<sup>75</sup> Whewell published his own theory of induction in *The Philosophy of the Inductive Sciences* in 1840, and Mill was delighted to have found an antagonist.<sup>76</sup>

Mill’s project was to further Whately’s anti-Baconian revival of formal logic. Whewell’s was to advance Bacon’s system of experimental induction by updating it. The two Victorians disagreed on much about induction—even on whether its use was good or bad for society—



but they agreed that, as used in the two centuries after Bacon, an induction was validated by identification of a cause.<sup>77</sup> But Mill had a much different conception of cause than Bacon had.

Up until Bacon's time, Aristotle's four causes—material, efficient, final, and formal—were the canonical reference point for discussions of cause. Bacon said it is the formal cause that one must find to validate an induction. What Bacon meant by formal cause or form, is what any Aristotelian of his day meant: A form is what makes something the kind of thing it is. He scolded those Aristotelians who thought this was some ineffable essence hidden within a substance. For Bacon, a form is ultimately just the arrangements and motion of (sometimes imperceptibly small) components. It can be discovered by carefully using an experimental and iterative method: begin with a varied inventory of observed instances, related absences, and related variations; then explore similarities and differences to find first a genus and then a differentia. Bacon noted that this exploration often proceeded haphazardly, but that it need not. He identified twenty-seven kinds of comparisons, "prerogatives," that were particularly helpful. A researcher, he said, should vary conditions—we would say, "design experiments"—so as to make these prerogative comparisons possible.

When Bacon uses his method to discover the formal cause of heat, he concludes that heat is a particular kind of motion of small particles. He then makes the extraordinarily universal claim, that if in any body whatsoever you can arouse this particular kind of motion, you will certainly generate heat, not because this motion will generate heat or the heat will generate the motion, but because this kind of motion *is* heat and heat *is* this kind of motion.

The notion of experimentation and of seeking causes to justify inductive inference survived, but the notion of formal cause did not. Bacon and others in seventeenth century had, in effect, shown that formal cause could be reduced to combinations of the other types, that is, to matter (the material cause) interacting (the efficient cause) with other matter,

possibly for some purpose (the final cause). After Newton's grand synthesis, simplification of the causal taxonomy accelerated. By Mill's day, debates about cause had been reduced to whether material objects literally move the objects they interact with or it is consciousness—a person's in the case of bodily actions or God's in the case of the natural world—that effects the motion. Efficient cause came to mean the action of a consciousness, ultimately, God's, and physical cause the action we perceive. Mill took his answer to this question from Thomas Brown.<sup>78</sup> Brown rejected a separate efficient cause operating in nature; what is going on in the mind of God is wholly inaccessible to us and whether it is involved or not in physical motion is irrelevant. Mill concurs, "The causes I concern myself with are not efficient, but *physical* causes."<sup>79</sup> Mill accepted that "The notion of Cause [...] [is] the root of the whole theory of Induction,"<sup>80</sup> but, following Brown, by the cause of something Mill meant (and meant only) the antecedent that invariably and unconditionally precedes it. "The only notion of a cause which the theory of induction requires is [...] that invariability of succession [...] found by observation to obtain between every fact in nature and some other fact which has preceded it."<sup>81</sup> Mill's concept of cause is purely temporal.

When discussing induction, Bacon generally paired "cause" with "nature," not with "effect." Given some nature, he wanted to know its cause. Mill, on the other hand, writes, "Inductive inquiry [...] [has] for its object to ascertain what causes are connected with what effects."<sup>82</sup> Bacon had three tables and twenty-seven prerogatives. Herschel had simplified these down to a multi-stage process with ten rules and a few ancillary supports.<sup>83</sup> Mill reduced all this to just four rules, his *Methods of Experimental Inquiry*.<sup>84</sup> Mill does not say these were the methods researchers *should* use, rather that they were the ones researchers *did* use.

Mill says the first two, the Method of Agreement and the Method of Difference, are the "simplest and most obvious." The third, probably following Herschel, "has been aptly named

the Method of Residues.”<sup>85</sup> Mill's fourth, what “may be termed the Method of Concomitant Variation,” highlights why Mill does not say researchers *should* use these four methods. This fourth method says that when two phenomena vary together, one is the cause of the other or the two have one mutual cause. Mill knew this was of limited use. It runs counter to the very principle that mere correlation does not establish causality. None of these conventional methods, Mill says, can be used when an effect could have multiple causes and an effect could be “mixed and confounded with any other co-existent effect.”<sup>86</sup> He called these two confounding conditions “Plurality of Causes” and “Intermixture of Effects.” And because of the pervasiveness of these two conditions, advanced science requires some method other than induction.

Henceforth induction theory would face two challenges. The first is whether the uniformity principle could be justified. Mill returned to the question late in Book III and elaborated on his proposal that this is one universal principle that can in fact be established by simple enumeration. The second challenge is that inductive inference could no longer rely on the ampliation earlier presumed inherent in abstraction and concept-formation. To know for sure whether all cardinals are red, all water boils at 100°C, and all magnets attract iron we need to know what makes a cardinal a cardinal, water water, and a magnet a magnet. But once formal cause was abandoned, such questions got disconnected from induction theory. So induction got disconnected from “mental philosophy” and made into a kind of mathematical inference. Since the late nineteenth century, the core issue for induction theory has been to determine the chances that the suppressed major is true in some individual case, i.e., determine the probability that what is true of a sample is true of all.

#### **IV. Conclusion**

The sources which Mill consulted served as working tools that helped him develop a series of original ideas that reformed the study of logic. Mill's *A System of Logic* was in many ways a revolutionary work. His overarching philosophical goal was to show that "[t]he doctrine that truths external to the mind may be known by intuition or consciousness, independently of observation and experiment" is misguided.<sup>87</sup> For Mill, *all* meaningful statements—including mathematical ones<sup>88</sup>—ultimately derive from experience of particular facts. His empiricism, had clear repercussions on his treatment of inference.<sup>89</sup> Inference in his view always proceeds from particulars to particulars.

In accordance with his conception of inference, Mill argued that the conclusion of a syllogism is not *inferred* from the major premise. Instead, it is inferred from the particulars of which the major provides a memorandum. Despite his denial that the syllogism involves inference, he nevertheless maintained that it provides a very useful tool to test the validity of arguments. In other words, on the one hand, we see Mill defending the usefulness of the syllogism, even relying on it when he shows how induction depends on a uniformity principle. Yet, on the other hand, we see him denying its longstanding inferential significance.

What was furthermore revolutionary about Mill's *magnum opus* was that it attempted to provide the conditions under which real inferences, i.e. inductive arguments, are valid. By contrast, Whately claimed that the discovery of universal statements, which serve as the basis for syllogistic arguments, is simply "out of the province of Logic."<sup>90</sup> "The business of Inductive Logic," Mill commented, "is to provide rules and models (such as the Syllogism and its rules are for ratiocination) to which if inductive arguments conform, those arguments are conclusive, and not otherwise."<sup>91</sup> Whereas in the early editions of *A System of Logic* Mill was quite optimistic that his *Canons of Induction* would furnish the required rules on the basis of which indisputable inductive conclusions could be established, in its later editions he

emphasized that the Canons only establish provisional conclusions and that they provide guidance only in very simple cases, in which Plurality of Causes and Intermixture of Effects are absent.<sup>92</sup>

Mill had come to a dead-end with ratiocination and induction. If the syllogism is understood as a kind of inference, he decided, the criticism that it commits the fallacy of *petitio principii* is valid. He concluded that the syllogism is simply not a kind of inference; it is rather a process of interpreting existing knowledge. It cannot provide new knowledge. Induction, on the other hand, is a kind of inference and could produce new knowledge, but, in the induction Mill got from Whately, a valid induction requires a uniformity principle that itself relies on induction. Even if this difficulty can be assuaged, Mill's four methods of inductive inquiry are effective only when there is no plurality of causes or intermixture of effects. For the most important advances in human knowledge, Mill concluded, we must look elsewhere. He proposes that "the main source of the knowledge we possess or can acquire respecting the conditions, and laws of recurrence, of the more complex phenomena,"<sup>93</sup> the method that has been responsible for the human mind's "most conspicuous triumphs in the investigation of nature,"<sup>94</sup> is what Mill calls the Deductive Method: develop an hypothesis using simplistic induction, deduce its implications using syllogistic reasoning, and verify or reject the hypothesis by comparison to experimental results.<sup>95</sup> Mill was sure this would be the dominant method in the future.

When Charles Darwin published the *Origin of Species*, in 1859, he appealed on its frontispiece to the principles of Francis Bacon and he hoped most for the approbation of Mill's nemesis, the neo-Baconian William Whewell.<sup>96</sup> But Thomas Huxley, the man who would become "Darwin's Bulldog," had been extolling Mill's Deductive Method as early as 1854<sup>97</sup> and in 1860 was saying Darwin's method was "rigorously in accordance with the canons of scientific logic," with the proper "process of scientific investigation," with the

process described in “Mr. Mill’s admirable chapter ‘On the Deductive Method’.”<sup>98</sup> In 1889, John Stuart Mill’s biographer, W.L. Courtney, said this method is sometimes called the “hypothetico-deductive method.”<sup>99</sup> And that is how we know it today.

## NOTES

<sup>1</sup> Jongsma (1982: 121–3, 259–61).

<sup>2</sup> Jongsma (1982: 268–311).

<sup>3</sup> See McKerrow (1987).

<sup>4</sup> Bacon (1857–1874: I.214–5).

<sup>5</sup> Jongsma (1982: 33–8).

<sup>6</sup> Jongsma (1982: 217–8, 256).

<sup>7</sup> E.g., Reid (1852: 369); Stewart (1829: II.229–63).

<sup>8</sup> Whately (1844: viii).

<sup>9</sup> Whately (1854: 12).

<sup>10</sup> De Morgan (1860: 341).

<sup>11</sup> Mill (1873: 125). All references to Mill are to the authoritative edition of *Collected Works of John Stuart Mill* (Mill, 1963-91 – hereafter *CW*, followed by volume and page number), unless otherwise indicated.

<sup>12</sup> See, Mill (1828).

<sup>13</sup> Mill (1843, *CW*: VII.162).

<sup>14</sup> See Robson (1974: lv–lxv [esp. lviii–lxi], xcvi–xcix).

<sup>15</sup> Mill (1873, *CW*: I.109).

<sup>16</sup> Mill (1843, *CW*: VII.lxii).

<sup>17</sup> See, Mill (1873, *CW*: I.125); Ellis (1888). See also, Robson and Stillinger (1981: xii).

<sup>18</sup> Other books on the syllogism which the society discussed included Philippe Du Trieu's *Manuductio ad logicam* (1618), Thomas Hobbes' *Computatio sive logica*, i.e. the first part of *De corpore* (1655), and Henry Aldrich's *Artis logicae compendium* (1691). See, Mill (1873, *CW*: I.125). According to his own testimony, Mill read Aristotle's *Prior* and *Posterior Analytics* at the age of twelve (*ibid.*, p. 21). In the following two years he read Samuel Smith's *Aditus ad logicam* (1613), Edward Brerewood's *Elementa logicae* (1614), Robert Sanderson's *Logicae artis compendium* (1615), Franco Petri Burgersdijk's *Institutionum logicarum libri duo* (1637), Hobbes' *Computatio sive logica*, and Du Trieu's *Manuductio ad logicam* (see Appendix B, "Mill's early Reading," *CW*: I.567–68, 572).

<sup>19</sup> Mill (1843, *CW*: VII.166).

<sup>20</sup> See, Mill (1828).

<sup>21</sup> Kubitz (1932: 25ff). *A System of Logic* contains some fifty references to Whately's *Elements* (see Appendix K, in *CW*: VIII.1233–35). For in-depth studies of Mill's views on syllogistic reasoning, see Ryan (1970: ch. 2); Scarre (1989: ch. 4); and, Skorupski (1989: chs 1-3). For general background on nineteenth-century logic, see Heis (2012).

<sup>22</sup> Whately (1831: 12; also Mill, 1828, *CW*, XI: 9–11).

<sup>23</sup> Whately (1831: 255ff).

<sup>24</sup> Jongsma (1982: 32).

<sup>25</sup> Jongsma (1982: 149, 154).

<sup>26</sup> Campbell (1776: I.174).

<sup>27</sup> Jongsma (1982: 33–8).

<sup>28</sup> Whately (1831: 240).

<sup>29</sup> *Ibid.*, p. 237.

<sup>30</sup> *Ibid.*, pp. 251–2, 256–7. There is a complication, however: earlier in his *Elements* Whately had argued that what counts as a *petitio principii* depends merely on one's state of knowledge (Whately, 1831: 160–61; Jongsma, 1982: 389–93).

<sup>31</sup> Mill (1828, *CW*, XI: 33).

<sup>32</sup> Mill (1828, *CW*, XI: 34).

<sup>33</sup> Mill (1828, *CW*, XI: 16).

<sup>34</sup> It is not very surprising then that Mill exempted his review of Whately's *Elements* from the papers collected in his *Dissertations and Discussions* (Mill, 1859; see also, Sparshott, 1978: vii; Kubitz, 1932: 33).

<sup>35</sup> Mill (1873, *CW*, I: 189–90).

<sup>36</sup> Mill (1843, *CW*, VII.184).

<sup>37</sup> When characterizing the *petitio principii* charge Mill followed Whately, who had defined it as the logical fallacy “in which *the Premise* either appears manifestly to be the same as the



Conclusion, or *is actually proved from the Conclusion* or, is such as would naturally and properly so be proved" (Whately, 1831: 199 [italics added]; cf. Mill, 1843, CW, VIII.820).

<sup>38</sup> Mill (1843, CW, VII.184 [italics added]).

<sup>39</sup> Mill (1843, CW, VII.186).

<sup>40</sup> Scarre (1984: 23–4 and 1989: 22, 39, 63–4); Kneale and Kneale (1984: 376); Jongsma (1982: 36–8).

<sup>41</sup> Mill (1843, CW, VII.185 [italics added]).

<sup>42</sup> Scarre (1989: 65–79).

<sup>43</sup> Mill (1865, CW, IX.416).

<sup>44</sup> Mill (1843, CW, VII.183).

<sup>45</sup> In his review James Mill did not discuss Stewart's views on deduction. He pointed out, however, that Stewart failed to give "what is yet so great a desideratum in logic, [namely] a complete system of rules, as complete, for example, as those which Aristotle provided for the business of syllogistic reasoning" (Mill, 1815: 193).

<sup>46</sup> Anschutz (1963: 135–6, 149–150); Kubitz (1932: 121–5).

<sup>47</sup> Locke (1975, III.iv, §11, pp. 601–2).

<sup>48</sup> Stewart (1829: II.21 [italics added]).

<sup>49</sup> *Ibid.*, II, p. 27, cf. pp. 107, 112, 127, 142.

<sup>50</sup> *Ibid.*, II, pp. 28–9 [italics added].

<sup>51</sup> *Ibid.*, II, p. 185.

<sup>52</sup> Mill (1843, *CW*: VII.190–1 [italics added]).

<sup>53</sup> Mill (1843, *CW*: VII.193).

<sup>54</sup> This may be seen further from Mill's attempt to replace the *dictum de omni et nullo* by an evidentialist principle based on "marks" (Mill, 1843, *CW*: VII.180; Scarre, 1989: 32–7). In his seminal study Kubitz claimed that the legalistic approach epitomized in Jeremy Bentham's *Rationale of Judicial Evidence*, which Mill edited in his early twenties (Bentham, 1827; Capaldi, 2004: 51–2), "may [...] be taken as one of the first circumstances to influence the development of Mill's logical doctrines" (Kubitz, 1932: 23, cf. pp. 49–53). Mill referred twice to the *Rationale* in *A System of Logic* (*CW*: VII.598, 627) and in his autobiography he asserted that Bentham's theory of evidence, which he considered as "one of the most important of his subjects," was "thoroughly imprinted" upon him (*CW*: I.119; Mill's notes on the *Rationale* are in *CW*, XXXI, pp. 5–92). Taken as a statement regarding the details of Mill's logical doctrines, Kubitz' claim remains highly unconvincing. If Kubitz' claim is construed more broadly, i.e. as implying that Bentham's writings on judicial evidence influenced Mill's views on the priority of evidence in logic and reasoning, then it is fairly plausible as John M. Robson has pointed out (Robson, 1989: xv–xvi). It seems that Mill took over Bentham's expression "the probative force (of evidence)" (Bentham, 1827: I.58; Mill, 1843, *CW*: VII.183, 191, 256; see also, Mill, 1827, *CW*: XXXI.13, 25, 38, 88).

<sup>55</sup> Mill (1843, *CW*: VII.194–5).

<sup>56</sup> Mill (1843, *CW*: VII.194).

<sup>57</sup> Mill (1843, *CW*: VII.210 [italics added]).

<sup>58</sup> Mill (1865, *CW*, IX.390); cf. Mill (1843, *CW*, VII.198).

<sup>59</sup> Mill (1843, *CW*, VII.193, 88–190).

<sup>60</sup> Mill (1843, *CW*, VII.203). In an early draft of *A System of Logic* Mill was more explicit on the implications of the view that all reasoning is from particulars to particulars: “We have now shown, that the distinction between Induction & Reasoning [i.e. Ratiocination], as commonly understood, has no real foundation. There are not two modes of arriving at truth, one proceeding upwards from particulars to generals, another downwards from generals to particulars” (see Appendix A, *CW*: VIII.1074).

<sup>61</sup> Keynes (1921: 272).

<sup>62</sup> Also of only secondary importance here is Auguste Comte. In the *Autobiography*, Mill says, “My theory of induction was substantially completed before I knew of Comte’s book [*Cours de Philosophie Positive*],” though he does add, “Nevertheless, I gained much from Comte, with which to enrich my chapters in the subsequent rewriting [April to December, 1841]: and his book was of essential service to me in some of the parts which still remained to be thought out” (Mill, 1873, *CW*: I.217).

<sup>63</sup> For a fuller treatment, see McCaskey, 2006.

<sup>64</sup> For a fuller treatment, see McCaskey, 2013.

<sup>65</sup> Bacon (1857–1874: III.284).

<sup>66</sup> Whately (1826: 209).

<sup>67</sup> Once the forthcoming debate got underway, Whately realized his oversight. In the fifth edition of *Elements of Logic*, in 1834, the discussion, now moved from the footnote to the

main body and expanded to several pages, referred not to Aldrich but to “most logical writers.”

<sup>68</sup> Even Baconians, though they did not typically use the description, could make the old Scholastic one serviceable enough. They, as Aristotle had in *Prior Analytics* B 23, used identification of essence, rather than complete enumeration, to justify the suppressed minor. See McCaskey, 2007.

<sup>69</sup> Hamilton (1833: 231).

<sup>70</sup> Mill (1828, *CW*: XI.33).

<sup>71</sup> See Appendix A, “Early Draft of *A System of Logic*,” *CW*: VIII.1106.

<sup>72</sup> Mill (1873, *CW*: I.215).

<sup>73</sup> See Appendix A, *CW*: VIII.1110.

<sup>74</sup> Mill (1873, *CW*: I.215).

<sup>75</sup> Mill (1873, *CW*: I.217).

<sup>76</sup> Mill (1873, *CW*: I.231).

<sup>77</sup> For Whewell and his debate with Mill, see Snyder (2012), literature cited there, and Snyder (2006). The debate is also addressed in chapter **XX** in this volume, “Revisiting the Mill-Whewell Debate.”

<sup>78</sup> In the preface to the first and second editions, Mill writes, “[A] previous familiarity with the earlier portion of Dr. Brown’s *Lectures* or with his treatise on Cause and Effect, would,

though not indispensable, be advantageous” (1843, *CW*: VII.cxiv). He mentions Brown several times elsewhere.

<sup>79</sup> Mill (1843, *CW*: VII.326).

<sup>80</sup> *Ibid.*

<sup>81</sup> *Ibid.*, pp. 326–7.

<sup>82</sup> *Ibid.*, p. 384.

<sup>83</sup> Herschel (1831: pt. 2, ch. 6).

<sup>84</sup> See Ducheyne (2008).

<sup>85</sup> Whewell had used the term a few years earlier. But when Whewell later criticizes Mill's four methods, he does not take credit for this one. Mill's use probably derives more directly from John F. W. Herschel's discussion of “residual phenomena.” Whewell says all four come from among Bacon's twenty-seven prerogatives.

<sup>86</sup> Mill (1843, *CW*: VII.434).

<sup>87</sup> Mill (1873, *CW*: I.232, cf. 134)

<sup>88</sup> For Mill's views on mathematical knowledge, see chapter **XX** in this volume, “Mill's Philosophy of Mathematics.”

<sup>89</sup> For the extremes to which he took empiricism, see Snyder, 2006, p. 106ff.

<sup>90</sup> Whately (1831: 230). In a letter to John Bowring in 1828, Mill criticized George Bentham's *Outline of a New Logic* (1827), which contains a critical examination of

Whately's *Elements*. According to Mill, Bentham produced “nothing but minute criticism” (CW: XII.23). Nevertheless, as the years progressed, Mill came to share Bentham's opinion that the search for “inductive rules” is “a portion of the study of Logic” (Bentham, 1827: 18, 172–4).

<sup>91</sup> Mill (1843, CW: VII.430).

<sup>92</sup> Ducheyne (2008: 362–3).

<sup>93</sup> Mill (1843, CW: VII.454)

<sup>94</sup> Mill (1843, CW: VII.462).

<sup>95</sup> Mill (1843, CW: VII.454–63, “Of the Deductive Method”).

<sup>96</sup> Snyder (2006: 185–202).

<sup>97</sup> Huxley (1870a; esp. *ibid.*, p. 86n1).

<sup>98</sup> Huxley (1870b: 293).

<sup>99</sup> Courtney (1889: 80).

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