

**Professor Higgins' Philosophy of Science:
Why Can't Induction Be More Like Deduction?**

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In *My Fair Lady*, frustrated in his dealings with Miss Eliza Doolittle, Professor Henry Higgins sings, 'Why can't a woman be more like a man / Men are so honest, so thoroughly square / Eternally noble, historically fair. / . . . / Why can't a woman be more like a man?'¹ By this thinking, man and woman are two kinds of something, one the ideal, the other the deficient. The more a woman can be made to be like a man—by adding some bits, by suppressing others, by forcible contortion if necessary—the better she will be. Many philosophers have a similar attitude toward induction. It is a type of inference, they say, but not the ideal kind. The ideal kind is deduction. As Nicholas Rescher put it, 'An inductive inference can always be looked upon as *an aspiring but failed deductive inference*.'² Like Professor Higgins dealing with Miss Doolittle, the modern philosopher judges induction by the standard of deduction, finds it wanting, and struggles in frustration to correct its shortcomings.

The attitude is not just modern. It was standard from Alexandrians of the sixth century to Zabarella in the sixteenth. All conceived of induction as a kind of propositional inference inferior to deduction. John Stuart Mill and countless writers since have shared the view. But it has not been universal. Bacon, Hume, and Whewell did not share it. Neither did Cicero, the man who gave us the term *inductio*. Not only did they not think of

To distinguish verbatim quotations from other text normally marked by quotation marks, verbatim quotations are here marked by single quotation marks. References are always provided. For other purposes, double quotation marks are used. In the notes, older and standardized primary sources, now so widely available in multiple, on-line, and often unpaginated editions, are cited by logical divisions such as chapter, section, paragraph, and so on. Translations are those listed in the bibliography except where noted.

¹ Loewe and Lerner, "Hymn to Him," *My Fair Lady*.

² Rescher, *Induction*, p. 10. Emphasis in original.

induction as inferior, they did not even think of it as, fundamentally, a kind of inference. We can get an excellent overview of the history of the concept of induction simply by tracing the alternating attitudes toward the relationship between induction and deduction. There have been four major phases in that history. In two, Professor Higgins' attitude prevailed, and in two it did not. This essay will describe all four.

(1) Aristotle: 'What sort of thing induction is, is clear.'

Aristotle's view of induction dominated antiquity and it seems he was the first to say an induction is inferentially forceful to the extent it mimics deduction. In *Prior Analytics* B23, his most concentrated and rigorous chapter on the subject, Aristotle writes, 'Induction(*epagōgē*) then—or the from-induction deduction—is deducing one extreme [to belong] to the middle through the other extreme.'³ He gives this example. (1) Man, horse, and mule are long-lived animals. (2) Man, horse, and mule are bileless. Because there are no other bileless animals (or so we can assume for purposes of illustration), the second premise can be converted (that is, subject and predicate can be swapped). Thus, (3) bileless animals are man, horse, and mule. Therefore, (4) all bileless animals are long-lived. C_1, C_2, C_3 are A; all B is C_1, C_2, C_3 ; therefore all B is A. We have—according to the conventional reading—deduced, by a syllogism of the type Scholastics called Barbara, that the major term, A, being long-lived, belongs to the middle, B, being a bileless animal, through the minor term, C, the union of man, horse, and mule. A universal statement about all bileless animals has been inferred from particular statements about the particular animals, man, horse, and mule, and a presumption that no others fit the class. Thus, by an enumeration presumed complete, an induction can be rendered as a deduction and the conclusion given inferential force.

Though this chapter, late in the *Prior Analytics*, and this reading of it have been tremendously influential, there are problems with the conventional understanding. If Aristotle wanted to present an archetypical example of induction by complete enumeration, why did he pick this example? As we know from his *Parts of Animals*, he

³ *Prior Analytics* B23 68b15–16. My translation.

knew there were bileless animals other than man, horse, and mule.⁴ Given what he is supposedly trying to do, why did Aristotle not pick a case where the particulars could plainly be enumerated, such as east, west, north, and south, or even and odd, or the only three possible kinds of triangles? Did he pick his example in order to make the point that inductions are frequently unreliable? No, he introduced the passage by saying he would show how induction provides *pistis* (proof, legitimate conviction, justified persuasion) just as deduction does. Furthering our suspicion that something is wrong is a passage in *Posterior Analytics* A5. Here, Aristotle says that knowing something to be true of scalene, isosceles, and equilateral triangles and knowing these are the only three kinds of triangles are not sufficient for knowing it to be true of triangles qua triangles. It may be known of every triangle considered individually, but not of triangles ‘universally.’⁵ But Aristotle repeatedly defines induction as reaching a universal. Thus this complete enumeration of triangles is not an induction. If it were, it would have led to knowing universally, and it did not.

An even larger problem with the conventional reading of *Prior Analytics* B23 is that it is so out of character with everything else Aristotle writes on induction. Though this chapter has attracted considerable, sometimes exclusive, attention, it contains only eight of the ninety-seven instances in the corpus of the noun “induction” (*epagōgē*) or the adjective “inductive” (*epaktikos*, as in *epaktikos logos*, “inductive reasoning”). Only a few are in other parts of the *Prior Analytics*. Aristotle’s most frequent mention of induction, by far, is in the *Topics*, followed by the *Rhetoric* and the *Posterior Analytics*. If we consider these works especially, but also mentions in the *Physics*, *Metaphysics*, and the ethical writings, we find a conception of induction internally consistent but inconsistent with the conventional reading of *Prior Analytics* B23.

Early in the *Topics*, in a short chapter introducing induction, Aristotle says that dialectical reasoning is of two types, induction and deduction.⁶ Elsewhere in the corpus he says the same of rhetorical reasoning, persuasion, learning, teaching, belief, obtaining

⁴ Aristotle includes deer, camel, mouse, and dolphin. *Parts of Animals* 4.2 676a15–7b11.

⁵ *Posterior Analytics* A5 74a25–33.

⁶ *Topics* 1.12 105a10–12.

premises—indeed all kinds of reasoning.⁷ He usually mentions induction first. In a rhetorical context, Aristotle says, induction is no less persuasive than deduction. In a dialectical context, both provide *pistis*.⁸ In the instances in which he says that something can be shown either by induction or by deduction, he makes no suggestion that one method is superior to the other. Whatever exactly induction is for Aristotle, it is one of two, and only two, kinds of equally valid reasoning, and deduction is the other. Neither is a kind of the other. In no unambiguous passage anywhere in the corpus does Aristotle waver on this.

In the same passage in the *Topics*, Aristotle gives a description and an example of induction. ‘Induction . . . is a proceeding from particulars to a universal. For instance, if the pilot who has knowledge is the best pilot, and so with a charioteer, then generally the person who has knowledge about anything is the best.’⁹ Having provided just two particulars, Aristotle makes a remarkably broad generalization. He could not possibly have thought that these were the only two professions in the world or that a complete survey of all professions had been made or even could be made. Yet here, in an introductory remark, Aristotle uses this as an archetypical example of induction. He writes similarly in the *Rhetoric* 2.23. To provide an overview of induction, he gives four examples, the first involving all mothers who speak in paternity cases, the second all irresponsible custodians, the third all wise men honored, and the last all cities ruled by philosophers. In the *Eudemian Ethics*, Aristotle says a universal statement about goodness (*aretē*) is justified by induction, in the *Physics* that a statement about contrariety and

⁷ Rhetorical reasoning: *Posterior Analytics* A 1 71a9–11; *Rhetoric* 1.2 1356b1. Persuasion: *Rhetoric* 1.2 1356b1, 1356b15. Learning: *Posterior Analytics* A18 81a40. Teaching: *Nicomachean Ethics*: 6.1 139b28. Belief: *Prior Analytics* B23 68b14. Obtaining premises: *Prior Analytics* A25 42a3; *Topics* 8.1 155b36; *Physics* 8.1 252a24. Reasoning (*logos*): *Posterior Analytics* A1 71a6.

⁸ *Topics* 1.8 103b2, b7.

⁹ *Topics* 1.12 105a13–19. Smith’s translation, but with ‘proceeding . . . to a universal’ for his ‘proceeding . . . up to a universal’ for Aristotle’s *epi ta katholou ephodos*; and ‘inductive reasoning’ for Smith’s ‘inductive argument’ for Aristotle’s *dialektikōn logon*. An odd aspect of this chapter may be noted. Book 1, at least to this point, is well-structured, and Aristotle maintains a running commentary on where in an outline of his material he is. Yet Chapter 12 does not have a place in the narrated outline. Nor does the content fit neatly. The chapter is also short and succinct, even perfunctory. It seems to me that in it Aristotle is, for the sake of completeness, merely summarizing what he expects his readers to already know. More on this possibility below.

another about causality are. The nature of motherhood, custodial management, honor, civic government, goodness, causal interaction, or contrariety could not possibly be justified by an enumeration of all instances. Aristotle clearly believes that an induction is warranted by something other than complete enumeration and provides universal and reliable knowledge that extends beyond the particulars that went into formation of the generalization.

Our best evidence for what Aristotle thought would warrant an induction is that he does not tell us. He regularly introduces induction to help explain some other, presumably less clear, issue. He generally introduces the term without preface or explanation. He never provides, as he does with so many other subjects, a list of competing views. He never says that his understanding of induction is new, controversial, or contested. In one passage, he mentions induction as third in a list of three. After explaining the first two, Aristotle passes over the third by saying only, ‘What sort of thing induction is, is clear.’¹⁰ Aristotle expected his students to already know what induction is and to assume his own view of it was conventional.

What conception of induction would an Athenian student of the late fourth-century have had? In the *Metaphysics*, Aristotle attributes the introduction of ‘inductive reasoning (*epaktikos logos*)’ to Socrates,¹¹ again without suggesting the term is unfamiliar. In the *Topics*,¹² Aristotle says that effective use of comparisons (*parabolai*) is characteristic of a good inductive reasoner and in the *Rhetoric*,¹³ that the use of such *parabolai* was Socrates’ distinctive method. At the same place in the *Rhetoric*, Aristotle gives an example of what he says is a Socratic induction,¹⁴ and it is comparable to many of Aristotle’s own, including the one involving the pilot and the charioteer. The similarity between that example and the countless portrayals in Plato’s early dialogues of Socrates’ search for universal definition is undeniable. To one of Aristotle’s students, Socrates would have

¹⁰ *Topics* 8.1 157a8.

¹¹ *Metaphysics* M 41078b28.

¹² *Topics* 8.1 4164a16.

¹³ *Rhetoric* 2.20 1393b5.

¹⁴ *Rhetoric* 2.20 1393b4–8. The example is actually of a paradigm, which Aristotle explains is a ‘rhetorical induction’ (*Rhetoric* 1.2 1356b5). In such an induction, the universal is left unstated but silently presumed in subsequent arguments.

been a figure of the fairly recent past and his style of arguing, at least as it was preserved in the Academy, well enough known. When Aristotle used the word *epagōgē*, he expected his students to understand it to be none other than what they would have known to be Socratic induction.

The passage in the *Metaphysics* reads, more fully, ‘Socrates was occupying himself with the excellences of character, and in connection with them became the first to raise the problem of universal definition. . . . For two things may be fairly ascribed to Socrates—inductive reasoning and universal definition.’¹⁵ Two examples can illustrate Socratic induction. In the *Euthyphro*, Socrates and Euthyphro argue back and forth, searching for the definition of piety. Euthyphro proposes a definition. Socrates claims the proposal covers only a subset. Euthyphro concedes and offers an alternative. Socrates says the new proposal is ambiguous. Euthyphro alters it, but to no avail. They start over, not from an example, but from a wider category with hopes of narrowing it. The search continues until Euthyphro is drawn away by other business. In the *Ion*, Socrates observes that the excellent pilot is one who knows best what to do at sea. He makes similar observations about a doctor, cowherd, wool-maker, and military man. Socrates makes the universal statement that the master of any craft ‘is the one who knows best matters falling within its subject-matter.’¹⁶ But this is not an inferential conclusion drawn from premises. Nor is Socrates simply giving examples. The instances here and those in the *Euthyphro* are components of an exploratory process to find the properties that define a class. The ‘inductive reasoning’ and ‘universal definition’ that Aristotle attributed to Socrates are not two unrelated things. For Socrates, inductive reasoning is the iterative, compare-and-contrast process by which one comes to a universal definition. But for Aristotle (maybe for Socrates too; we don’t know) induction can serve a broader end also.

For Aristotle, induction is used to find all properties, not just defining ones, that characterize all and only the members of a class. Aristotle called each such a property an

¹⁵ *Metaphysics* M4 1078b24–29. Ross’s translation, slightly modified. Cf. a similar passage in *Nicomachean Ethics* 6.3 1139b26–33.

¹⁶ The observations here about Socratic induction are drawn from Gregory Vlastos, ‘Editor’s Introduction,’ in *Protagoras*, xxix, n 18 and *Socrates: Ironist and Moral Philosopher*, 267–8. The quote is from p. 268 of the latter.

idion kata hautō, a property that distinguishes by the nature of the thing, or a *proton katholou*, a primitive universal.¹⁷ Such a property counter-predicates and converts with the class just as a definition does, but might not be part of the definition. Having three angles, having three sides, and having angles that sum to 180° are all such properties of triangles. Anything that has one of these properties has the other and is a triangle. Being a rational animal, a featherless biped with broad nails, an animal by nature civilized, an animal that cooks its food, and an animal that laughs all counter-predicate with man, though only the first makes a good definition. While Socrates seems to have offered nothing beyond frustrating interrogation to someone in search of counter-predicating properties, Aristotle offered a whole book of guidelines, book 5 of the *Topics*. Presumably by utilizing such guidelines, Aristotle—outside of the syllogism in *Prior Analytics* B23—concluded that all particulars that are long-lived are also bileless, and vice versa. That is, in that chapter the result of the induction was not the conclusion of the syllogism; it was a conclusion reached elsewhere and used in constructing that syllogism. When Aristotle introduced his discussion with the compressed ‘Induction—or the deduction from induction—is deducing . . .,’ he was using a lecturer’s shorthand and saying, “Let us now discuss induction, that is, let us discuss the deduction that proceeds by incorporating a premise provided by induction. Such a deduction-from-induction is deducing . . .”

We can now see what is really going on in the troubling chapter. Let us follow Aristotle’s account of the syllogism there. The first two premises are

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| (1) Man, horse, and mule are long-lived. | C ₁ , C ₂ , and C ₃ are A. |
| (2) Man, horse, and mule are bileless. | C ₁ , C ₂ , and C ₃ are B. |

From this alone, little more can be said, but then Aristotle converts the second premise.

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| (3) The bileless are man, horse, and mule. | B is C ₁ , C ₂ , and C ₃ . |
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This, the minor premise, along with the first premise, the major, yields the conclusion.

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| (4) The bileless are long-lived. | B is A. |
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¹⁷ Because of its importance, later commentary ignored the other types and used *idion* for *idion kata hautō*. Latin *proprium* is regularly said to be the same as Aristotle’s *idion*, but is in fact the same as Aristotle’s *idion kata hautō*. Aristotle also uses *idion haplos* (distinguishing without qualification) for *idion kata hautō*.

What, however, justifies the conversion from (2) to (3)? Aristotle says the conversion is valid if B ‘does not reach beyond’¹⁸ C, that is, if there are no instances of B outside of C₁, C₂, and C₃. This condition can apply, as here, when there are no Cs beyond those surveyed. But then the conclusion is limited to the particulars surveyed. When the conclusion is meant to apply to the class universally, Aristotle says, it is induction which justifies the conversion, because it is by induction that we know that every instance of C is also B, and vice versa. In the process, the instances drop out, so to speak, and one is left with a universal statement crafted from observations about the particulars, an induction by which distinguishing properties of the particulars were discovered, and a syllogism which provided the formal mechanism by which a statement involving particulars became a statement about universals.

Now this presentation of a revisionist view of *Prior Analytics* B23 is too compressed to be convincing in total,¹⁹ but some understanding of Aristotle’s chapter is necessary to understand the subsequent history of induction. If the history of European philosophy is a series of footnotes to Plato, as Alfred North Whitehead said, the history of induction is a series of footnotes to *Prior Analytics* B23. For our purposes, the important conclusion of the above is that, for Aristotle, induction is not a kind of propositional inference (not even a probabilistic one). It is not a kind of arguing by which some proposition follows (always or usually) from other stated propositions. That, in fact, is Aristotle’s very definition of deduction.²⁰ For him, induction does not work fundamentally at the propositional level. It works at the conceptual level. It is the process by which we compare and contrast things and identify the characteristics that distinguish some from others. The result may be a definition, as it prominently was for Socrates, or may be more generally, as for Aristotle, identification of an *idion kata hautou*, a *proton katholou*, a property that counter-predicates with its subject. In this case, induction is the key

¹⁸ *Prior Analytics* B23 68b24.

¹⁹ For the full argument, see “Freeing Aristotelian Epagôgê from *Prior Analytics* II 23,” *Apeiron: A Journal for Ancient Philosophy and Science* 40:4 (December, 2007), 345-74.

²⁰ *Prior Analytics* A1 24b19; *Rhetoric* 1.2 1356b16; *Topics* 1.1 100a25; *Posterior Analytics* B5 91b15.

component in the production of universal principles, as we see in the Aristotelian discussions about the nature of goodness, contrariety, good governance, and longevity.

This Socratic conception of induction was adopted not only by Aristotle but by his successors. From a report by Philodemus, we can infer it was adopted by both Stoics and Epicureans.²¹ It was also adopted by a contemporary of Philodemus, one of history's most influential writers on induction, the orator and statesman Cicero (106–43 B.C.) He is influential not only because he coined the term *inductio*, which has been universally adopted as the root translation for *epagōgē*, but because he will later be a source for Renaissance conceptions of induction. He treats *inductio* in two works, *De Inventione* (c. 85 B.C.) and the *Topica* (c. 44 B.C.) In both, the second of which is intended as a summary and guide to Aristotle's *Topics*, Cicero associates induction not with Aristotle but with Socrates.²² One of his examples of induction is this: That house which is well-managed is one managed according to a deliberate plan; that army which is well-managed is one managed according to a deliberate plan; that ship which is well-managed is one managed according to a deliberate plan; indeed in general those things which are well-managed are those which are managed according to a deliberate plan. Cicero is not saying that he has checked several instances of well-managed operations, found that they were all managed according to a plan (or vice versa), and then predicted that the pattern would continue. He is instead saying that the very nature of being well-managed is to be managed deliberately rather than haphazardly. As they are in these examples, all cases of being well-managed are cases of being managed according to a plan, and vice versa. The terms

²¹ The term *epagōgē* does not appear much in Hellenistic writing, but the phrase “argument from similarity (*homooitēs*)” does, and Aristotle used this phrase for a certain kind of inductive argument. Philodemus uses it in his account of a disagreement over validation of a certain kind of contrapositive argument. Philodemus reports that the Epicureans accept, but Stoics reject, arguments like this: We know that if Plato is a man (p), Socrates is a man (q), because if Socrates were not a man (not-q), Plato would not be a man (not-p). Though the Epicureans admit that there is no causal link between Plato and Socrates, they argue that one could not form the concept of man without subsuming under it both Socrates and Plato. Though the two sides disagreed on the validity of the argument, they agreed that an argument from similarity, and thus of induction, is not essentially a kind of propositional inference from premises to conclusion, but the reasoning by which our identification of similarities and differences force (or do not force) us to recognize particulars as instances of a class. Philodemus, “Controversy between Stoics and Epicureans”; Asmis, *Epicurus' Scientific Method*, pp. 197–211; Long and Sedley, *The Hellenistic Philosophers*, pp. 93–7, pp. 261–6.

²² *Topica* 42, *De Inventione* 1.31, 35.

counter-predicate. Discovering this, by some process separate from deduction, is what Cicero calls *inductio*. Unlike Aristotle, Cicero gives no guidelines for how to perform the induction. The Roman rhetorician Quintilian (c. 35–c. 100 A.D.) also identified *inductio* as the method ‘chiefly used by Socrates.’²³ Like Aristotle, and Cicero before him, Quintilian wrote of induction as if the reader could be expected to know what it is and that it is a process by which one can identify the essential attributes of a class. In the century after Quintilian, Galen (129–c. 199 A.D.) wrote extensively on induction in his work, *On Demonstration*. Unfortunately, this magnum opus on scientific method, known to run to fifteen volumes, has not survived. But from scattered mentions, we can get a sense of Galen’s view. The central element is that an argument from induction is most definitely not the stringing together of instances and drawing a universal conclusion therefrom. Instead a proper induction discovers the cause that makes something the kind of thing it is. From this, it sounds like Galenic induction is the same thing it had been since Socrates, but from other comments, we get a sense that there might be a debate brewing not just over which inductions can provide reliable conclusions, but over the very nature of induction.²⁴

Aristotle said that induction is a proceeding from particulars to a universal, but there is an ambiguity here. Did he mean particular things and universal ideas or particular and universal statements? From Socrates to Galen, the first of these was presumed. In *Prior Analytics* B23, the particulars were not particular statements, but particular animals (or kinds of animals). The universal was a property shared by all of these particulars. It was not the conclusion of the syllogism or even some other proposition. This was the view of induction at least till the time of Galen. Across the five centuries we have surveyed there were debates about whether and how one could know or discover what properties are shared by all members of a class and debates about how to convert knowledge about particular instances into universal propositional knowledge, but induction was not

²³ *Institutio Oratoria* 5.11.3.

²⁴ From *In Hippocratis librum de officinali medici commentarii iii*, we learn that in Galen’s day induction was generally associated with Plato, that is, with Socrates. In *De simplicium medicamentorum temperamentis ac facultatibus*, Galen insists that some people now misunderstand the nature of induction. He indicates his own thinking in *Galenii Isagogici Libri*.

conceived fundamentally to be a kind of inference, that is, not a kind of reasoning in which we draw a propositional conclusion from the truth of given propositional premises. Socratic induction is not a kind of inference but the method of forming valid, well-delineated concepts. The ancients did not think of induction as a defective form of deduction. Induction was not a kind of propositional inference but a kind of abstraction.

(2) **Scholasticism: Father, Son, and Holy Ghost**

The Neoplatonists of late antiquity introduced a new way to think about induction. By the earlier understanding, universals are obtained by examining particulars. To gain universal knowledge of courage, for example, one looks at courageous deeds, compares them to each other and to uncourageous deeds, and determines the group of characteristics that distinguish courageous from uncourageous.²⁵ The universal is thus empirically accessible. It can be discovered by observation, for it has some kind of existence in the world of perceived particulars. But the Neoplatonists (and the Christians of late antiquity) did not share this confidence that the universal could be obtained by observation of particulars, for they believed universals have an existence prior to the existence and observation of particulars. They accepted that induction is the progression from particulars to a universal, but for them if induction were to have any reliability it would need to mimic the method of reasoning they most trusted, the one that proceeds from prior universals to dependent particulars, that is, deduction. The understanding of induction they developed was the result of a long series of small changes to the conventional view. While each step claimed sanction in Aristotle, together the steps amounted to a wholly new view of the nature of induction.

The first step appears in the early Church Father Clement (c. 150 A.D.) He was well trained in Greek philosophy and became head of the Christian catechetical school in Alexandria in 180 A.D. His life thus overlapped Galen's. He actively sought to reconcile various aspects of Greek philosophy with Christianity and greatly influenced early development of Christian theology. He discusses induction in book 8, chapter 6 of *The*

²⁵ That one can know instances of a kind before having a definition of it Aristotle explicitly asserts. E.g., *Topics* 1.14 105b25–29.

Stromata. The chapter demonstrates familiarity with Plato and Aristotle as well as a desire to reconcile the two. But the attempt forces Clement to contradict or misread Aristotle. In the chapter, Clement discusses definitions and their sources. He says, 'Induction leads to the universal and the definition.'²⁶ In this he is wholly conventional. But his understanding of the process is new. Clement takes material from *Posterior Analytics* B5–7, and casts it as saying that a definition is the 'summation resulting from Division,'²⁷ that is, that the whole is defined by a complete enumeration of its parts. Now this is a terrible distortion of the *Posterior Analytics*. Aristotle stresses, contra Plato, that definitions are not the result of division, not that they are. Clement co-opts the style, structure, and language of Aristotle but defends a Platonic rather than Aristotelian position. It is not clear whether Clement was intentionally offering a new view of definition and induction or he was simply misreading Aristotle. But either way, by acknowledging that the process of determining a definition is induction but then saying that definition of a whole results from a complete enumeration of its parts, Clement introduced the idea that induction obtains its force from some kind of complete enumeration. And by adopting the language and structure of Aristotle's text, Clement began the process of attributing this view to Aristotle.

About twenty years after Clement became head of the ecclesiastical school in Alexandria, Alexander of Aphrodisias was teaching Aristotelian philosophy, possibly in Athens. He too overlapped with Galen, and in fact the two corresponded. Alexander is generally considered the last thoroughly Aristotelian philosopher of antiquity, but regarding induction he joined Clement and broke with his master. Recall that Aristotle's treatment of induction is primarily in the *Topics*, the *Rhetoric*, and the *Posterior Analytics*, and from these a consistent Socratic view of induction emerges. In a commentary on that introductory chapter from the *Topics* discussed earlier, Alexander rejects the established view. 'For the universal does not follow by necessity from the particulars . . . because we cannot get something through induction by going over all the

²⁶ *Stromata* 8.6.

²⁷ *Stromata* 8.6.

particular cases, since the particular cases are impossible to go through.²⁸ For understanding induction, one should not, Alexander says, look to the *Topics* but to chapter B23 of the *Prior Analytics*, and there one should understand Aristotle to say that inductive justification is subsumed under syllogistic justification and that nothing substantive need be said about induction beyond what must be said about deduction.²⁹ Alexander recognized that this proposed reading of B23 is inconsistent with what is in the *Topics*, but he held that the chapter in the *Prior Analytics*, read as he read it, is Aristotle's definitive treatment.

In the next century, the third, Diogenes Laertius preserved the older view,³⁰ but others such as Sextus Empiricus adopted the new emerging skepticism about induction. He wrote:

It is also easy, I consider, to set aside the method of induction. For when they propose to establish the universal from the particulars by means of induction, they will effect this by a review either of all or of some of the particular instances. But if they review some, the induction will be insecure, since some of the particulars omitted in the induction may contravene the universal; while if they are to review all, they will be toiling at the impossible, since the particulars are infinite and indefinite. Thus on both grounds, as I think, the consequence is that induction is invalidated.³¹

In the fourth century, the Greek commentator Themistius took the step that Clement had not explicitly taken, that of attributing to Aristotle the view that *Posterior Analytics* B5–7 claims a valid induction is an enumeration of all subsumed particulars.³²

It was around 500 A.D. that the new understanding became firmly entrenched, for at that time it got incorporated into a new grand Neoplatonic reinterpretation of Aristotle executed by the school in Alexandria that included Ammonius Hermiae, Simplicius, and

²⁸ *On Aristotle's Topics* 86.25–28.

²⁹ *On Aristotle's Prior Analytics* 1.1–7 44.1–3.

³⁰ "Plato," *Lives of the Eminent Philosophers* 3.53.

³¹ *Outlines of Pyrrhonism* 2.15, as quoted in Milton, "Induction Before Hume," 56. Note that here the particulars are things, not propositions. Cf. Alexander, *On Aristotle's Topics* 86.27–32.

³² *Analyticorum Posteriorum paraphrasis*, 5.1 44–46 in *TLG*, 2.8 in *CAGL*.

John Philoponus. It is difficult to know who gets credit for which innovation, but together they integrated several distinctions that Aristotle had made but left unconnected, including deduction vs. induction, better known by nature vs. better known to us, prior vs. posterior, and knowing the fact vs. knowing the reasoned fact.³³ The result was a mighty synthesis, but in making all the pieces fit, the Alexandrian Neoplatonists significantly altered several of Aristotle's views. A couple of these alterations had a lasting influence on understandings of induction.

Aristotle drew a distinction between that which is better known with respect to us (*pros hēmas* or *hēmin*) and that which is better known with respect to nature (*phusei* or *haplōs*). By the first he meant that which is nearer to sense-perception; to know *pros hēmas* is to know things as particulars. To know with respect to nature, on the other hand, is to know things as instances of universals, to know them generally (*haplōs*) or by their nature (*phusei*, literally, from the perspective of their coming to be what they are).³⁴ What he means by the difference may not be clear, but in both cases Aristotle is talking about knowledge of the perceived world *by man*. But the Alexandrians took it otherwise. For these Neoplatonists, universals have an existence outside human consciousness. Philoponus held that "better known with respect to nature" did not mean "known *by man* with regard to the essential nature of the subject matter," but actually "known *by nature*." That is, for Philoponus and his colleagues, there are two kinds of knowers, two kinds of conscious beings, man and nature. For man the knower, particulars are epistemologically prior. They are what he knows best and first. For nature the knower, universals are epistemologically prior. They are what nature knows first and best. From nature's perspective, particulars are posterior and derivative. Indeed in Neoplatonism, it is the universals known by nature that give the particulars known by man their very existence. The universals are the prior causes, particulars the posterior effects. Argument from

³³ For an examination of the synthesis and its originality, see Donald Morrison, "Philoponus and Simplicius on Tekmeriodic Proof." For background, see Richard Sorabji, ed., *Philoponus and the Rejection of Aristotelian Science*. Key texts for purposes are Philoponus's commentaries on the *Prior* and *Posterior Analytics* and Simplicius's commentary on the *Physics*.

³⁴ Recall that Aristotle used *idion haplos* as a synonym for *idion kata hautō*, the kind of characteristic induction identifies.

universal to particular, i.e., deduction, thus became argument from the prior, i.e., argument *a priori*. Induction became argument *a posteriori*. Deduction came to be argument from causes and induction argument from effects. But arguing from cause to effect was, in Aristotle, knowing the reasoned fact, which is knowing a syllogism in which the cause is the middle term. Arguing from effect to cause was knowing the fact, knowing a syllogism in which the effect was the middle term. Induction, then, was just a kind of syllogism. It was a problematic one, however, because although one can reliably argue from cause to effect, one cannot reliably argue from effect to cause, for a given effect can have any number of different causes. Though in its omniscience the knowledge nature has is certain, man can never know ultimate causes with certainty, since he can argue only from the particular effects he observes.

It was all a comprehensive and influential synthesis. It dominated thinking about Aristotle, about induction, and about the relation between induction and deduction for the next thousand years, and its effects are still with us. But the synthesis required contravening Aristotle at key junctures. In fact, it probably would never have caught on and become so embedded—or at least not attributed to Aristotle—if not for the way Aristotle's works were subsequently transmitted. With the Alexandrians, the ordering of Aristotle's *Organon* became finally fixed. The order was top-down, from the most abstract and general to the more concrete and particular. The first work, the *Categories*, introduces such abstractions as substance, quantity, quality, and so on. Next, *On Interpretation* introduces propositions and the relations between words. The *Prior Analytics* examines logical reasoning and the *Posterior Analytics* scientific investigation. Lastly, the *Topics* is a practical handbook for debaters, *Sophistical Refutations* and (when included) the *Rhetoric* an extension of the *Topics*. All this was prefaced by an introduction, the *Isogoge*, by the Neoplatonist Porphyry. Over time, the works of the *Organon* were lost or replaced back to front. In the West, Aristotle's *Topics* and its affiliated works got replaced by Boethius's. Reading of the *Posterior Analytics*, in both East and West, was discouraged on religious grounds. By the seventh century, it was a rare reader who got to even the second book of the *Prior Analytics*. Thus, for readers after

the sixth century, the first substantive mention of *epagōgē* they would encounter was that unclear statement, “Induction—or the deduction from induction—is deducing” Whatever explanatory aid existed came from the Greek Neoplatonist commentators.

The first Islamic commentator to paraphrase and gloss the whole *Organon* was al-Fārābī (early 870s–950) in Baghdad.³⁵ He was the first pivotal figure in the transmission of Aristotelian logic from its Syriac inheritors into Arabic and thus eventually back into Latin Scholasticism. His renown gained him the title Second Teacher (Aristotle being the first). Al-Fārābī’s commentary on the *Prior Analytics* includes a considerable treatment on induction (six percent of the whole treatise), and his treatment is detailed, careful, and systematic. By all the conventional teaching to which al-Fārābī would have been exposed, induction is a kind of deduction effected by complete enumeration. But unlike his immediate predecessors, al-Fārābī read the books in the second half of the *Organon* and there found that Aristotle claims not that induction is a kind of deduction but that it is another way of knowing that provides the premises for deductions. Regardless how frequently and forcefully Aristotle says this, al-Fārābī was working within a framework inherited from the Alexandrian Neoplatonists, and he rejected Aristotle’s position. Given his starting position, his argument is acute and forceful. ‘It may be intended to show something by an induction in order to use the thing as [a universal] premiss in a syllogism.’³⁶ He argues from this example:

- (1) Every motion takes place in time.
- (2) Swimming is a motion.
- (3) Therefore, swimming takes place in time.

Either, al-Fārābī says, swimming was not considered when using induction to develop the major premise, in which case the premise cannot be known to be true; or swimming was considered, in which case the syllogistic argument is superfluous, or worse, an improper

³⁵ For an introduction to Al-Farabi, see Majid Fakhry, *Al-Farabi, Founder of Islamic Neoplatonism*. For details important to the history of induction and transmission of the *Organon*, see Nicholas Rescher, “Al-Farabi on Logical Tradition,” and Rescher’s introduction to Al-Farabi, *Short Commentary on Aristotle’s Prior Analytics*.

³⁶ *Short Commentary on Aristotle’s Prior Analytics* 7.265.15–16.

attempt to show something better known by means of something less known.³⁷ In either case, induction cannot provide the universal premise on which a proper syllogistic inference depends—contra the position Aristotle takes in the second four books of the *Organon*. Al-Fārābī went on to offer his own theory about how universal premises are to be developed, but for us here, the importance of al-Fārābī is this: He approached induction not from the *Topics*, *Rhetoric*, or *Posterior Analytics*, but by working through the *Prior Analytics* beginning to end. At the end he found that troublesome statement, “Induction—or the from-induction deduction—is deducing” This and the Neoplatonic commentary gave him the standard to which all his subsequent study of induction had to conform. When he read something else in Aristotle, he concluded Aristotle was wrong.

Like al-Fārābī and philosophers before Clement, Avicenna of Persia (Ibn Sīnā, 980–1037), recognized that Aristotle believed induction is used to identify the essential nature of something, and the identification in turn provides universal propositions that can be used as premises in syllogisms.³⁸ But, following al-Fārābī, Avicenna said Aristotle is wrong here and induction just cannot do this. Avicenna forcefully articulated the Alexandrian reading of *Prior Analytics* B23 and explicitly said that induction is a kind of deduction. He then launched a powerful criticism of the kind of induction he found in the rest of Aristotle’s writings. This Aristotelian (and Socratic) induction, Avicenna claimed, was caught in a hopeless circularity: One cannot define courageous deeds by considering instances; for one cannot know which deeds are courageous without having a definition of *courageous*. Avicenna concluded that induction is incapable of providing the necessary and universal premises needed for deduction. It should not be surprising that if induction is a kind of deduction then it would be circular to try using it to ground deduction, but Avicenna was the first to work this out so forcefully.

³⁷ The argument was anticipated, though not as fully developed, by Sextus Empiricus and Alexander, above. Note that while Alexander made his argument while commenting on the *Topics*, al-Farabi made his while commenting on the *Prior Analytics*.

³⁸ Jon McGinnis, “Scientific Methodologies in Medieval Islam.”

The third of the major figures in the transmission and development of Aristotelian epistemology in Islamic philosophy was Averroës (1126–1198) in Spain. He articulated the mature and unambiguous Arabic view: '[Induction] is an argument which has the force of the syllogism in the first figure, since the minor term is that universal matter, the middle the particulars, and the major the judgment.'³⁹ This statement comes not from Averroës' discussion of the *Prior* or *Posterior Analytics*, but from his commentary on the *Topics*, a work originally lacking the *Analytics*' technical vocabulary with which Averroës is now interpreting it.

Although these Arabic commentators were major carriers of Aristotelianism back into the Latin West, Aristotle's ideas had not been wholly lost in Europe. In modified form, they survived in the translations, commentaries, and treatises of Boethius (c. 476–524).⁴⁰ Throughout these writings, Boethius held that an induction is just a secondary kind of deduction. 'Whether [something] is an enthymeme, induction or example, it takes its force as well as the belief [it produces] most of all from the syllogism; and this is shown in Aristotle's *Prior Analytics*, which we translated. So it suffices to discuss the syllogism which is, as it were, principal and inclusive of the other species of argumentation.'⁴¹ As did the Alexandrians, Boethius considered *Prior Analytics* B23, and not the *Topics*, to be Aristotle's authoritative treatment of induction. Boethius translated into Latin not just the *Prior Analytics* but the *Topics* as well. These two translations, however, were generally displaced by Boethius's own *On Categorical Syllogisms* and *De Topicis Differentiis*, respectively. They were widely used into the sixteenth century. All Boethius's writings presented the same simplified view of induction as a kind of deduction and in fact were the source for the work most responsible for the canonical view of induction in the medieval Latin Scholasticism, Peter of Spain's *Tractatus* (or *Summule Logicales*).

Peter's *Tractatus* was the most popular and most emulated textbook of the late Middle Ages. In the Renaissance alone it was reprinted over a hundred and sixty times.

³⁹ *Short Commentary on Topics* 48.

⁴⁰ On Boethius's influence in logic, see John Marenbon, "Boethius's Influence in the Middle Ages"; Jonathan Barnes, "Boethius and the Study of Logic"; Osmund Lewry, "Boethian Logic in the Medieval West"; and David Lindberg, "The Transmission of Greek and Arabic Learning to the West," pp. 53–4.

⁴¹ *De Topicis Differentiis* 46 1184D6–15. The second emendation is the translator's; the first is mine.

Virtually every textbook of so-called Aristotelian logic since the thirteenth century has followed the structure of the *Tractatus*, and that structure derives not from the *Organon*, but from Boethius. Peter's whole treatment of induction is, 'Induction is a progression from particulars to universal. For instances, Socrates runs, Plato runs, Cicero runs, et cetera; therefore every man runs.'⁴² He later mentions that the syllogism is a perfect and complete way of arguing, that there are many ways an otherwise perfect thing can be deficient, and that induction is one kind of imperfect syllogism.⁴³

Other Scholastics followed Peter in this, but they gave much more attention to exactly how one may correct the deficiency and make an induction into a good syllogism. If the list is numerable, there is little difficulty. When the list is not numerable, the corrective, Scholastics explain, is the addition of "et cetera" (or "et sic de aliis" or "et sic de singulis"). This addition gives an induction the form of a first-figure syllogism that can provide a universal conclusion. Albert (c. 1200–1280) gives this example,

- (1) Everything that is this man, or that man, et cetera, is an animal.
- (2) Every man is this man, or that man, et cetera.
- (3) Therefore, every man is an animal.⁴⁴

Albert's treatment became canonical for centuries. Note that all his particulars are of the same kind. In the Aristotelian passage on which Albert is commenting, the instances are three different kinds of animals, i.e., man, horse, and mule. But in Albert's example there is just one kind. By the Socratic understanding of induction, instances should be widely varied. To identify the essence of courage, for example, one should survey many kinds of courageous deeds. To understand longevity of animals one should consider several kinds of long-lived animals. But by the alternate understanding, induction is essentially enumeration (complete or otherwise), and the instances, as Albert understands them here, should all be of the same kind. Thus the instances are man #1, man #2, man #3, etc. If the instances are all surveyed—or it is pretended so by adding "et cetera"—then the

⁴² *Tractatus* 56.12–15. My translation.

⁴³ *Tractatus* 90.1–11.

⁴⁴ *Commentary on Prior Analytics* 2.7.4 794. My translation.

induction, i.e. the enumeration, is complete, and can be given the form and force of a syllogism. For Albert, variety in the instances in an induction is not required or desired.

Even though Europeans gained more access to the Aristotelian corpus in the thirteenth century, Albert's successors made little change to the established conception of induction. The project they undertook instead was to find a way to reconcile this canonical conception with the newly discovered mentions of induction elsewhere in the Aristotelian logical and scientific corpus. None of those mentions were concentrated, explicit, and unambiguous enough to dissolve the now calcified understanding. But they were there nonetheless and commentators must comment. The commentators introduced a host of distinctions, including formal vs. material reduction to syllogism, formally valid vs. materially valid, induction vs. abstraction, and regular induction vs. demonstrative induction, all designed to let them say that in the newly discovered mentions of induction, Aristotle was referring to something other than regular induction. Duns Scotus (1265–1308) offered extended and important commentary on the relationship between particulars and universals, but none of it is cast in the language of induction. When he uses the term, it always means the survey of a finite list. It was the same with William of Ockham (c. 1285–1349?). His example of an ideal induction was one that concluded something is true of God because it is true of the Father, Son, and Holy Ghost.⁴⁵

Even after Latin theoreticians gained access to virtually the entire Aristotelian corpus, their understanding of induction remained remarkably conservative. They fully adopted the Alexandrian synthesis, held *Prior Analytics* B23 to be Aristotle's definitive treatment, and held that this chapter claimed induction gained its force by being rendered a syllogism. The few mentions of induction in the *Posterior Analytics* and elsewhere caused some difficulty, but the mentions were isolated and incidental enough that they could be addressed creatively or just dismissed. A partial explanation for why access to the Aristotelian corpus did not pose a greater challenge is that Scholastics had relatively little interest in Aristotle's *Topics*, the main source of the alternate view of induction. For that

⁴⁵ *Summa Totius Logicae* 3.31–35.

field, Boethius's version remained dominant. There was much greater interest in Aristotle's *Physics*, and this work indirectly supported the conventional understanding of induction because its prominent discussion of "better known with respect to us" and "better known with respect to nature" in book 1, chapter 1, could be fully assimilated into the Alexandrian synthesis. So by a sort of package deal, induction got swept up into a comprehensive and largely Neoplatonic interpretation of Aristotelian epistemology. Not until the *Topics* of Aristotle and of Cicero gained attention, and not until there was broader familiarity with Socratic induction, was the Alexandrian interpretation of induction challenged. That challenge came with the arrival of Renaissance humanism. From Clement until the Renaissance, the Higginsian attitude prevailed: Induction was worthy to the extent it looked and acted like deduction.

(3) Renaissance Humanism: Returning the stolen horse

Though Jean Buridan, a contemporary of Ockham's, was probably the first to challenge the established canon, the big change came in the following century, the fifteenth, when the Scholastic study of logic got complemented by a humanist one.⁴⁶ Four aspects of this innovation were important for the history of induction. The new logic was as disputatious as the Scholastic, but instead of training a student to memorize the categories, moods, figures, forms, and rules by which a syllogistic conclusion is drawn, it trained the disputant in a broader project, which included not just drawing the conclusion but developing the premises, and not just using canonical syllogistic forms but

⁴⁶ Buridan agrees with his predecessors that an induction can be turned into a deduction by adding "et cetera" to the list of particulars. But, he insists, the "et cetera" can legitimately be added only when it serves as a shorthand for a finite and surveyable list, such as the list of heavenly planets. Unlike his immediate predecessors, however, Buridan does not think that the inability to legitimately add "et cetera" and to thus convert an induction into a deduction poses any threat to the validity of inductive conclusions generally. For Buridan, an induction with a finite and surveyable list of particulars is hardly induction at all. If it is induction, it is a special case. Induction, properly, is not the inferential process described by the established understanding of *Prior Analytics* B23, but, Buridan insists, the process of abstraction described in *Posterior Analytics* B19. (*Summulae de Dialectica* 6.1.4, 6.1.5, 8.5.4.) For the first time, someone faced with the inconsistency between these two passages gave the second preference.

By a happenstance of history, Buridan's view on induction had relatively little effect. It appeared in the parts of his *Summulae de Dialectica* that got replaced regularly in manuscript and always in print by the commentary of John Dorp. Buridan's views on induction have never been printed in Latin. An English translation appeared only in 2001.

marshalling other types of argument as well. The second aspect was a change in pedagogic material. Medieval logic traced its roots, whether through Scholastics, Islamic writers, Peter, Boethius, the Alexandrians, Epicureans, or Stoics, back to the first books of Aristotle's *Organon*. The new logic found its home instead in the *Topics*, the catalog, whether Aristotle's, Cicero's, or Boethius's, of tools for composing a persuasive argument. The centrality of the *Topics* has recently gotten the new logic labeled "topics-logic."⁴⁷ Third, the preeminence of Cicero in humanist scholarship and the injunction to return to ancient sources broke the monopoly that Boethius's *De Topicis Differentiis* had on the field. Aristotle's own *Topics* and Cicero's *Topics* gained attention. Both presented a different view of induction than Boethius's. The fourth important aspect of the shift was access to the Platonic dialogues, which first became accessible with the rise of Greek literacy in the early fifteenth century and accelerated with the Latin translations late in the century. In these texts, students of persuasion met the man Cicero and Aristotle said was the great practitioner of inductive reasoning. The *Topics* of Cicero and Aristotle and the Socratic dialogues of Plato all presented an understanding of induction different than the received view. The result would be disagreement, confusion, eclecticism, and eventually a gentle disregard of the old view. The first important agent of change was the Italian Lorenzo Valla (1407–1457). He brought Socrates, the *Topics*, and Cicero fully back into the discussion of induction.

Cicero, who recall coined the term *inductio*, had been absent from the discussion of the subject since antiquity, but Valla begins a full chapter on induction in *Repastinatio Dialectice et Philosophie* (1439) with this: 'Cicero defines induction as follows, and offers the following example.'⁴⁸ Valla quotes Cicero's definition and one of Cicero's examples, and then writes, 'Boethius, who followed a different school, disagrees with this definition and example.'⁴⁹ Valla insists that Boethius has stolen and corrupted the proper view of induction, a view Valla associates partly with Cicero, and even more with Socrates. Valla

⁴⁷ On topics-logic and these trends, see E. J. Ashworth, "Traditional Logic" and "The Eclipse of Medieval Logic"; and Lisa Jardine, "Humanistic Logic" and "Humanism and the Teaching of Logic."

⁴⁸ *Repastinatio dialectice et philosophie* 3.16.1. My translation.

⁴⁹ *Repastinatio dialectice et philosophie* 3.16.3. My translation.

says that Boethius acts like someone who has stolen a horse and tries to hide the theft by cutting and dyeing the horse's hair.⁵⁰ Valla plans to unmask the crooks. He criticizes those who try to get around the fact that they cannot enumerate all of induction's particulars by adding "et ita de singulis" to account for the unobserved. This is fatuous, he says, for if the claim is true, then it is just a statement of the conclusion. He similarly dismisses those who add the premise, "And these are all the particulars." Indeed, he insists, all attempts at rendering an induction as some kind of deduction miss the point that induction and deduction are two completely separate things, neither a form of the other.⁵¹ Valla says that there have been several proposals about the nature of induction and the popular ones are simply wrong. Many of what others have called instances of induction are just not so. The only style of arguing, Valla says, that can properly be called induction is that of Socrates.

Valla's successor in the campaign to promote topics-logic was the Dutch humanist Rudolph Agricola (1443/4–1485), whose *De Inventione Dialectica* would, decades after his death, become a very popular textbook across Europe. Agricola cites Cicero and Socrates as the authorities on induction and gives this example:

[One] asks whether it is admitted that the soul is better than the body. But this also must be built up from a Socratic induction. It must be asked whether the driver is superior to his chariot, the helmsman to his ship, the master to his house, and the ruler to his people, or in general whether he thinks that that which commands is superior to that which serves, and whether he thinks the body is ruled by the soul. Which if he concedes it, it will be necessary for him to concede that the soul is superior to the body.⁵²

This is indeed a good example of Socratic induction. The particulars are varied, the results depend on coming to understand the essential nature of "to command" and "to be superior," and the conclusion is valid for instances beyond those surveyed. Agricola says

⁵⁰ *Repastinatio dialectice et philosophie* 3.16.5.

⁵¹ *Repastinatio dialectice et philosophie* 3.16.14.

⁵² *De Inventione Dialectica* 2.18. My translation.

little else on induction, but importantly, in this popular textbook, he holds that the authorities on the matter are Cicero and Socrates.

Buridan, Valla, and Agricola notwithstanding, in the early 1480s, thirty years after the invention of printing, almost everything one would read on induction told a common, Scholastic and Higginsian, story. In the late fifteenth century, the most popular logic textbooks were still Peter of Spain's 250-year-old *Tractatus* and the modification of it edited by Buridan. These remained the models for many textbooks, including the popular epitomes published for students at Oxford and Cambridge.⁵³ The Boethian translations of the *Organon* were still standard, Boethius's treatise on the *Topics* was still widely preferred to Cicero's or Aristotle's, and Boethius's logical treatises were still popular.⁵⁴ All these, as well as Scholastic treatises and Arabic commentaries still widely read, presented essentially one view of induction.

But starting in the 1480s, texts emerging from the presses offered a different view. In 1484, all of the Socratic dialogues became available in Marsilio Ficino's new Latin translation. It thus became easier to see what Aristotle meant when he said Socrates introduced induction. About a dozen years later (1495–98), nearly the whole Aristotelian corpus in the original Greek was published by Aldus, facilitating new translations and further consideration of everything Aristotle had to say on *epagōgē*. Starting in 1493, commentaries began to deal with the *Organon* as a whole instead of with books in isolation.⁵⁵ Ancient Greek commentaries by Alexander, Philoponus, Simplicius, and others began to appear in Latin translations.⁵⁶ Though these presented the received view of induction, they added new perspectives that needed to be integrated and reconciled. Editions of Cicero's *Topics*, with its Socratic view of induction, were printed in Venice in 1480, 1484, 1485, 1492, and 1495. Valla's *Repastinatio Dialectice et Philosophie* came into print, and Agricola's *De Inventione* was finally published in 1515. In 1525, the Aldine

⁵³ *Libellus sophistarum ad usum Cantabrigiensium* and *Libellus sophistarum ad usum Oxoniensium*.

⁵⁴ Anthony Grafton, "Epilogue: Boethius in the Renaissance"; Osmund Lewry, "Boethian Logic in the Medieval West," p. 121; F. Edward Cranz, *A Bibliography of Aristotle Editions: 1502–1600*; Henri Durel, "Francis Bacon lecteur d' Aristote à Cambridge."

⁵⁵ Ashworth, "Traditional Logic," p. 144.

⁵⁶ For just the most important, see the thirty or so volumes of reprints in *Commentaria in Aristotelem Graeca: Versiones Latinae temporis resuscitatarum litterarum (CAGL)*.

edition of Galen's works in Greek exposed his attitude toward induction. In the 1520s, Aristotelian texts and commentaries in the established model dropped sharply, but a new and vigorous humanist Aristotelianism emerged just as sharply starting with the Latin *Opera* published in 1538. The 1540s saw new translations, new commentaries, and new concerns.⁵⁷ Underexplored works in the corpus such as the *Posterior Analytics*, *De Generatione et Corruptione*, and the *Rhetoric* attracted new attention.⁵⁸ Among many the *Posterior Analytics* came to be seen as the book about induction and the *Prior Analytics* the book about deduction.⁵⁹ Study of Aristotelian induction could no longer be limited to simply what was found in *Prior Analytics* B23.

In the last book of the *Topics*, Aristotle had said that what induction is, is clear, and in a short chapter in the first book, he offered a plain description. In a commentary on that very chapter, published in 1542, the prolific and influential Paduan commentator Agostino Nifo wrote that the nature of induction had become a matter of vexing disagreement.⁶⁰ Is it a kind of deduction or something else? If something else, is it a kind of reasoning? Must all singulars be included or are merely some sufficient? Is the result of an induction categorical or hypothetical? Is an induction one proposition or many? If induction is an argument, what is the middle term? Where does it come from? By what ability does the mind form inductions? The confusion made its way into textbooks. In England, the two new textbooks popular mid-century were John Seton's *Dialectica*, first published in 1545, and Thomas Wilson's *The Rule of Reason*, first published in 1551. Seton

⁵⁷ The vigor of and large changes within Renaissance Aristotelianism have been the subject of several articles, monographs, conferences, and edited volumes. Some entries to the literature, especially as it regards the current topic, are works by F. Edward Cranz, Edward P. Mahoney, Constance Blackwell, Eckhard Kessler, Daniel A. Di Liscia, Marianne Pade, Charles Schmitt, E. J. Ashworth, and Charles Lohr listed in the bibliography.

⁵⁸ For *De Generatione et Corruptione*: Eckhard Kessler, "Metaphysics or Empirical Science, The Two Faces of Aristotelian Natural Philosophy in the Sixteenth Century." For the *Rhetoric*: Keith V. Erickson, *Aristotle's Rhetoric: Five Centuries of Philological Research*, p. 12.

⁵⁹ Evidence for this comes from a humorous and unusual source. In 1544 the Protestant apologist Celio Secondo Curione, an Italian professor living in Switzerland, published a defense of Protestant views in the form of a tale. In the tale the character Pasquine recounts a trip he made to heaven. Before he learns how to get to heaven, Pasquine comes upon a friar. In a pun a reader was expected to understand, the story goes, 'He [the friar] complained that his father Prior commended much more that part of Aristotle called *Posteriora*, than the other called *Priora*, and that being in this preposterous opinion, he never used demonstrations, but only induction.' Celio Secondo Curione, *Pasquine in a Traunce*, f. 10v.

⁶⁰ *Aristotelis Stagiritae Topicorum libri octo*, f. 18v.

places his treatment of induction in the conventional location and begins it in the conventional way. But he then begins to deviate. Instead of saying induction is a kind of deduction made whole by addition of “et cetera,” he describes it as an inverted syllogism, rising from particulars rather than descending from universals. This recalls Aristotle and Cicero. The textbook author summarizes Agricola, and says induction is abstraction according to Themistius. ‘Induction is called Socratic, because Socrates used it so frequently.’⁶¹ Thus in Seton’s chapter nearly all traditions made an appearance, but the author made no attempt to sort them out. In *The Rule of Reason*, Thomas Wilson at least tried. In his first edition, he gave a thoroughly conventional Scholastic treatment.⁶² But in the second edition, ‘newly corrected,’ published only one year later, Wilson added a section, longer than the first, discussing what he explained is another kind of induction, “called by the learned, Socrates['] Induction.”⁶³ It is clear from his examples that, try as he might, Wilson did not understand this newfangled induction. From neither Seton nor Wilson could a student have come away with an understanding of induction any more settled than the discussions of Nifo and his colleagues.

Into this eclecticism stepped Francis Bacon (1561–1626). More engaged in Aristotelian and Renaissance philosophy than generally recognized nowadays,⁶⁴ Bacon was the first to explicitly make induction the centerpiece of an epistemological system, and his conception of induction was essentially that of Socrates and (properly understood) of Aristotle. It is to Socratic induction that Bacon refers when he says, ‘[the correct procedure] has not yet been done, nor even certainly tried except only by Plato, who certainly makes use of this form of induction to some extent in settling on definitions and ideas.’⁶⁵ Bacon’s induction is a codification of Socrates’.

⁶¹ *Dialectica*, bk. 3, K3v.

⁶² *The Rule of Reason*, ff. 64v–68r.

⁶³ f. 66r in the 1552 edition; f. 32v in following editions. The sentence means that learned men call this kind of induction “the Induction of Socrates,” not that the learned Socrates called it “Induction.” An apostrophe to show possession was not yet standard. Any ambiguity was removed in 1553 and subsequent editions by addition of the comma after ‘learned’ as well as a marginal heading, ‘Socrates Induction.’

⁶⁴ To give just one bit of evidence: In about a page of introductory remarks to the *Novum Organum* (in the *Distributio Operis*), forty-one times Bacon uses or cites technical terms or issues in recent Aristotelian scholarship. He knew his Aristotle, or at least Scholastic Aristotelianism, and presumed his readers did too.

⁶⁵ *Novum Organum* 1.105.

Bacon came to induction late and indirectly, for his interest was not primarily epistemological but practical. He sought some method by which someone could confidently make things that had never been made before. The method would need to ensure two things, what he called certainty and liberty.⁶⁶ The first, Bacon thought, was easy—if one ignored the second. It takes no great genius or much method to know that heat melts butter (my example, not Bacon’s). The next dollop thrown on the skillet will melt. We can continue doing what we have always done, and we know what will happen. But what of cheese? What about wax? Clay? What about a new artificial material, envisioned but not yet produced? As we exercise our liberty, as we try things increasingly dissimilar, we lose our certainty—at least without a proper method. Bacon wanted a method that would allow liberty without sacrificing certainty.

To solve his problem Bacon turned to Aristotle’s concepts of *kata pantos* and *katholou proton*.⁶⁷ A property that is true *kata pantos* is true for *all* members of a class. But a property that is true *katholou proton*, recall, is true of *all and only all* members of a class. Thus a proposition predicating a *katholou proton* property is convertible; that is, subject and predicate can be swapped. All triangles have angles that sum to 180° , and any polygon whose angles sum to 180° is a triangle. This suggests a rule: If you want a polygon whose angles sum to 180° , make a triangle. But even if the properties are *katholou proton*, the rule may not be useful. Having a flat surface, feeling smooth, appearing bright, and being able to see your face in it may all be *katholou proton* properties of a metal, but to make a metal all of these, you need to know which causes the others, or, to use Bacon’s term, which is more ‘original.’⁶⁸ It is not enough to know that properties ‘cluster and concur,’⁶⁹ it is important to identify which is the cause. But which cause? Bacon dismisses the final cause as inapplicable in cases outside of human actions. And he thought knowing just the material and efficient causes can provide certainty but not liberty. That

⁶⁶ *Valerius Terminus* II, p. 235 in Spedding.

⁶⁷ *Valerius Terminus* II, p. 236 in Spedding (“This notion Aristotle had in light, though not in use”); *Advancement of Learning* 2.17.12; *De Augmentis Scientiarum* 6.2. In Latin these went by the names *de omni* and *universaliter*, respectively, but Bacon preferred either the Greek, as in his published works, or the Ramist forms “rule of truth” and “rule of prudence,” as in *Valerius Terminus*.

⁶⁸ *Valerius Terminus* II, pp. 240–1 in Spedding.

⁶⁹ *Valerius Terminus* II, p. 240 in Spedding.

knowledge helps only to ‘achieve new discoveries in material which is fairly similar.’⁷⁰ What is needed, Bacon says, is to identify the ‘form or formal cause.’⁷¹ The formal cause is what makes something the kind of thing it is. Bacon says that ‘Aristotle’s school’ was right ‘that there is no true knowledge but by causes, no true cause but the form, no true form known except one.’⁷² But Aristotle’s school misunderstood the form and consequently—and wrongly—regarded its discovery as hopeless.⁷³

A form, Bacon says, is merely a certain arrangement and motion of (frequently imperceptible) physical components. In Book 2 of the *Novum Organum*, Bacon presents a method for identifying that arrangement and motion. He says the search should begin with a comprehensive inventory of observed instances, related absences, and related variations. He offers twenty-seven kinds of observations (“prerogatives”) that are particularly valuable for discovering the essence or formal cause of something. When he uses his method to discover the formal cause of heat, he concludes that heat is a particular kind of motion of imperceptible particles. He then makes the remarkable claim,

If in any body you can arouse a motion . . . [of this certain kind], you will certainly generate heat. It is irrelevant whether the body is elementary (so-called) or imbued with heavenly substances; whether luminous or opaque; whether rare or dense; whether spatially expanded or contained within the bounds of its first size; whether tending toward dissolution or in a steady state; whether animal, vegetable or mineral, or water, oil or air, or any other substance whatsoever.⁷⁴

From an analysis of particulars, Bacon came to a tremendously universal conclusion, one of both certainty and liberty. He eventually came to call his method a kind of induction.⁷⁵

⁷⁰ *Novum Organum* 2.3.

⁷¹ *Valerius Terminus* 11, p. 241 in Spedding; *Novum Organum* 2.2.

⁷² *Valerius Terminus* 11, p. 239 in Spedding.

⁷³ *Novum Organum* 2.2.

⁷⁴ *Novum Organum* 2.21.

⁷⁵ Bacon does not make the connection between his method and the term *induction* in *Valerius Terminus*, which was likely written in 1603. *The Advancement of Learning* of 1605 only hints in the direction. The association appears in the manuscript *Partis Instaurationis Secundae Delineatio et Argumentum* of 1607 and is strong in *Cogitata et Visa de Interpretatione Naturae*, also of 1607. It is unclear what gave Bacon the

Bacon stresses that this particular kind of motion is not the efficient cause of heat, that is, it is not the case that there is one thing, the motion, that produces another thing, the heat. Rather the particular kind of motion is what heat is. If you can produce this kind of motion, you produce heat, because the motion and the heat are the same thing. Looked at from the perspective of Scholastic logic, Bacon makes an important shift. A conventional Scholastic induction would set out particulars like this:

Exploding French gunpowder is hot.

Exploding German gunpowder is hot.

Exploding English gunpowder is hot.

and then ask: Have we surveyed enough explosions to know if all exploding gunpowders are hot? Bacon is saying that is the wrong question. The right question is: What is heat? Bacon shifts attention from the subject to the predicate and looks at the same problem this way:

Exploding French gunpowder is hot.

Exploding German gunpowder is hot.

Exploding English gunpowder is hot.

Moreover he insists that you can learn nothing from positive instances only. You must have a wide range of contrasts. Consider unignited French gunpowder. Consider burning charcoal. In fact, consider everything from the heat of burning leaves, of sunshine, and of horse dung to the lack of heat or varying grades of heat in moonlight and starlight, different animals, natural springs, and rotting vegetables. For Bacon an induction is performed not by positive instances that confirm, but by comparisons that contribute to the definition of the predicate. Finding that definition by this process of compare-and-contrast is the essence of Socratic induction.

This Baconian process was widely and intentionally adopted by natural philosophers from the mid-seventeenth century and to the mid-nineteenth. Robert Boyle is just one example. He railed against those who would seek a form as some essential and universal

idea. It could have been one of the Humanists, such as Valla or Agricola. The timing would be consistent with a possible influence from William Harvey.

substance lurking within particulars.⁷⁶ Following Bacon, he insisted that a form is merely a particular arrangement and motion of particles. Two-thirds of his publications are applications of Bacon's compare-and-contrast method to discovering the forms of heat, cold, color, porosity, odor, taste, volatility, corrosiveness, and other physical qualities. If Boyle is to be called the father of modern chemistry, it is not for the discovery of Boyle's Law, but for the radical reconceptualization of qualities that he effected. Similarly, the great contribution of Boyle's older contemporary William Harvey was not discovering the circulation of the blood *per se*; it was discovering the essence of what a heart is, viz., a pump.⁷⁷ He discovered it by comparing countless animals—large and small; warm-blooded, cold-blooded; aquatic, terrestrial, and airborne. In his *De Generatione Animalium*, Harvey says he is using Bacon's method when, after twenty-four chapters of comparing the gestation of a hen's egg to that of hawk, pigeon, ostrich, pheasant, butterfly, worm, snake, bee, wasp, shrimp, crayfish, tortoise, mole, hare, deer, horde, man, and others, Harvey concludes he is ready to say what an egg is.⁷⁸ Harvey's method was to seek the essence of some substance, entity, or property by a broad comparison. In his most mature work he calls it Bacon's method. In his earlier lecture notes, he called it *regula Socratis*, the rule of Socrates.⁷⁹

Looking back from the mid-nineteenth century on two hundred years of scientific development, William Whewell, saw things a little differently. Though he saw the Baconian project as it has been here described, he concluded that, as things turned out, the most important scientific breakthroughs had not been merely discovering the formal cause or essence of some recognized concept, such as heat, porosity, or corrosiveness, but creating—and then defining—completely new concepts. Newton's integration of information about falling apples, revolving moons, planetary orbits, tides, comets, and so on did not merely result in better definitions of old concepts, such as *gravitas*, but more importantly the formation of new concepts, such as *mass*. Priestley did not discover

⁷⁶ In, among other places, *The origine of forms and qualities, according to the corpuscular philosophy*.

⁷⁷ Cunningham, "William Harvey: The Discovery of the Circulation of the Blood," pp. 65–76; French, *William Harvey's Natural Philosophy*, pp. 71–93.

⁷⁸ *Exercitationes de generatione animalium* 25.

⁷⁹ French, *William Harvey's Natural Philosophy*, p. 83.

oxygen in the way one discovers an island. The chemical had been there under everyone's nose all along. Priestley's breakthrough was isolating and rearranging observations and forming a new concept, for which he created a new term ("dephlogisticated air"). Whewell went so far as to say that every proper induction is completed with the forming or reforming of a concept. In *Novum Organum Renovatum*, he offered eighty-eight pages on how such new concepts have been and should be assigned names.⁸⁰ Whewell himself coined 'anode,' 'cathode,' 'ion,' and, in 1833, the very word 'scientist.'

Whewell was the last major epistemologist working in the Socratic/Humanist/Baconian tradition, the last to see induction as fundamentally about particular things and universal concepts rather than about propositions. Bacon had said, "The syllogism consists of propositions, propositions consist of words, and words are the tokens of notions. Hence if the notions themselves . . . are confused and abstracted from things without care, there is nothing in what is built on them. The only hope is true induction."⁸¹ Whewell agreed.

After Bacon, the next big turning point was not David Hume, who lived a century before Whewell. Hume wrote virtually nothing, or at least nothing critical, on what in his day was called induction. He said he intends to base the *Treatise on Human Nature* on the philosophy Bacon introduced. He uses the term *induction* there only twice, in both cases to defend some argument he is making.⁸² In none of the instances does Hume suggest he sees any problem with induction. Indeed, Whewell and his contemporary, John Stuart Mill, managed to write, between them, at least seven volumes on the history, theory, and practice of induction without finding it necessary to give Hume any significant attention. As we will see, the association between Hume and induction is a product of the late nineteenth and early twentieth centuries. Someone had to lay some groundwork before

⁸⁰ *Novum Organum Renovatum* (1858) 4, an expansion of the seventy-two pages, "Aphorisms Concerning the Language of Science," in *The Philosophy of the Inductive Sciences* (1840).

⁸¹ *Novum Organum* 1.14, "tokens" for Silverthorne's "counters." Cf. *Advancement of Learning* 2.13.4.

⁸² *Treatise on Human Understanding* 1.2.1.2, 1.3.7.7. The word does not appear in *An Enquiry Concerning Human Understanding* or *An Abstract of a Book Lately Published, Entitled A Treatise of Human Nature*. It appears once in *An Enquiry Concerning the Principles of Morals*, at the very beginning, again in a passage indicating Hume saw no problem with induction. For the reference to Bacon, see Hume's full title, *A Treatise of Human Nature: Being an Attempt to Introduce the Experimental Method of Reasoning into Moral Subjects*, and then Hume's description of the 'experimental method' in the introduction to Book 1.

the association could get made. That someone was the Oxford logic professor Richard Whately.

(4) Whately's Revolution: The Major, Not the Minor as Aldrich Says

After Bacon, the view that induction was some derivative of deduction largely fell by the wayside. But it never entirely vanished. When, as in dictionaries or reference works, a short summary was sufficient and little if any elaboration required, it was not uncommon to see induction defined as an enthymeme with the minor premise suppressed. This was one of the Scholastic definitions, and although Baconians generally did not speak this way, the definition could, with only a little distortion, be made serviceable.

Let us look at what that definition meant. An enthymeme, of course, is a syllogism in which one of the premises is left unstated but presumed true. The unstated premise is said to be "suppressed." When supplied, a valid syllogism is formed. Scholastics from Albert to Zabarella conceived induction as beginning with a premise about particulars, let us say, using a then common example, "This magnet, that magnet, and the other magnet attract iron" and concluding with a universal statement, "Every magnet attracts iron." Here, "every magnet" is the minor term, "attracts iron" the major. The long "this magnet, that magnet, and the other magnet" will be the middle term, and the suppressed minor premise then "Every magnet is this magnet, that magnet, the other magnet." By supplying that premise, the enthymeme with the suppressed minor premise becomes this first-figure syllogism in Barbara:

(maj) This magnet, that magnet, and the other magnet attract iron.

(min) [Every magnet is this magnet, that magnet, and the other magnet.]

(con) Therefore, every magnet attracts iron.

Now the major premise and the conclusion are clear enough, but what does that minor premise even mean? Many tried to read it as "Every magnet is *either* this magnet, that magnet, *or* the other magnet" but that "either" and "or" do not sit well with the rules of Scholastic logic. It would need to be put back into the major premise, but that would destroy the whole point of the premise. This was one reason Nifo could see that there was no established agreement about induction. If induction was defined with the technical

vocabulary that best seemed to capture the long-standing understanding, its validity required introduction of a premise whose very meaning, let alone truth, was unclear.

Another approach was to play loose with singulars and plurals and craft a syllogism like the following.

(maj) This magnet, that magnet, and the other magnet attract iron.

(min) [All magnets are this magnet, that magnet, and the other magnet.]

(con) Therefore, all magnets attract iron.

But again, it is not fully clear what the newly supplied minor premise means, let alone whether we can know if it is true. Its conversion “This magnet, that magnet, the other magnet, are magnets,” or “. . . are all magnets,” is clear enough, but again by the rules of Scholastic logic, the conversion is not uncontroversially justifiable. Scholastic logic just does not handle well a syllogistic term that is a union.⁸³ A Baconian might be able to say that by discovering the form or essence of a universal, a proper induction establishes the relation between the individuals and the universal and thus justifies the needed minor premise. This approach could find support in *Prior Analytics* B23 if it had been properly understood, but except possibly by Whewell, it was not so understood.⁸⁴ And even if this move were made, it would defeat the whole purpose of defining an induction as an enthymeme, for the move would be to say that induction provides the minor premise, not that induction is the completed syllogism. But as it turned out, Baconians simply lost interest in this old attempt to render induction as a kind of deduction. Even if the claim that an induction is an enthymeme made valid by supplying a suppressed minor was left unchallenged, little was done with it. The project to render an induction as a deduction was quietly set aside.

Indeed, from Bacon’s day forward, the whole study of syllogistic logic had been increasingly set aside. By 1800, of the major English, Scottish, and Irish universities, only at Oxford was it still of much significance. As efforts were made to lessen it there too, a

⁸³ Cf. investigations by William Hamilton, Augustus De Morgan, and others a generation after Whately into quantification of the predicate.

⁸⁴ “Criticism of Aristotle’s Account of Induction,” in *William Whewell’s Theory of Scientific Method*, pp. 311–21.

few logicians sought to revise and revive it. One was Edward Copleston (1776–1849) and another his student and then colleague Richard Whately (1787–1863). In a pamphlet that received little circulation, *The Examiner Examined* (1809), Copleston advanced two views important for the future of induction, one general, one specific. The general one was that logic is not primarily about things, but about language. Logic is a kind of grammar, he insisted. The specific view was that induction is an enthymeme with the major premise suppressed. But since few noticed Copleston’s proposal and most attributed it to his disciple Whately, let us consider it as Whately presented it.⁸⁵

As part of the Oxonians’ effort to reverse the Baconian trend and revive traditional logic, Whately published in 1826 his *Elements of Logic*. The work contains the most momentous footnote in the history of induction. Whately writes that induction is ‘a Syllogism in *Barbara* with the major* Premiss suppressed.’⁸⁶ In an earlier version of the text, published in 1823 as “Logic” in the *Encyclopaedia Metropolitana*, the asterisked note read only, ‘Not the minor, as Aldrich represents it.’⁸⁷ Henry Aldrich was author of *Compendium Artis Logicae*, the standard logic textbook at Oxford at the time and the textbook Whately wanted to supplant. What Whately fails to mention is that the view of induction was not just Aldrich’s. It was standard among almost everyone who had treated induction as a kind of deduction.⁸⁸ Whately’s footnote also fails to indicate the reason Whately disagrees. As the note first appeared, it could have looked like Whately was merely correcting a technical oversight or typographical error in Aldrich’s textbook. But in the version of Whately’s text published as a standalone volume in 1826, the note was expanded to read,

⁸⁵ For background on these developments, see Raymie E. McKerrow, “Richard Whately and the Revival of Logic in Nineteenth-Century England,” and especially Calvin Jongsma, “Richard Whately and the Revival of Syllogistic Logic in Great Britain in the Nineteenth Century.”

⁸⁶ *Elements of Logic* 4.1.1, p. 209 in first edition. Capitalization and emphasis Whately’s.

⁸⁷ “Logic,” *Encyclopaedia Metropolitana*, p. 230.

⁸⁸ A notable exception is Christian Wolff in Germany. He had earlier proposed Whately’s alternate (*Philosophia Rationalis*, 1728, 478–81), but I do not know what influence he had in this. In *Science of Logic* (1811–1816), Hegel retained the older view, understood as I said a Baconian could interpret it. I believe it is by Whately (because of adoption by Mill, and evidenced by the reaction in England) that the view came to be widely adopted. I doubt Whately was influenced by Wolff, but Copleston might have been. Hamilton comments on Wolff’s view and its adoption in “Recent Publications on Logical Sciences,” p. 233. The path from Wolff to Ernst Friedrich Apelt’s *Die Theorie der Induction* (1854) warrants study.

Not the minor, as Aldrich represents it. The instance he gives will sufficiently prove this: “This, that, and the other magnet attract iron: therefore so do all.” If this were, as he asserts, an Enthymeme whose *minor* is suppressed, the only Premiss which we could supply, to fill it up, would be, “All magnets are this, that, and the other;” which is manifestly false.⁸⁹

Whately wants to show that induction has the power it does because it can be rendered as a deduction. But he realizes the old way of so rendering it did not really work. He proposes a new way.

In this passage, Whately does not give us the syllogism he has in mind but we can reconstruct it using his example: each tyranny examined is short-lived; therefore all tyrannies are short-lived.⁹⁰ The minor term of a syllogism in Barbara is the subject of the conclusion, and the major is the predicate. It would be natural then to understand “tyrannies” as the minor term, “short-lived” as the major. But Whately wants “short-lived” to be the minor. So he introduces some verbal trickery. He says the major term is not “tyrannies” but “property of all tyrannies.” This gets him the enthymeme in Barbara that he wants:

- (maj) [A property of the examined tyrannies is a property of all tyrannies.]
- (min) The property of being short-lived is a property of the examined tyrannies.
- (con) Therefore, the property of being short-lived is a property of all tyrannies.
- (con) Therefore, all tyrannies are short-lived.⁹¹

The old enthymeme had problems, but this one does, too. The first is this trick of using “property of” to make a predicate look like a subject and a subject look like a predicate. It is a trick that confuses grammar with content. In Scholastic logic, “tyrannies” would be the substance and “long-lived” the property, regardless of the grammar of the proposition. Whether one says, “tyrannies are short-lived,” “being short-lived is a property of

⁸⁹ *Elements of Logic* 4.1.1. Capitalization and emphasis Whately’s.

⁹⁰ *Elements of Logic* 4.1.1. Sometimes, as in this example, Whately qualifies the conclusion with “is likely to” or a similar phrase. But this does not change the structure of the syllogism. Rather it would necessitate adding the phrase to the supplied premise.

⁹¹ A look at Copleston, *The Examiner Examined*, pp. 35–43, at an earlier remark in the *Elements of Logic*, p. 124, and at later, expanded editions of the text confirm that we have reconstructed as Whately intended.

tyrannies,” or “the property of short-lived belongs to tyrannies,” the content of the statement 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 to Whately, who adopted Copleston’s position that logic is about words and not things, the grammar of the syllogism, not the ontology of its subject matter, determines which term is minor and which major. Second, the trick messes up rules of number that come with the rules of what is and what is not a valid syllogism in Barbara. If Whately wants to change a term from “X” to “property of X,” then he needs to be consistent and put quantifiers like “some” and “all” outside, not inside, the term. He needs a quantified term like “all properties of X,” not “property of all Xs.” Third, in a syllogism with a suppressed or unstated premise, the suppressed premise should be the one least in doubt, and here, the suppressed premise is the very heart of the question at issue, as Whately himself admits.⁹² Whately wanted to revive syllogistic logic and show that the induction that had become so widely admired is just a kind of good old-fashioned deduction, just an enthymeme in Barbara with the major premise suppressed. But to do that he needed to contort the old-fashioned meanings of “enthymeme,” “Barbara,” and “major” and to adopt Copleston’s view that logic is a kind of grammar, its objects words, not things.

Contortion or not, Whately’s move was quickly recognized as radical. In 1828, young John Stuart Mill, writing anonymously in the *Westminster Review* and applauding the great effect Whately’s book was already having on the study of logic in Oxford and England generally, said that Whately’s new view of induction was ‘original’ and ‘extremely important.’⁹³ In fact, Mill said, 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 . . . [was responding]. They in fact mistook altogether the inductive syllogism, completing it by the addition of a *minor*, instead of a *major*.’⁹⁴ Mill’s suggestion is that the whole Baconian era could have been avoided had someone identified the Scholastic error before Bacon proffered his alternative. Whately’s proposal became fundamental in Mill’s

⁹² *Elements of Logic* 4.1.2.

⁹³ “Review of *Elements of Logic*,” p. 170.

⁹⁴ “Review of *Elements of Logic*,” p. 170. Emphases Mill’s.

later *System of Logic*, where he wrote, ‘As Archbishop Whately remarks, every induction is a syllogism with the major premise suppressed.’⁹⁵ In 1833, William Hamilton, writing anonymously in the *Edinburgh Review*, denounced the enthusiasm Whately’s proposal had generated. Hamilton endorsed Whately’s attempt to revive the casting of induction as a syllogism, but he found this new way of doing so ‘palpably suicidal.’⁹⁶ He thought there would simply be no way to justify that suppressed major. It is just another statement of the very question at issue. The correct approach, Hamilton insisted, is to return to the Scholastic syllogism.⁹⁷

Whately did not get everything he wanted, but over the next few decades he did succeed in turning philosophers to thinking of induction as a kind of propositional inference. Recall that ambiguity in Aristotle’s statement that induction is a proceeding from particulars to a universal. Did Aristotle mean particular things and universal ideas or particular and universal statements? The second was presumed from the Alexandrian Neoplatonists until the humanist challenge. The question was at the core of the sixteenth-century confusion Nifo reported. Bacon took a firm stand that the conclusion of a well performed induction is not a proposition, but a well defined *notio*, or concept. This perspective was maintained in the line of thinkers ending in Whewell, who said no induction is complete without the forming or reforming of a concept. Whately, on the other hand, thought that although the Baconian understanding of induction reflected the

⁹⁵ “Of the Ground of Induction,” *A System of Logic* 3.3.1. See also the discussion about Kepler’s law at 3.2.5.

⁹⁶ “Recent Publications on Logical Sciences,” p. 231.

⁹⁷ In succeeding editions of *Elements of Logic*, Whately responded to the praises and criticisms his proposal drew. By the fourth (1827) edition, he had added a footnote stressing that his meaning of the term *induction* was the “original and strict sense.” In the fifth (1834) edition, the first after Hamilton’s review, Whately replaced “Aldrich” with “most logical writers” and replaced the footnote with three pages of in-line elaboration and an explanation of how the major premise gets defended. In the eighth (1849) edition, several paragraphs were added, variously responding to a concern Mill raised, acknowledging a limited usefulness for the Scholastic approach, and demarcating the situations in which Whately’s approach applies. His original seven-word footnote had spawned pages of discussion by all the major logicians of the time.

In *Die Theorie der Induction* (1854), Ernst Friedrich Apelt proposed yet a third way to cast an induction as a deduction. An induction, he said, is a disjunctive syllogism. Modern attempts to fit Bacon into a Higginsian box have frequently drawn on Apelt’s proposal.

‘original and strict sense’⁹⁸ of the term, he himself preferred the Scholastic sense. Mill and Hamilton followed Whately on this. For all three of them, induction is a propositional inference. It begins with propositional premises and ends with a proposition that follows from those premises. In 1847, Augustus De Morgan recognized that ‘what is now called induction’ is the Baconian process but did not think this was the ‘original and logical’ sense of the term.⁹⁹ Mill’s disciple, Alexander Bain, in his 1874 textbook, warned the student against confusion on this matter. ‘By Induction, we arrive at *Propositions*, . . . [It is not Induction] where what we arrive at is a Notion or Definition.’¹⁰⁰ In the 1870s’ works of W. Stanley Jevons, the view Bain warned against had wholly and silently vanished. In fifty years, one aspect of Whately’s revolution had been completed. Induction had become a kind of propositional inference, not a normative process of abstraction.¹⁰¹

Whately knew that the syllogism he advocated presented challenges. How could the premise that what is true of the observed is true of all be justified? Whately’s answer was that the resulting conclusion was not really justified in the conventional syllogistic way, that is, one does not first accept the major and minor premises and then infer the conclusion. Rather, Whately explained, first the minor premise is obtained from observation. Then, by some domain-specific insight, one comes to accept the conclusion. In accepting the conclusion, one *ipso facto* expresses conviction in the suppressed major premise. Thus, the suppressed major premise is not really an antecedent premise at all. It is just part of the formal mechanism by which the universal conclusion can be said to have force. That is, it is the mechanism that can make an induction look like a deduction, even if the resulting syllogism does no real cognitive work. The real work is deciding

⁹⁸ *Elements of Logic* 4.1.1n2.

⁹⁹ “On Induction,” *Formal Logic* 9, p. 215. De Morgan was a friend of Whewell’s.

¹⁰⁰ “Meaning and Scope of Induction,” *Logic: Inductive and Deductive* 3.1.1.

¹⁰¹ Nowadays the old view survives most in studies of Aristotle. Conventional interpretation is that Aristotle had two meanings for the term *epagōgē*, one an inferential meaning expressed in *Prior Analytics* B23 and one somehow related to abstraction, scattered throughout the corpus and best exemplified in *Posterior Analytics* B19. Most editors and translators are comfortable using “induction” for the first, but not for the second. If they do, they gloss it to warn the reader.

whether the major premise is justified by the minor, that is, deciding based on observations of some whether what is true of some is true of all.¹⁰²

Though accepting Whately's syllogism, Mill rejected Whately's justification of the major. Mill held instead that there is one

assumption involved in every case of induction This universal fact, which is our warrant for all inferences from experience, has been described by different philosophers in different forms of language: that the course of nature is uniform; that the universe is governed by general laws; and the like . . . [or] that the future will resemble the past.¹⁰³

He held that this premise is justified by a simple enumeration, but one in which the enumeration is so large and the generalization so broad that it is 'duly and satisfactorily proved.'¹⁰⁴

The final move that gave induction the central operational character it has today was made by Augustus De Morgan. Whately said that confidence in the major was subject to 'degree of evidence,'¹⁰⁵ Mill that the major is a uniformity principle. Contra Mill, Whately stressed that the major premise is not universal but specific to each induction. De Morgan put all this together with developing theories of statistics and probability. He saw that, when induction is understood as Whately and Mill were developing it, an inductive inference amounts to a problem in "inverse probability": Given the observation of effects, what is the chance that a particular uniformity principle is being observed at work? That is, given Whately's minor premise that observed instances of some kind share some property (membership in the kind being taken for granted), what are the chances that all instances of the kind do? De Morgan's attempt to answer this failed,¹⁰⁶ but he made the

¹⁰² This explanation was added in the eighth (1844) edition, p. 234.

¹⁰³ *A System of Logic* 3.3.1.

¹⁰⁴ *A System of Logic* 3.21.3.

¹⁰⁵ *Elements of Logic* 4.1.2, Whately's emphasis.

¹⁰⁶ Strong, "The Infinite Ballot Box of Nature: De Morgan, Boole, and Jevons on Probability and the Logic of Nature."

crucial step of connecting probabilistic inference to induction.¹⁰⁷ The connection survives today, and it would have made little sense (as De Morgan himself saw) were induction to be understood in the Baconian rather than Whatelyian sense of the term.

The study of induction (and of logic generally) during the five decades after Whately's 1826 *Logic* was remarkably vigorous. John F. W. Herschel's *Preliminary Discourse on the Study of Natural Philosophy* was published in 1830. Whewell's three-volume *History of the Inductive Sciences* was published in 1837, the first version of his *Philosophy of the Inductive Sciences* in 1840. Whewell published further editions, expansions, and related essays on induction for twenty more years. De Morgan introduced the concept of mathematical induction in 1838 and the relationship of probability to induction in *Formal Logic or the Calculus of Inference* in 1847. Mill's *Logic* came out in eight editions from 1843 to 1872. Bacon's works became more available than ever before. The first complete English translation since 1733 of the *Novum Organum* was printed in 1831. Three more translations were printed in 1844, 1855, and 1858. The fifteen-volume *Collected Works* edited by Spedding, Ellis, and Heath started coming out in 1857. A three-volume edition of Bacon's works was published almost annually from 1841 to 1859. Thomas Fowler's great Latin edition of the *Novum Organum* with commentary was first published in 1870. But through these years, even while his works were experiencing a remarkable popularity, Bacon's reputation as a philosopher was declining. In England, Sir David Brewster began the trend when he roundly discounted any influence by Bacon on subsequent science.¹⁰⁸ By the 1870s, Bacon had been cast as a writer of historical but not philosophical interest. Mill had displaced Bacon (and Whewell) as the authorities on induction. As all Scholastic logic textbooks had roots in Peter of Spain's *Tractatus*, now all logic textbooks—at least their parts on induction—had roots in Mill's *Logic* and so indirectly in Whately's *Elements*.

¹⁰⁷ All this applied only in the case of incomplete enumeration, what De Morgan called "pure induction." In the case of complete enumeration, the induction could be rendered as a syllogism with the minor, not the major, suppressed, as the Scholastics had done.

¹⁰⁸ *The Life of Sir Isaac Newton* 19.

Throughout all these treatises, commentaries, essays, and chapters on induction, one will search in vain for a substantive mention of David Hume. As much as his name became bound to the “problem of induction” in the twentieth century, it was no part of discussions on induction until late in the nineteenth or early in the twentieth century. The phrase “problem of induction” comes from Mill, not Hume, and Mill did not think the problem insurmountable. The problem was simply the one to which he was contributing a solution. In the 1870s, Fowler loosely connected Hume to induction when he mentioned in an endnote, ‘since the time of Hume, the nature of our conception of Cause has formed one of the principal topics of philosophical controversy, . . . [but in regards to induction, the controversy] possesses a historical rather than a practical or scientific interest.’¹⁰⁹ In 1889, John Venn explained that the uniformity of nature was a necessary presumption to any inference, deductive or inductive. He listed several defenses of the principle. He cited Hume’s as the best so far, but he then offered his own.¹¹⁰ In 1906, Ernst Cassirer explained that the very concept of an experimental inference involves a great *petitio principii*: Induction owes all its force to the premise that the future will be like the past, which is just what the induction itself seeks to infer. In the middle of this disquisition, suggesting an association with the whole argument, Cassirer inserted, ‘as Hume relentlessly insisted.’¹¹¹ Hume relentlessly insisted on many of the things Cassirer was discussing, but it was Cassirer not Hume who associated those things with induction. In the *Treatise of Probability* of 1921, John Maynard Keynes wrote, ‘Hume’s sceptical criticisms are usually associated with causality; but argument by induction— inference from past particulars to future generalizations—was the real object of his attack.’¹¹² Only since the 1930s has it been common to hear induction treated as if its full name were “the Humean problem of induction.”

That Hume could get associated with induction was just one of the legacies of Richard Whately. Another is that induction became a philosophical topic involving

¹⁰⁹ *The Elements of Inductive Logic* 1 note 2.

¹¹⁰ *The Principles of Empirical or Inductive Logic* 2.1.1, 5.3.

¹¹¹ *Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit* 5.5.2. Translation from review by Sabine.

¹¹² *A Treatise on Probability*, p. 272.

primarily propositions instead of concepts. That is, the “universal” in the description of induction as a proceeding from particulars to universal got taken to mean universal propositions, not universal concepts. Today, one studying induction studies how we attain universal statements by propositional inference not how we attain universal concepts by abstraction. Induction has become a field for logicians, mathematicians, and statisticians, not for those studying philosophy of mind. These logicians, mathematicians, and statisticians presume that underlying all inductive inference is some uniformity principle as a major premise and simply accept that defense of this premise lies outside their purview. They hold deduction as the ideal and reliable type of inference and induction as the unreliable, uncertain, and inferior type. They understand their task as making induction more like deduction—like Higgins trying to make a woman be more like a man.

What if Higgins’ Whole Approach Is Wrong?

In our survey, we have seen two broad conceptions of induction. The first we may call Socratic (or Socratic/Aristotelian/Ciceronian/Humanist/Baconian/Whewellian). By it, induction is a compare-and-contrast process for discovering properties that characterize all members of a kind, some of which properties are distinctive to that kind, some of which even define the kind. Induction, that is, is fundamentally abstraction. The reliability of the induction depends on the depth and breadth of the comparisons. The second conception of induction we may call Higginsian. By it, induction is a kind of inference made good by making it more like deduction. This conception has two forms. In the first, the Scholastic, induction is forceful to the extent it mimics a syllogism with the minor premise suppressed, that is, to the extent it acts like a deduction by complete enumeration. In the second, the Whatelian, induction is forceful to the extent it mimics a syllogism with the major premise suppressed, that is, to the extent that what is true of some is true of all.

The Higginsian approach locates normativity and ampliation at the propositional level. Here, an induction’s components are particular propositions. The approach presumes that these components can be judged good or bad, in this case, true or false,

and asks whether and under what conditions a resulting universal proposition can be judged good or bad, true or false. This approach does not ask whether the components of the components are valid. The Socratic approach acts differently. It presupposes that concept-formation is a normative process, that there can be such a thing as a bad concept, and that getting the concepts right is necessary, and even potentially sufficient, for sound propositional inference. As Bacon said, “The syllogism consists of propositions, propositions consist of words, and words are the tokens of notions. Hence if the notions themselves . . . are confused and abstracted from things without care, there is nothing in what is built on them. The only hope is true induction.”¹¹³ Propositional inferences can *only be as good as* the concepts from which they are formed. This was Socrates’ point. But—and this was Bacon’s point, and Whewell’s—propositional inferences *can be as good as* the concepts from which they are formed. If the concepts are formed properly, inferences, even ampliative inferences, can be certain.

The classic example of swans can help make the point. You see only white swans and conclude that all swans are white. Your opponent shows you a black swan and mocks your inductive naiveté. But you can reply, “That black thing is not a swan.” Maybe you are just being quarrelsome, but you have a point. Why would it be wrong, bad, incorrect to exclude this newly discovered thing from the set of all swans? By what standard should we judge whether whiteness should or should not be a characteristic of anything to which we apply the name *swan*? To have a normative theory of inference, we first need a normative theory of concept-formation.

The Socratic view of induction, moreover, takes it that ampliation occurs at the conceptual, not perceptual, level. We describe an inference as ampliative if the result says more than was already implicitly contained in the components. But this going beyond is already functional at the conceptual level. Based on observations, we form the concept *chair*. Thereafter, whenever we use the term, we mean all chairs, not just the ones that went into formation of the concept. The issue of whether and when we can legitimately proceed from particulars to universals confronts us at a level below the propositional. If

¹¹³ *Novum Organum* 1.14.

there is a problem of ampliative cognition, it is at the level of abstraction not inference. On the Socratic view, questions of induction—of proceeding from particular to universal—are primarily questions about abstraction, not about propositional inference. If Socrates, Bacon, and their fellow travelers are right, then standards for ampliative inference must be based on normative standards for concept-formation, and without the second, developing the first is hopeless.

And if that is correct, then an induction is not an aspiring but failed deduction, and the Scholastic and Whatelian—and what we now call Humean—way of thinking about an induction is as fundamentally flawed as Professor Higgins' way of thinking about a woman.

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