

# Aristotle on Induction and First Principles

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ARISTOTLE THINKS ALL OUR SCIENTIFIC UNDERSTANDING (ἐπιστήμη) about some given domain can be organized in an axiomatic system that makes clear why the things we understand about that domain must hold. What makes this clear, he argues, is a certain sort of explanatory *demonstration*, and one of the requirements on demonstrations is that they begin from the *first principles* proper to the scientific domain being studied. So for instance, an astronomer might begin with some principles concerning the motion of celestial bodies, and demonstrate on their basis why lunar eclipses must occur as they do. In doing so she would exhibit the sort of understanding of eclipses Aristotle takes as his cognitive ideal.

The first principles from which demonstrations begin are explanatory primitives. Since demonstrations explain their conclusions, these first principles cannot themselves be *demonstrated*. But they are nonetheless grounded in other forms of knowledge: as Aristotle tells us in *APo* B19, we learn first principles by *induction* (ἐπαγωγή), a form of cognitive development that begins with perception and progresses through a series of increasingly sophisticated states in which various universal concepts come to be formed in our souls. The result of this development is a cognitive state called νοῦς, the state we find ourselves in when we grasp first principles.<sup>1</sup> Thus on Aristotle's view, though we can't develop a *demonstrative* understanding of first principles, we can come to grasp them in a *nondemonstrative* way. We do so by induction.

My main thesis in this paper is that there's good sense to be made of Aristotle's account of our cognitive development, and in particular that there's good sense to be made of the claim that we come to know first principles by induction. It's natural enough to think otherwise. For one thing, first principles are *propositions*, while Aristotle's account focuses squarely on the formation of universal *concepts* in our soul.

1. I leave this term untranslated: most common translations (e.g. "intellect," or "intuition") already suggest an interpretation of the role the state plays in Aristotle's epistemology — an interpretation that should be argued for, and that I'll argue we should in fact resist. Note that Aristotle thinks of νοῦς as a kind of ἐπιστήμη, though of course not the typical kind, which is demonstrative ἐπιστήμη (see for instance *APo* A3 72b18–21). Unless otherwise noted, translations in this paper are my own, though for *APo* I've often based them on Barnes (1993).

But it's not clear how our conceptual development would determine the propositions we know. Even supposing our conceptual repertoire somehow corresponds to the knowledge of certain propositions, we might expect an account detailing how the correspondence would work—telling us *which* propositions we come to grasp by developing some given universal concept.<sup>2</sup>

But suppose we can resolve this initial worry (I'll suggest a solution below). Aristotle's account may still seem inadequate. For *voûç* of first principles, on Aristotle's view, requires *more* than knowing certain key propositions—it requires knowing these propositions *as* the necessary and explanatorily primitive truths from which all our scientific understanding is derived.<sup>3</sup> And even if Aristotle's account is successful in explaining how we grasp the *content* of first principles, this alone wouldn't make it clear how we come to know first principles *as such*: one might grant that induction allows us to establish certain propositions, but deny that it reveals anything about the theoretical role these propositions play in an axiomatized science.

Commentators have addressed this difficulty in one of two ways. Some have argued that *voûç* should be understood both as the state we acquire when we know first principles *and* as the faculty which allows us to move from some inductive conclusion—knowledge that humans are rational animals, say—to the theoretically-sensitive grasp we're supposed to reach in the last stage of our intellectual development—knowledge that “humans are rational animals” meets the requirements necessary to count as a biological or zoological first principle.<sup>4</sup> Others have urged a deflationary reading of the chapter, on which Aristotle is only offering a highly elliptical explanation of our acquisition of first principles, and omitting a number of key post-inductive stages from our complete epistemic ascent.<sup>5</sup> In both cases,

2. See Ross (1949: 675–76) for an expression of this worry.

3. I'll argue for this reading below. The view is also defended (in different ways) by Charles (2003: 266), Kosman (1973: 383–85), and McKirahan (1992: 258).

4. See *e.g.* Bayer (1997: 136–41), Irwin (1988: 134–37), or Le Blond (1939: 136).

5. See *e.g.* Bronstein (2012: 52–54), or Kahn (1981: 367–68).

the motivating thought is that induction simply couldn't be sufficient to explain how we come to grasp first principles in the right sort of way—and principles of charity quickly lead to the conclusion that Aristotle must be relying on some additional faculties, or explaining something else.

I think this line of thought should be resisted: it fails to do justice to the subtle role induction plays in Aristotle's account, and rests on an overly narrow view of the sort of achievement inductive progress represents. In what follows I'll be defending a more expansive reading of Aristotelian induction, and argue that, properly understood, induction *is* a reasonable answer to the question how we grasp first principles. My argument will have two parts. I'll begin by describing the role induction plays in the developmental account provided in *APo* B19. I'll argue that induction is the process responsible for (i) our cognitive advance from perceived particulars to certain universal conclusions we grasp as explanations for our perceptions, and (ii) our cognitive advance from a range of universal conclusions of this sort to a theoretically-sensitive grasp of scientific first principles. I'll then spell out what both forms of progress have in common, and argue that their characterization as forms of *induction* makes good sense in the context of *APo*.<sup>6</sup>

### 1. Understanding and Demonstrative First Principles

Scientific understanding, for Aristotle, is demonstrative in character. We understand some truth scientifically when we can demonstrate it from premises that explain why it must hold, and we understand some *domain* scientifically when we know how to demonstrate the truths belonging to that domain.<sup>7</sup>

6. Readings emphasizing induction's role have been defended before (see for instance Barnes [1993: 259–71], Hankinson [2011], Leshner [1973], or Modrak [1987]), but such readings say little about the development of a grasp of scientific principles *sensitive to their theoretical role*, and so don't directly address the difficulty I've raised above.

7. Scientific understanding is therefore not a generic sort of *knowledge*, but rather a form of demonstrative expertise we might develop towards the things we know (Aristotle characterizes understanding as a “disposition to demonstrate

Aristotle thinks of *demonstrations* (ἀποδειξις) as chains of syllogisms whose premise pairs explain their respective conclusions—in his terminology, the middle term *B* in a premise pair *AaB*, *BaC* will explain why *AaC*, the middle term *C* in a premise pair *AaC*, *CaD* will explain why *AaD*, and so on for all syllogisms in a deduction linking an initial premise *AaB* to some demonstrated conclusion *AaX* (for some term *X*).<sup>8</sup> The premises from which demonstrations begin are explanatory primitives: they explain all the truths that compose some scientific domain, and are explained by none of them. Such premises are *first principles* (ἀρχαί); statements expressing the essence of the natural kinds definitive of some scientific domain.<sup>9</sup> So for instance, “human beings are rational animals” might count as a zoological first principle, and “planets are celestial bodies near the earth” as an astronomical one, if indeed these aren’t explained by any further zoological or astronomical truths. On Aristotle’s view, grasping demonstrations from such principles in the

right sort of way makes possible an understanding why the truths in some domain must hold.<sup>10</sup>

Here’s an immediate challenge facing such a demonstrative account of scientific understanding (a challenge Aristotle himself raises in *APo* A3). If we only understand the things we demonstrate, we won’t *understand* indemonstrable first principles. And if we don’t understand them—if we only grasp them in some less robust manner, or don’t grasp them at all—it’s not clear how we could understand what’s demonstrated on their basis. So it’s natural to ask what kind of knowledge we have of first principles, and how that knowledge might be brought about.

It’s clear that Aristotle doesn’t think this challenge really threatens the *possibility* of scientific understanding. Despite acknowledging that demanding demonstrations of first principles would yield an explanatory regress, and that such a regress would make scientific understanding impossible (*APo* A3 72b5–15), his response is simply to insist that we do, in fact, possess scientific understanding, and that we must therefore have a nondemonstrative grasp of principles of some kind or another (72b18–22).

But such insistence doesn’t answer the *explanatory* demand implicit in the challenge: if the concern was that Aristotle’s account failed to *explain* our grasp of first principles, then insisting that we must have such a grasp is no help. What we want to know is how, on Aristotle’s account, we could come to grasp them in the way that makes understanding possible.<sup>11</sup> A satisfactory explanation, moreover, would

[ἔξις ἀποδεικτική]” at *EN* Z3 1139b31–32). In what follows I will use “knowledge” to refer to γνώσις broadly construed (*i.e.* roughly what we call “knowledge”), and reserve “understanding” or “scientific understanding” for the special kind of knowledge exhibited by someone with an expert demonstrative grasp on some scientific domain (*i.e.* ἐπιστήμη, as Aristotle uses the term in *APo*). So understanding is a kind of knowledge, but not all knowledge qualifies as understanding.

8. Explanation here is an asymmetric and transitive relation, and demonstrations proceed by chains of syllogisms in *Barbara* (at least in the ideal, paradigmatic case). Note that Aristotle’s explanatory relation is something that holds between two *facts* (*e.g.* the fact that planets are near the earth explains the fact that planets don’t twinkle), and not just between two *properties* (proximity to the earth, non-twinkling), though Aristotle often uses the latter formulation. So, to be fully explicit, a syllogism’s conclusion is “explained by a middle term” when the fact expressed by this conclusion is explained by the fact that the referent of its subject term possesses the property referred to by the syllogism’s middle term. A demonstration consists of one or more explanatory syllogisms of this sort.
9. In fact Aristotle thinks there are three kinds of first principles: *axioms* (ἀξιώματα), *definitions* (ὀρισμοί), and *suppositions* (ὑποθέσεις). What I have to say about induction only concerns *definitional* first principles, though in what follows I’ll often be speaking as though all first principles are definitions. Aristotle himself typically speaks this way.

10. To grasp a demonstration *in the right sort of way* is (roughly) to recognize the explanatory role played by the middle terms in its syllogisms, and to recognize that the attributes some subject has been shown to have are attributes it *must* have if it really is to be the kind of subject it is. For instance, to recognize that *being near the earth* explains why planets don’t twinkle, and to recognize that, if a celestial body *really is* a planet, then it must be near the earth, and so must not twinkle.
11. Aristotle’s other remarks in A3 also fail to address this concern (“we argue in this way; and we also assert that there is not only understanding but also some principle of understanding [ἀρχή ἐπιστήμης] by which we know [definitional] first principles” [72b23–25]). The “principle of understanding” in

have to make clear not only how we come to grasp the *content* of first principles, but also how we come to grasp the principles *as such*. That is, it wouldn't be enough to explain how we discover propositions which happen to express necessary, explanatorily basic facts; Aristotle's account requires an explanation how we recognize first principles *as necessary and explanatorily primitive*.<sup>12</sup> This isn't something Aristotle ever says directly, but there are good reasons, both interpretive and philosophical, to think he held such a view.

On the philosophical side, Aristotle's conception of scientific understanding clearly requires a grasp of explanations in their theoretical role. For Aristotle thinks we understand things scientifically only when we know "of the explanation why something is the case that it is its explanation" (*APo* A2 71b10–12). And an explanatory demonstration only yields understanding of this sort for someone who recognizes its middle term *as an explanation* for the demonstration's conclusion.<sup>13</sup> Naturally someone could grasp a demonstration without recognizing the theoretical role played by its premises (or by the terms within its premises), but on Aristotle's view such a person wouldn't *understand* the demonstrated conclusion: she might see that the conclusion is *true*,

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question is later identified as νοῦς (*A33* 88b36, *B19* 100b15), but aside from giving it a name Aristotle doesn't describe the state any further. (Aristotle makes a similar argument at *EN* Z6, where after ruling out other candidates [ἐπιστήμη, φρόνησις, σοφία] he concludes by elimination that we must have νοῦς of first principles [1141a7].)

12. In what follows, I will exclusively concern myself with our recognition of principles in their explanatory role, setting aside our recognition of their necessity. On Aristotle's view, the necessity of definitional principles is closely linked to their role as explanatory primitives: demonstrated truths are *necessary* because they express unchanging facts about natural kinds. To grasp indemonstrable principles *as necessary* is to grasp them as a basis for the demonstration of such unchanging facts — and for Aristotle this coincides with our grasping them as an *explanatory* bedrock for the demonstrable truths in some domain.
13. Or, if the demonstration requires multiple explanatory syllogisms, for someone who grasps the explanatory role played by the middle terms of each syllogism that makes up the demonstration.

but wouldn't know why it must be so.<sup>14</sup> Demonstrations only yield understanding when grasped in a theoretically-sensitive way.

It's natural to think that this requirement for theoretical sensitivity would extend to the first principles from which demonstrations begin. To deny this is to claim that we could grasp the explanatory status of any *demonstrated* truth, yet somehow remain ignorant about the explanatory status of the premises from which our demonstrations begin. And this is implausible: an expert astronomer will surely recognize not only what astronomical first principles explain, but also that they are not themselves explained by further astronomical facts.

There is also a more direct interpretive reason to favor an ambitious interpretation of our grasp of first principles, which is that some of Aristotle's arguments rest on the assumption that we grasp the theoretical role of first principles, and not just their content. Consider for instance the claim that we trust first principles more (πιστεύομεν μᾶλλον) than the conclusions derived on their basis. The reason adduced is that "something always holds more (μᾶλλον ὑπάρχει) of that because of which it holds — *e. g.* that because of which we love something is more loved" (*APo* A2 72a29–30). Since we trust our scientific conclusions *because* of the principles from which we derive them, Aristotle argues, we will trust the principles more than these conclusions. Whatever one makes of this argument, it's clear that it depends on our grasping principles *as explanatory* of their conclusions — that is, as the things because of which our conclusions hold. If we didn't, we wouldn't trust them more, or at least not for the reason Aristotle gives here.<sup>15</sup>

14. She would, in other words, find herself in the same position as someone inferring that planets are near the earth from the fact that they don't twinkle, and that things that don't twinkle are near (*i. e.* someone deriving an explanans from its explanandum). As Aristotle explains in *APo* A13, this person only understands her conclusion in a derivative sense (she only has ἐπιστήμη ὅτι, not ἐπιστήμη τὸ διότι), because she doesn't grasp the explanation *why* planets are near, even though her inference does allow her to grasp full well *that* they are near. On this point see also *B8* 93a35–b3 and *B16* 98b21–24, as well as Kosman (1973: 283–84).
15. It can't be a brute psychological fact about us that we find principles convincing: Aristotle often emphasizes that principles are the things which are *least*

So Aristotle owes us an account of how a grasp of first principles might be brought about, and, if my argument so far is right, this account would have to make clear not only how we come to know the *content* of first principles, but also how we come to recognize their status as explanatory primitives.

## 2. Aristotle's Account in *APo* B19

Such an account is precisely what Aristotle presents in *APo* B19. The chapter is set up as an answer to two questions: how first principles come to be known, and what the state is which knows them.<sup>16</sup> The second question is set aside until the last few lines of the chapter (100b5–17), where Aristotle argues that  $\nu\omicron\upsilon\varsigma$  must know first principles because it's the only state truer and more exact than scientific understanding.<sup>17</sup> The point here is purely terminological:  $\nu\omicron\upsilon\varsigma$  is just the name of the state which grasps first principles, and this conclusion isn't meant to shed any light on the nature or origin of the state.<sup>18</sup> Aristotle's main concern is the first question, about how definitional first principles come to be known, and his response to it will be my focus in what follows.

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convincing to us, and that it takes a lot of study to develop the conviction a scientific expert would display in her principles (see e.g. *Top* Z4 141b36ff, *Met* A9 992b24ff, or *Met* Z3 1029b3–13).

16. To ask what the state is which knows first principles is to ask what state a subject must be in when grasping first principles (cf. Barnes [1993: 260]). So to say that  $\nu\omicron\upsilon\varsigma$  knows principles is not to say that  $\nu\omicron\upsilon\varsigma$  is a *faculty* that enables a grasp of principles; only that  $\nu\omicron\upsilon\varsigma$  is the state we should ascribe to a subject who grasps them.
17. Aristotle's notion of exactness ( $\acute{\alpha}\kappa\rho\iota\beta\epsilon\iota\alpha$ ), as it appears here, can be taken as a rough analogue to his notion of priority — a piece of knowledge is more exact than another if it's closer to first principles (so that knowledge of first principles is most exact). For a similar usage, cf. *APo* A27. This is also the term used by Plato (in a cognate form) to characterize the kind of geometrical knowledge Meno's slave might acquire after some practice on his own (*Meno* 85cd).
18. In this respect his response here is similar to the one given in *APo* A3 and *EN* Z6. I take Barnes' arguments in favor of such an interpretation to be decisive (1993: 267–70).

Before turning to this response I want to make a few preliminary points about its scope. I argued above that Aristotle's account will have to be ambitious: it must not only explain how we come to grasp certain propositions, but also how we come to grasp their theoretical status. But it's important to keep in mind the sort of explanation Aristotle is attempting here. Aristotle is *not* trying to describe an *inferential procedure* or *method* which, if carefully followed, would reliably establish the first principles proper to some scientific domain, and show that these principles are explanatory primitives. His aim is to describe the kind of *cognitive development* necessary for us to acquire the state required for a proper grasp of first principles — and it's a separate question what sort of inquiry would be best suited to *bring about* this cognitive development.

So when Aristotle tells us that we learn first principles by induction, he doesn't mean that there is some sort of inductive *inference* that all aspiring scientists should be following. What he means is that a certain sort of cognitive development (an *inductive* form of development) leads to the state required for a grasp of principles.<sup>19</sup> *APo* B19 should therefore not be taken as a practical guide for the student of nature — what we have is a high-level psychological account of our learning of first principles that describes how various concepts arise in our souls, and which cognitive states are involved in their acquisition.

Strictly speaking, an account of our conceptual development wouldn't explain how we come to grasp the *propositions* that serve as definitional first principles (a worry briefly raised at the start of this paper). But Aristotle doesn't think of this as a significant explanatory gap. For on his view the possession of certain concepts manifests itself in a grasp of propositions *involving* these concepts: once we've

19. This interpretation of Aristotle's inductive account is shared by McKirahan (1992: 249). It will be defended more fully below, but for now note that thinking of induction as the sole *method* by which we learn scientific principles flatly contradicts Aristotle's methodological remarks in *APo* B8–10 and B13. It also conflicts with the concern Aristotle voices in *DA* A1, namely that there may be no single method we could apply to discover definitions in any domain (402a16–17).

described how a certain grasp of some concept develops, we'll have explained how a certain grasp of definitional propositions involving the concept in question might arise.<sup>20</sup> If such an explanation makes clear why the resulting grasp would be sensitive to the theoretical status of the relevant propositions in the right sort of way, it will constitute a good response to the challenge raised in *APo* A3.

One last preliminary point. It's significant, for reasons I'll shortly be making clear, that Aristotle presents his account as an alternative to a certain kind of innatism, according to which the states grasping first principles would always be present within us in some latent form. On such a view first principles would come to be known by some sort of recognition process that would make these innate states manifest—a form of Platonic recollection, say.<sup>21</sup> Aristotle thinks that this kind of innatist view is absurd. He argues instead that we develop our scientific understanding on the basis of some distinct, less exact form of knowledge, and that this knowledge is provided by the perceptual capacity we share with other animals:

[1] we must possess some sort of capacity, but not one which will be more valuable than these states [which know first principles] in respect of exactness. And this certainly seems to be the case for all animals: they have an innate discriminatory capacity called perception. (99b32–35)

20. In fact Aristotle often speaks as though the grasp of a concept and the grasp of propositions with constituent terms corresponding to the concept in question are *identical*: someone might be said to understand *human being*, or, equivalently, to understand the definitional principle "human beings are rational animals," where these are simply two different ways of saying that this person displays demonstrative expertise in the field of human zoology. See Barnes (1993: 271), Kahn (1981: 393–95), or Modrak (1987: 164) for more thorough expositions of his usage.

21. I won't take a position here on whether Aristotle's account is a direct response to Plato's theory of recollection — it's enough for my argument that he is dealing with a Platonic problem, and seeking an alternative to its common Platonic response. For more on the relationship between *APo* B19 and Plato's views, see Adamson (2010).

Aristotle's argument here is somewhat condensed, for presumably we would have wanted him to identify some preexisting *knowledge* or *state* rather than a preexisting capacity. But the general thought is clear: perception is a capacity that gives rise to certain states in a perceiving subject, and these states are meant to constitute the basic form of knowledge from which our knowledge of first principles is then derived.

Naturally perception itself doesn't yield knowledge of first principles—we perceive particulars, while scientific understanding deals with universals (A31 87b33–35), and we never perceive anything *as* necessary, or *as* explanatory of some given phenomenon (B7 92b2–3).<sup>22</sup> We therefore need some process to take us from our perceptions to *voũs* of first principles; the process Aristotle goes on to describe in the rest of the chapter, and which he eventually identifies as induction (100b4). So on Aristotle's account our ability to understand things scientifically isn't the result of some innate knowledge within us, but rather the result of our progressive inductive development from basic perceptual knowledge to a sophisticated grasp of the principles proper to some scientific domain.

This framing is significant because, to my mind, it already rules out certain deflationary readings of Aristotle's inductive account. For the kind of Platonic view Aristotle is opposing here concerns the development of an especially robust kind of scientific understanding. Recollection isn't just meant to explain how we come to grasp certain basic propositions from which we might go on to learn first principles in some other way: it's supposed to yield the first principles themselves (or their Platonic equivalents).<sup>23</sup> So what we would expect from Aristotle,

22. It's important for Aristotle that perception be a *nonintellectual* form of knowledge, which need not itself be based on prior knowledge. For Aristotle is committed to the view that all *intellectual* or *thought-involving* learning (*μάθησις διανοητική*) must proceed from preexisting knowledge (A1 71a1–2). Perception is not subject to this requirement, and can therefore serve as a basic source of knowledge. (On this point see also Mignucci [1975: 2–3].)

23. Not everyone would agree that recollection always plays this role for Plato. (See for instance Bostock [1986: 67–68], though he distinguishes

in the rest of this chapter, is precisely this sort of account, and not an explanation of how one comes to learn certain basic generalizations from which νοῦς of first principles is then developed by other means. A *partial* account of our learning simply wouldn't constitute a proper response to the kind of innatist portrayed in B19.<sup>24</sup>

Further evidence that Aristotle intends his account as a complete one is provided by the range of cognitive capacities he thinks it must involve:

[2] Given that perception is present in them, some animals retain what they've perceived, and others don't—and those that don't have no knowledge except what they perceive (either none at all, or none concerning the things they don't retain). But some can still hold [what they perceive] in their soul even after perceiving. When many

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recollection's role in the *Phaedo* from its role in the *Meno*. Fine [2003: 61–65], Nehamas [1985: 20–24], and Scott [1995: chs. 1–2] all take recollection to result in advanced knowledge.) For my purposes, however, it's sufficient that *Aristotle* considers the kind of knowledge being retrieved to be knowledge of a sophisticated sort. And I think his emphasis on the exactness of this knowledge is good evidence that he does—recall that Plato also emphasizes exactness when describing the kind of knowledge Meno's slave might acquire after rehearsing his geometry lesson on his own (as noted above, fn17).

24. One possible response is that Aristotle is only really concerned with the *origins* of our knowledge, and that he distinguishes himself from the innatist already by positing perception, rather than some latent innate knowledge, as the source of our more advanced forms of knowledge (this is what Bronstein [2012: 36] suggests). I'm not convinced by this response. I agree that the perceptual origin of our knowledge is a key part of Aristotle's view, but "perception" is a satisfactory answer to the question how first principles come to be known only if that answer is accompanied by an account of our development from perception to νοῦς of first principles. Pointing to the origin of our knowledge of first principles might be enough to *distinguish* one's view from an innatist one, but it isn't enough to provide a plausible alternative to innatism, conceived of as an explanation for a sophisticated sort of learning. Nor would it be sufficient to posit perception as our starting point and go on to describe the preliminary steps of our development: the innatist could happily grant that this preliminary learning happens as Aristotle describes, yet insist that *advanced* learning, which yields a much more robust form of knowledge, requires us to posit some sort of latent innate knowledge, and a recollection mechanism to make it manifest.

such things are [retained] there's a further difference: in some reason (λόγος) comes about from the retention of such things, while in others it doesn't. (99b36–100a3)

As I read it, this passage offers a classification of animals according to the capacities they're endowed with or which they naturally develop: all animals can perceive, only some of these can remember what they perceive, and fewer still come to reason based on what they remember.<sup>25</sup> In the rest of the chapter Aristotle will explain how these capacities make possible certain forms of knowledge—in particular how they make possible νοῦς of first principles in animals who can develop an ability to reason.

So far, then, Aristotle has argued that we come to know first principles on the basis of our *perceptual* knowledge—a basic, nonintellectual kind of knowledge available to any animal whatsoever—and he's

25. Some commentators translate the λόγος at 100a2 as "account" rather than "reason," and interpret the last sentence in this passage as a rather condensed description of our cognitive development, where grasping an account is assimilated with grasping a definitional first principle (see for instance Barnes [1993: 262], Bayer [1997: 120], Frede [1996: 169], Hankinson [2011: 46], Modrak [1987: 162], or Tuominen [2010: 123]). An interpretation closer to my own is defended in Bronstein (2012: 40–41), Gregorić and Grgić (2006: 21–23), and Hamlyn (1976: 176–77). Barnes (1993: 262) argues that such an interpretation "cannot be squared with the developmental language of 100a2–3" (*i.e.* γίνεσθαι λόγον ἐκ τῆς τῶν τοιούτων μονῆς). But I find this unconvincing: animals can be classified according to whether or not they *develop* certain capacities as much as whether or not they're born with them (in fact, similar language is used at *Met* A1 980a27–29, in a passage which is clearly not meant to summarize our cognitive development). In any case, if Aristotle *were* offering a condensed version of our cognitive development, he'd be omitting some of the intermediate stages he seems keen on emphasizing in other texts, most notably experience (ἐμπειρία). For a parallel passage that supports my favored interpretation, see *Met* A1 980a28–b28, which ends by drawing a contrast between nonhuman animals, who live "by appearances and memories" and human beings, who live "also by craft and by reasonings (λογισμοῖς)." The contrast doesn't exactly match the classification in [2], but it does lend some support to the thought that λόγος should be taken here as a nonspecific kind of reasoning ability. See also *DA* Γ3 427b11–16, where animals are being classified according to their capacities, and those able to think (διανοεῖσθαι, in a quite general sense) are said to have λόγος.

mentioned some of the capacities involved in our epistemic ascent from perception to first principles. I'll now turn to Aristotle's account of this ascent, paying special attention to the role played by induction.

### 3. Induction and Epistemic Ascent in *APo* B19

Here's Aristotle's initial description of our epistemic ascent:

[3] So from perception there comes memory, as we say, and from repeated memories of the same thing [there comes] experience (*ἐμπειρία*); for many memories constitute a single experience. And from experience, or rather from the whole universal which has come to rest in the soul, the one apart from the many, that which is one and the same in all these things, [comes] a principle of craft or understanding [*i. e.* *νοῦς*]—of craft if it concerns coming-to-be, of understanding if it concerns what is. (100a3–9)

The main interpretive difficulty here concerns the *ἢ* at 100a6. I've rendered it as progressive ("or *rather*") rather than epexegetic or disjunctive; that is, I think Aristotle doesn't *assimilate* experience with the stage at which "the whole universal has come to rest in the soul," but rather thinks of these as two different stages on the path to first principles.<sup>26</sup> Such a reading seems to me well supported by *Met* A1, where Aristotle associates the grasp of universals with a certain kind of craft knowledge, and distinguishes this knowledge from that possessed at the stage of experience—as he puts it, "experience is knowledge of particulars, and craft of universals" (981a15–16). I'll be discussing this

26. I don't know of anyone committed to a disjunctive reading (but see Tuominen [2010: 126–27]). Defenders of the epexegetic reading include Barnes (1993: 264), Hasper and Yurdin (2014: 122–23), Le Blond (1939: 129–30), and Ross (1949: 674). Recent proponents of the progressive reading include Bronstein (2012: 44), Charles (2003: 150), Leshner (1973: 59), and McKirahan (1992: 243). I call this reading "progressive" rather than "corrective" to underline that it wouldn't be *false* to claim that a principle of craft or understanding comes from experience—it is simply more *accurate* to say that it comes from the proximate state following experience.

passage in more detail below—for now I only want to note that such remarks are hard to square with the view that experience would itself be the state in which some universal has come to rest in our soul. If this is right, it gives us some reason to think that Aristotle is distinguishing *four* stages prior to *νοῦς* of first principles:<sup>27</sup> perception, memory, experience, and an unnamed stage beyond experience in which the inquiring subject grasps "the whole universal."

How do we progress from one cognitive stage to the next? Aristotle starts with a rather unhelpful analogy:

[4] Thus the states [which know first principles] neither inhere [in us] in a determinate form, nor come about from more knowing states, but rather from perception—just as in battle when a rout has occurred, one [soldier] makes a stand, then another does, then another, until a starting-point is reached (*ἕως ἐπὶ ἀρχὴν ἦλθεν*).<sup>28</sup> And the soul is the sort of thing that can undergo this. (100a10–14)

Without reading too much into the details of the battle scene, Aristotle seems to be suggesting here that our progress from perception to first principles resembles a rout in which soldiers make successive stands. It's hard to determine what these stands might represent on the basis of this passage alone, but Aristotle elaborates in the next few lines:<sup>29</sup>

[5] Let's repeat what we've just said, though not clearly.  
[5a] When one of the undifferentiated things (*τῶν ἀδιαφόρων ἐνός*) makes a stand, there is for the first

27. In this passage *νοῦς* is identified as a "principle of craft or science," which is in line with the terminology Aristotle uses elsewhere in *APo* (see *A3* 72b24, *A33* 88b36, and *B19* 100b15).

28. Taking the *ἦλθεν* at 100a13 in an impersonal sense. For a survey of the many possible interpretations of this simile, see Leshner (2010).

29. I take the "just" (*πάλαι*) at 100a14 to refer to 100a3–9, rather than anything farther back (cf. Barnes [1993: 265]).



time a universal in the soul; for although you perceive particulars, perception is of universals — *e.g.* of human being, not of Callias-the-human-being. [5b] And again a stand is made among these, until something partless and universal makes a stand — for instance ‘such-and-such an animal’ makes a stand, until ‘animal’ does; and likewise with ‘animal.’ [5c] Thus it’s clear that we must get to know the primitives (τὰ πρῶτα) by induction; for this is how perception creates universals in us (τὸ καθόλου ἐμποιεῖ). (100a14–b5)

In broad terms, the structure of this passage is this: a first stand occurs when [5a] a universal is first brought about from perception, after which [5b] higher and higher universals successively make their own stands until we reach a universal which is “partless and universal.” Aristotle concludes [5c] that we must grasp first principles (which he calls “primitives” here) inductively, because (γὰρ) it’s through induction that perception creates universals in us.

A natural thought here would be that the universals perception creates in us just *are* first principles. On this reading Aristotle would be claiming that a single inductive process takes us straight from perception to νοῦς of first principles, and that this is why we grasp first principles inductively. But there are good reasons to reject such an interpretation. For one thing, it wouldn’t tell us anything about how induction relates to the various cognitive states Aristotle identified as key steps in our cognitive ascent. It also seems hard to square this kind of reading with Aristotle’s description of various interrelated universals making *successive* stands in our soul — unless all these universal stands are somehow meant to be part of a single inductive process.<sup>30</sup>

30. One might also worry about such an interpretation on philosophical grounds. For it makes Aristotle’s account structurally similar to the kind of innatist view he seeks to reject: recollection is also a process that takes us from certain perceptions to a sophisticated grasp of theoretical notions (*e.g.* from our perception that two sticks are both equal and unequal to a grasp of the Form of

In fact Aristotle’s argument is more subtle than this. He begins (in [5a]) by identifying a first “stand” with the development of a first universal in our soul. When he proceeds (in [5b]) to describe the development of higher universals in terms of “stands,” his point is that the *kind* of process responsible for the first stand is also responsible for subsequent ones. And when he concludes from this (δῆλον δὲ, in [5c]) that *induction* must be responsible for our grasp of first principles, he’s leaving out the key premise that induction is the process responsible for the first stand in our soul — which is precisely the premise he supplies to support (γὰρ) his conclusion at the very end of our passage.<sup>31</sup> In short, then, his argument has the following form: some sort of process is responsible for our first grasp of a universal, the same sort of process leads us to grasp higher and higher universals until we reach first principles, so *induction* must lead us to first principles, since induction is the process responsible for our first grasp of a universal.

What we should take away from this is that Aristotle isn’t claiming that a *single* induction takes us from perception to first principles. Nor is he inferring, as most commentators assume, that we know first principles inductively merely from the fact that we come to grasp increasingly *general* universals. His claim is rather that the processes responsible for the first and subsequent universal stands in our soul are all *instances* of a certain kind of induction — namely, the kind of induction at play when we first grasp a universal on the basis of our perceptions. We grasp first principles through repeated inductions

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Equality). So at the very least induction would have to be described in more detail if it is really meant as an alternative to the sort of recollection an innatist might posit.

31. I disagree with Hamlyn, who denies that the οὕτω at 100b5 refers to induction on the grounds that universals are already said to be present in the soul at the perceptual level, before any induction has taken place (1976: 180–81). Hamlyn fails to consider that one might grasp universals in quite different ways: a universal might be in the perceiver’s soul even if she doesn’t recognize it as such, and induction might therefore produce a certain *kind* of grasp of universals which perception does not. I’ll be discussing the grasp in question in more detail below.

of this sort, rather than relying on a single inductive step, and this regardless of the relative generality of the universals in question.

One difficulty with the reading I'm suggesting is that these inductive processes don't seem to have much in common: the first takes us from a grasp of one or more perceived individuals to a grasp of some universal, while subsequent inductions begin already at the level of universals, and take us to further universals. Moreover, the two processes may seem to reflect different sorts of cognitive achievements. For (one might think) the development from perception to our very first grasp of some universal happens at a rather basic conceptual level, while progressing through higher universals involves serious intellectual work—especially if the advance involves a theoretically-sensitive grasp of the relevant universals. So it's not clear at all how these two forms of progress could be of the same type.

I think we face an interpretive dilemma. If "induction" is just understood as a placeholder for "any cognitive progress from the less to the more general" (cf. Barnes [1993: 267]), then it's clear enough how it might account for both our advance from particular perceptions to certain universal conclusions and our later ascent to further, more general universals. But it's hard to see how "progressing to the more general," on its own, would ever yield a *theoretically-sensitive* grasp of definitional principles. Assuming we've encountered a number of human beings and come to grasp that human beings are rational animals, for instance, how are we supposed to *induce* that we shouldn't look for a further explanation of this fact, or *induce* that it expresses what it is, essentially, to be a human being? If induction is just a form of progress to the more general, it would never tell us anything about any proposition's explanatory role—which is precisely what (I've argued) Aristotle seeks to explain in this chapter.

If, on the other hand, "induction" is taken to be a more robust sort of process—the sort of process that might actually yield a theoretically-sensitive grasp of first principles—then our interpretive challenge is to explain what *sort* of cognitive progress it's meant to represent. For it isn't clear what unifies our progress from perception to universals

and our later progress to first principles, or, in Aristotle's terminology, what unifies the first and subsequent universal stands in our souls. And even if these two forms of progress do have something in common, it may seem doubtful that they could count as cases of Aristotelian induction—for induction, one might think, never affords us the grasp of *explanatory priority* required for our epistemic ascent.

I think we should opt for the second horn of this dilemma: the more robust notion of induction can be given a unified account, and some of Aristotle's remarks elsewhere in *APo* suggest that ἐπαγωγή can encompass quite sophisticated forms of cognitive progress. Before offering a defense of these claims, however, I want to clarify one last point about the (quite difficult) passage [5].

Aristotle claims in [5a] that "undifferentiated things" (ἀδιάφορα) make a stand in our souls. I'll be interpreting these as *infimae species*, which are "undifferentiated things" because one can't differentiate them into further species.<sup>32</sup> A worry that's often raised with this interpretation is that it seems to make Aristotle's account incomplete, assuming from the start that we can grasp universals like "human being" without explaining their development on the basis of what we perceive—for simply stating that perception is somehow "of universals" isn't saying much. My response to this worry is twofold. First, our perceptual grasp of universals should not be *assimilated* with our grasp of undifferentiated things: the fact that perception is "of

32. Some commentators (e.g. Bronstein [2012: 55]) suggest taking the ἀδιάφορα as *individual members* of some species, undifferentiated because they belong to the same species, while others (e.g. Bolton [1991: 6]) identify them with the "confused" (συγκεχυμένα) universals of *Phys* A1 184a22, undifferentiated because their features haven't yet been spelled out in detail. One difficulty with the first kind of reading is that it isn't clear how the *next* stand—that by which we reach a higher universal—would be "made among these (ἐν τούτοις)" (cf. Hankinson [2011: 48]). For the items among which this stand is made are themselves universals (e.g. "such-and-such an animal" or "animal"), and it's natural to read "these" at 100b1–2 as referring back to the ἀδιάφορα, which made the first stand. Bolton's alternative makes good sense, but the *Physics* passage on which it rests speaks of moving from the universal to the particular, and this doesn't seem to sit well with the move from ἀδιάφορα to higher universals described here.

universals" features in Aristotle's *explanation* how a grasp of *infimae species* might possibly come about, but it doesn't yield that grasp itself. Second, nothing in B19 prevents the "first stand" from occurring at a stage we reach after we've already undergone a good portion of the cognitive development described in [3]. Indeed, given that one of the key stages in this development is described as that in which some *universal* has come to rest in the soul, there is good reason to identify the first stand with the grasp of a universal we develop *after* having progressed through the stages involving perception, memory, and experience. As I'll be showing in what follows, Aristotle describes these pre-universal states in some detail in other texts, so interpreting the ἀδιάφορα as I'm suggesting doesn't make his account incomplete.<sup>33</sup>

So far, then, I've argued that each of the "stands" being described in [5] represents a separate use of induction, and that "induction" here is just the kind of process responsible for the first stand of a universal in our soul. I've further argued that this first stand represents our grasp of some *infima species*, and that it only occurs after we've progressed through three of the four cognitive states prior to νοῦς of first principles. I'm now going to consider what this first stand involves and what it has in common with subsequent stands in our soul, before trying to make sense of the claim that these should all count as *inductive* forms of cognitive progress.

#### 4. The First Stand: Perception to Craft-Knowledge

The objects of perception, for Aristotle, are particular things in particular places at particular times.<sup>34</sup> But there's nonetheless some sense in which we also perceive the universals to which such particulars belong — as Aristotle notes in passage [5], we don't just perceive Callias, but Callias

33. Or at least, no more incomplete than it would be on anyone else's interpretation. It remains true that Aristotle never says much about how a *rudimentary* grasp of universals might arise out of our perception of particulars.

34. See for instance *APo* A31, or *Mem* 449b10–15. The type of perception at play in *APo* is typically not the perception of proper or common sensibles, but rather the kind of "extrinsic" (κατὰ συμβεβηκός) perception Aristotle mentions at *DA* B6 418a20–21.

as the human being he is. Now, perception is clearly not meant to yield an *advanced* grasp of universals — it's not merely by perceiving Callias that we're able to explain a range of zoological phenomena, or recognize what attributes must belong to any human, or suddenly know how to produce demonstrations involving human beings.<sup>35</sup> Indeed, at the perceptual stage an inquiring subject may not even have the concepts necessary to *articulate* what she perceives, much less reason about it. Still, the perceiving subject will bear some relation to the universals instantiated by the things she perceives — and this, together with the subject's other cognitive capacities, will allow her to develop a more advanced grasp of universals.

Part of what makes this development possible is our capacity to achieve a form of *experience* on the basis of repeated perceptions of a certain type, retained as memories. Experience is a state Aristotle describes in some detail in *Met* A1:<sup>36</sup>

[6] To have a judgment that when Callias was ill of this disease this did him good, and similarly in the case of Socrates and in many particular cases, is a matter of experience; but to judge that it has done good to all persons of a certain constitution, marked off in one class, when they were ill of this disease, *e.g.* to phlegmatic or bilious people when burning with fever, this is a matter of craft. (981a7–12)

35. It's a difficult question what sort of universal grasp perception *does* yield. The grasp shouldn't count as "universal" merely because universals like "human being" are somehow *deducible* from basic perceptual data, or because the things we perceive *happen* to instantiate certain universals — for perception's universal character is itself supposed to explain something about our cognitive development. Though I can't argue for it here, I think our perceptual grasp of universals should be understood as a grasp of particular things that's *responsive* to the universals governing their behavior: perceptible particulars possess certain features because they instantiate certain universals, and perception allows us to discriminate these features and experience them as action-guiding aspects of our environment.

36. I follow Ross' translation, with a few minor modifications.

An experienced doctor, then, remembers the particular treatments which cured particular patients with particular diseases. On the basis of these past cases, she's able to determine which treatment will be effective given some particular patient with some particular disease. But her diagnoses are always rooted in and directed towards particulars—the experienced doctor doesn't pick a treatment by recognizing that Callias belongs to the type “phlegmatic human being,” noting that an instance of “being affected by malarial fever” is present in him, and inferring that “bloodletting with leeches” would be a good treatment. Reasoning of this sort is only available to a physician capable of identifying the explanation for symptoms of some given type independently of any particular case presented to her—and as Aristotle goes on to explain, such an ability is proper to the person who knows the *craft* of medicine (981b6).<sup>37</sup>

So when Aristotle claims, in [3], that experience arises out of “repeated memories of the same thing” and that “many memories constitute a single experience,” he is trying to explain how perceptual knowledge, whose objects are particular things in particular places and times, could ever provide a sufficient basis for the sort of reliable behavior displayed by those with experience. His explanation rests in part on the fact that perception is “of universals,” even for perceivers who don't yet possess the concepts necessary to *reason* about the universals they perceive. It also rests on the fact that animals endowed with memory can retain their perceptions, and that many memories of the same sort of thing might, in some of these animals, yield the kind of unified, reliable experience described above.<sup>38</sup> Experience does require more than memory, since the experienced person has internalized some of the connections between her memories and is able to predict

37. For a more detailed account of experience and its relation to craft, see Charles (2003: 151–56).

38. So, for instance, memories of a certain type of symptom and of some prescribed treatment's effects might constitute a “single experience” of some curing process. An experienced doctor would presumably rely on a number of experiences of this sort.

future outcomes on the basis of new perceptions of a certain type.<sup>39</sup> But it also remains a relatively basic state: the experienced person doesn't yet *recognize* the connections between her memories as connections between certain types which the remembered individuals instantiate.<sup>40</sup>

A physician possessing the craft of medicine differs from an experienced doctor in two significant ways: first, the physician can identify the *explanation* for some successful treatment, while the experienced doctor acts without any explanatory knowledge, and second, the physician can recognize the effects of some *type* of disease in some *type* of patient, while the experienced doctor merely treats symptoms on a particular, case-by-case basis. It may seem good to keep these points distinct, for one could recognize patients as being of a certain type—as “phlegmatics,” say—without yet knowing the explanation for the symptoms that phlegmatic people might display. But here Aristotle assimilates the two: in the sense at play in this passage, grasping universals makes clear certain explanations that invoke the universals in question.<sup>41</sup> So even if an ability to make

39. For the sense in which such connections are “internalized” in an experienced subject, see Gregorić and Grgić (2006: 9–10).

40. Of course this isn't to say that we couldn't express the content of an experienced doctor's knowledge in universal terms — *we* might claim that the doctor described above knows that all malarial phlegmatics should be leeches, even if the doctor herself doesn't think of her patients or treatments in such terms. On this point, see LaBarge (2006: 39). (And see Hasper and Yurdin [2014] for a competing view, on which the *content* of experience is dissociated from the particular discriminations it allows us to make.)

41. Compare for instance 981a5–7 and 981a16, where craft is associated with universals, with 981a24–28, where craft is associated with explanatory knowledge. See also 981b10–13, where knowledge of particulars is contrasted with explanatory knowledge (rather than *universal* knowledge, as one might have expected). Bronstein has recently argued that Aristotle *does* distinguish the two at 981a30–b6, when he separates the “manual craftsman” from the “master craftsman” (2012: 48–49). On this view the *master* craftsman has general explanatory knowledge, while the *manual* craftsman has general knowledge, but no grasp of explanations. This interpretation seems to me difficult to reconcile with the contrast drawn between particulars and universals in the rest of the chapter. For my purposes, however, all that matters is that a grasp of explanations be the real marker of cognitive *progress*; and Aristotle's dismissive treatment of manual craftsmen as “lifeless things who act

judgments about types of individuals “marked off in one class” is a criterion for craft-knowledge, as Aristotle suggests in [6], it’s really our grasp of *explanations* which makes us wiser and allows us to “know in a stronger sense” (μᾶλλον εἰδέναι, 981a31) than someone with mere experience. The main mark of our cognitive progress beyond perception and experience is an *explanatory* form of understanding.

Aristotle never explains the development of such understanding in much detail, but it doesn’t seem too hard to fill out his account: a doctor reliable in her treatment of a range of particular patients might consider whether certain symptoms were common to certain *types* of patients, and whether some *type* of treatment was effective. If this kind of demarcation proves helpful, she might also be led to consider whether some type of disease (malaria, say) might account for the symptoms in question, and explain the treatment’s effectiveness. And if she’s successful in identifying the relevant disease, she’ll have developed the kind of explanatory grasp proper to the craft of medicine. Her progress will consist in identifying some universal (“being malarial”) to which feverish phlegmatics, considered as a class, belong, and in seeing that their belonging to this universal explains their symptoms and the effectiveness of certain treatments. It’s at this point, as I read Aristotle, that a universal will have “come to rest” in the physician’s soul. For this is the first time our physician grasps universals *as universals* — the first time she is able to reason about what’s “one and the same” in the many patients she encounters and prescribe a general type of treatment for some general type of symptom, recognizing both as such, that is, as “one apart from the many,” as Aristotle puts it in [3].

A person in this state doesn’t yet have νοῦς of medical first principles. She doesn’t yet know, for instance, whether the diseases she’s identified are explanatorily basic or not, nor could she situate any of her explanations in an axiomatic science of medicine.<sup>42</sup> At this

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without knowing what they do” (981b2–3) seems to me good indication that this is so even in the passage under consideration.

42. Here I speak of axiomatic medicine a *science* rather than a *craft*. In context, I don’t take the distinction to be significant: Aristotle clearly indicates in [3]

point she may not know if such a science is even to be found — it might simply not be possible to organize medical explanations in the well-ordered fashion a demonstrative science requires. Still, she has made significant progress in this direction by reflecting on the practical and particular-minded grasp she had at the stage of experience, and which she developed on the basis of a range of (remembered) perceptions. If my reading of B19 is correct, the universal conclusions reached on this basis each represent a separate use of induction.

The point I wish to emphasize here is that the resulting grasp of universals does not simply consist in an ability to form general judgments, or identify some group of individuals as members of a certain class. This is a necessary component of our advance from experience, but it isn’t sufficient. For our progress also consists (as Aristotle makes very clear in *Met* A1) in recognizing the *explanatory relations* between these universals — someone with the craft of medicine, for instance, won’t just grasp that all feverish phlegmatics are cured by being leeches; she will grasp that “feverish phlegmatics” belong to the class of “malarial patients,” that their belonging to this class *explains* their fever, and that they would therefore be cured by being leeches. Someone with such a craft could not yet be said to have νοῦς of the first principles of the science of medicine, but she would at least have an explanatorily-sensitive grasp of some of the conclusions the science might aim to secure.

So suppose, for now, that it’s correct to call this kind of progress *inductive* (I’ll be defending this claim later). What does it have in common with the subsequent universal stands in our soul? Once you’ve grasped certain portions of the science of medicine in the manner described above, how might you learn the basic principles of medical science, and recognize their explanatorily primitive role — and how does the progress from perception to medical craft compare with the progress from medical craft to νοῦς of medicine? I’ll turn to these points in this next section.

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that our epistemic ascent is the same in theoretical domains as it is in productive ones.

### 5. Subsequent Stands: From Universals to $\nu\omicron\varsigma$

Suppose you're an astronomer with a theoretically-sensitive grasp of certain universals. You don't yet grasp astronomical first principles, and so you may not yet know how to produce proper demonstrations of all the astronomical events you've witnessed, but you can still explain some of them, and reason about them in universal terms. You might know, for instance, that shooting-stars are caused by a trail of vapor gleaming through the sky, that comets are caused by a fiery exhalation in the celestial sphere, and that the milky way is caused by a concentration of bright constellations outside the tropics.<sup>43</sup> In each case, you grasp an explanation for a range of perceived phenomena, and can reason about the explanation and the phenomena in general terms, without *perceiving* any one of their instances.

At this stage you only grasp distinct explanations for distinct types of astronomical phenomena. But you might seek some further explanation which would provide a more basic and unified account than the ones you currently have. For instance, you might come to see that the shooting-star's vapor and the comet's fiery exhalation are both instances of *condensation of the air*, and recognize that this condensation explains their behavior. And if you push the search further, you might come to see that the circular motion of the celestial sphere, together with some basic properties of air and fire, can explain this condensation as well as the presence of the Milky Way and a host of other astronomical phenomena. In doing so, you would come to recognize common explanations for a range of phenomena you were already able to explain in a piecemeal manner.

I claim that the cognitive development at play in this recognition is similar in structure to the one the experienced doctor undergoes when she learns the universal explanation underlying her treatment of a range of particular patients. Consider them side by side. The doctor's progress stems from the recognition that feverish phlegmatics are all

43. These examples are from *Metr* A4–8. See also Lennox (1987) for a detailed treatment of Aristotle's search for explanations in *HA* and *PA*, and its relation to his methodological remarks in *APo*.

malarial, and that this explains their symptoms and the effectiveness of having them leeches. Your progress as an astronomer stems from the recognition that vapor and fiery exhalation are both instances of a certain kind of condensation, and that this explains why they have the effects we observe them to have. In both examples, a universal is identified under which a range of cases are found to fall, and the fact that the cases instantiate the universal is supposed to explain their behavior. Why do vapor and fiery exhalation behave as they do? Because they're both instances of *condensation*. Why does leeching cure this feverish phlegmatic, and this other feverish phlegmatic, and so on? Because all these feverish phlegmatics are *malarial* (or, to put it more conspicuously, because they all instantiate malarial disease). If the medical example is a case of induction, there's good reason to think of your own astronomical progress as a case of induction, too.

Now, it's not yet clear how this kind of progress could yield  $\nu\omicron\varsigma$  of first principles. What we have so far is a process which yields a grasp of certain universal explanations, and this alone won't tell us which universals *don't* admit of further explanation.<sup>44</sup> So one might think that even the robust sort of induction I've been describing would have to be supplemented to truly provide a grasp of principles as explanatory primitives.

But in fact this is unnecessary. To see why, it'll be important to consider a common Aristotelian assumption, namely that we can and should begin our inquiries by gathering all the scientific explananda relevant to some domain. Aristotle makes this point in a number of places, but here is a representative passage from *APr*:<sup>45</sup>

44. It also hasn't yet been made clear how knowledge of an explanation, or even of a series of explanations, would translate into knowledge of a *demonstration* containing the relevant universal as its middle term. But finding demonstrations is easy once we grasp explanations: if we already know that feverish phlegmatics instantiate malarial disease and that this explains why they should be leeches, for instance, it's a small step to form a demonstration establishing as much ("all feverish phlegmatics are malarials, all malarials should be leeches, so all feverish phlegmatics should be leeches").

45. See also *APo* B1 89b29–31, *HA* A6 491a7–14, *PA* B1 646a8–12, or *DA* A1 402b22–403a2. I follow Striker's translation here, with a few modifications.

[7] The situation is the same in any other craft or science [as it is in astronomy]; once it has been grasped what belongs to each thing, at that point we will be prepared to make plain the demonstrations. For if nothing that truly belongs to the things has been left out in the collection of observations, we will be in a position to find the demonstration and demonstrate anything that admits of demonstration, and where there cannot be a demonstration, to make this evident. (A30 46a17–27)

On Aristotle's view, then, our ability to find demonstrations and determine what cannot be demonstrated is dependent on an exhaustive survey of some domain of facts.<sup>46</sup> Once all the domain-specific facts have been gathered, we will have at our disposal all the terms necessary to describe the domain, and be ready to distinguish those attributes that belong to a subject's essence from those which are demonstrated on their basis.<sup>47</sup>

The assumption that we have a comprehensive set of candidate explananda and explanantia at our disposal suggests a way induction could yield a grasp of principles as explanatorily basic. The idea is simply that repeated inductions would eventually reveal all the explanatory connections in the domain under consideration. And if induction repeatedly fails to produce a universal explanation for some fact (that the celestial sphere moves in circular way, say), it will "make evident" (46a27) its explanatorily primitive status: since we've assumed that we have an exhaustive collection of facts at our disposal, no further

46. Aristotle does seem to think that we could provide approximate principles with an incomplete set of facts (*DA* A1 402b22–403a2). But ideally we would have all the facts at our disposal.

47. Aristotle never explains how we would know we've amassed "all the facts" about some given domain, or how we would know which facts belong to which domain in the first place (which is nontrivial given that at this point in our inquiry we wouldn't have identified the principles definitive of any domain). So it's a key assumption here that we be able to engage in this fact-gathering activity at a pretheoretical stage.

observation could possibly serve to explain it. And insofar as induction makes this evident, it will yield an explanatorily-sensitive grasp of the definitional principle expressing the fact in question. Though it won't *prove* its explanatorily basic status, there's a clear sense in which induction will reveal it.<sup>48</sup>

I've argued so far that there's good sense to be made of the claim that we come to know demonstrative first principles (and come to know them in a theoretically-sensitive manner) by induction *if* induction is understood a certain way—roughly, if induction is understood as a form of cognitive progress from a range of particular truths to some universal explanation why all these truths hold. It's now time to defend the claim that Aristotle does indeed use "induction" and its cognates to denote this kind of progress.

## 6. Induction and Explanation

Aristotle defines induction as "an advance (ἐφόδος) from particulars to a universal" (*Top* A12 105a13–14). On its own, this definition doesn't tell us much. It's left open both what the "advance" consists in, and *how* we grasp the particulars from which it begins or the universal that is its result.

Some commentators have suggested that the advance be understood as an *inference* beginning from particular premises to some general conclusion.<sup>49</sup> But this does not reflect Aristotle's typical and much broader usage of the term—the broader usage on which all our learning can be said to come from perception, demonstration, or induction

48. One might still want to know, of course, what allows us to establish explanatory priority *correctly* (e.g. to recognize that the presence of malarial disease in a subject explains the effectiveness of leeching, rather than the effectiveness of leeching explaining the presence of malarial disease). Aristotle is silent on this point, but he may simply think that there is nothing one could say about how to identify causes *in any science whatsoever*, because the methods and norms for establishing causal priority are always domain-specific (this is the suggestion advanced by Lennox [2013: 33]).

49. Ross, for instance, singles this out as one of the key senses of the term ἐπαγωγή (1949: 481–87).

(*APo* A18).<sup>50</sup> For clearly Aristotle does not have in mind, in passages like these, that some specific sort of inference is responsible for all our nondemonstrative, nonperceptual learning.

Yet even if our inductive advance is not understood as a specific sort of inference, one might worry that it must remain an advance from *particulars* to *universals*, and that this would already disqualify it from playing the role I've suggested above. For example, when an astronomer induces that the shooting-star's vapor and the comet's fiery exhalation are both explained by their being instances of condensation, is she not advancing from *universals* ("vapor," "fiery exhalation") to some further *universal* ("condensation")? If so, it might be hard to see how this could count as a case of Aristotelian induction.

But such an objection rests on a mistaken interpretation of what Aristotle means by "particulars" and "universals" in this context. For Aristotle routinely invokes induction on *types*—indeed, right after defining induction he gives as an example that "if the skilled pilot is the best, and likewise the skilled charioteer, then in general the skilled person is the best at his work" (*Top* A12 105a15–16), and it's clear he's invoking pilots and charioteers as *types* of skilled individuals here.<sup>51</sup> So the particulars from which induction begins and the universals to which it leads aren't meant to pick out specific *logical*

categories—induction is not (or not *merely*) the move from a grasp of *tokens* to a grasp of *types*, or from a set of propositions about tokens to a general proposition about the type to which these tokens belong. The "particulars" and "universals" in question are better understood as descriptions of the *form* of our grasp before and after induction: we begin with some grasp of a range of facts *as particular cases*, that is, without recognizing any unifying feature they share, and we induce such a unifying feature, which we thereby grasp *as a universal*.<sup>52</sup> This can all be done regardless of the logical status of the terms featuring in our pre- and post-inductive knowledge.

One might nonetheless object that grasping some conclusion *as a universal* does not mean grasping it *in its explanatory role*: we can have knowledge of some general conclusion without yet knowing anything about what this conclusion might explain. If induction served merely to secure the *truth* of general conclusions about a feature shared by some range of particular things, it wouldn't serve the purpose I've argued it must—though it might still be responsible for providing all the general *terms* featuring in the comprehensive survey of some domain (cf. p.15), and thereby supply us with *candidate* explananda.<sup>53</sup>

But there are good reasons to think that induction does yield an explanatorily-sensitive grasp of universals—or at least that it does so in the context of *APo*. For when Aristotle speaks of grasping *universals* in *APo* the grasp in question typically involves a grasp of *explanations*: someone grasping something *καθόλου* doesn't merely grasp some general proposition or term, but grasps a universal explanation for a range of particular facts. Consider for instance Aristotle's explanation of perception's contribution to scientific knowledge, at *APo* A31. After having explained why perception doesn't (by itself) yield the kind of

instance *APo* A1, where Aristotle describes someone inducing that some particular triangle *token* has angles equal to two right angles (71a21–24).

50. It's not even clear Aristotle *ever* uses ἐπαγωγή to pick out such a form of inference. He does treat induction as a certain kind of syllogism at *APr* B23, but he tells us at the outset that the inductive syllogism *arises or issues from* induction (it's a syllogism ἐξ ἐπαγωγῆς), and this leaves open a range of views concerning the relationship between inductive reasoning and the syllogism that arises out of it. Moreover, the syllogism in question clearly *presupposes* some other form of inductive reasoning: the argument's *premises* (in his example, "longevity belongs to all Cs" and "bilelessness belongs to all and only Cs," for some animal genus C) are precisely the sorts of truths one would grasp inductively. See Caujolle-Zaslavsky (1987) and Engberg-Pedersen (1979) for further criticism of readings on which induction is a specific form of inference (and see Hintikka [1980] for a dissenting view). Commentators sympathetic to a broad reading of Aristotelian induction include Charles (2003: 270–72), Hamlyn (1976), and McKirahan (1983).

51. See also *Rhet* B20 1393b4–8, for an argument by example (which Aristotle says "has the nature of induction" at 1393a26) that operates on types and not tokens. Induction need not even yield a conclusion about types: see for

52. So, in Aristotle's example, we would recognize *skill* as the unifying feature shared by various groups of people we know to be good at their work.

53. This line of thought is an important motivation for deflationary readings of *APo* B19 (see Bronstein [2012: 46–47] for an explicit endorsement of such an interpretation). Thanks to Gisela Striker for pressing me on this point.



knowledge of universals required by scientific understanding, Aristotle describes how perception does contribute to our grasp of universals:<sup>54</sup>

[8] Some features [of problems] are such that if we perceived them, we would not seek; not because we know by seeing, but because we grasp the universal from seeing. For instance, if we saw the glass having been pierced and the light going through it, it'd be plain why it does, too, even if we see separately in each particular [case] but think at a single time that it's such in every case. (88a12–17)

The case presented here is an example of our grasping some universal based on what we see: we see a pierced piece of glass, and understand why light goes through glass. How exactly this is supposed to work is not something I wish to address here—I only want to draw attention to the fact that our perceiving light going through the glass is supposed to make clear *why* it does, and that this is meant to exemplify our grasping something *universal* from what we see. A similar remark is made later on in *APo* B2, when Aristotle notes that our witnessing a lunar eclipse from the moon would help make plain both the fact that and the reason why the eclipse is occurring, because (γὰρ) “we’d come to know the universal from perceiving” (90a28–29).<sup>55</sup>

In cases like these, grasping the universal does not just mean grasping general facts. It means grasping the universal *in its explanatory role*. In this sense, someone could have *general* knowledge about triangles (say) without yet having *universal* knowledge about them, as Aristotle illustrates at *APo* A5:<sup>56</sup>

54. The text for this passage is problematic, but not in any way that would affect the use I am making of it here. I follow Barnes’ reading of the manuscripts.
55. Aristotle never explicitly labels the cases above as instances of induction, but in context it’s clear that they should be taken this way—as Engberg-Pedersen (1979: 309) and Ross (1949: 599) both note. In *APo* Aristotle almost never mentions induction by name.
56. I follow Barnes’ reading of the manuscripts and slightly adapt his translation. See also Hasper and Yurdin (2014: 131–32) for a reading of this passage

[9] Even if you prove of every triangle, either by one or by different demonstrations, that each has two right angles—separately of the equilateral and the scalene and the isosceles—you do not yet know of triangles that they have two right angles, except in the sophistical way; nor do you know it of triangles universally, not even if there are no triangles aside from these. For you do not know it of triangles as triangles, nor even of every triangle, except in number—not of every triangle according to the form [triangle], even if there is no triangle of which you do not know it. (74a25–32)

Thus even if we can *prove* of each and every species of triangle that it has two right angles, we won’t thereby know that triangles have two right angles *universally*. What’s missing is the realization that these species of triangles are *exhaustive* of their genus, and that it’s *because* they belong to the genus triangle (or “according to the *form* [triangle]”) that they have the angular sum they do. As above, the proper, non-sophistical grasp of the universal is an explanatorily-sensitive one.<sup>57</sup>

The grasp of a universal resulting from our inductive advance should (I suggest) be understood along similar lines—as the grasp of some universal *as an explanation* for a range of particular cases. So, to borrow Aristotle’s example, induction won’t merely tell us that skillful people are good at their work. It will also tell us that

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along similar lines.

57. Nor is this association between καθόλου knowledge and explanatory knowledge restricted to *APo*. Recall (p.12) that Aristotle contrasts craft knowledge and ἐμπειρία by noting that the latter has particular objects, while the former requires an understanding of *explanations* which is assimilated to our grasp of certain universals (*Met* A1 981b10–13; see also A2 982a24–25). In a similar vein, Aristotle claims at *Met* E1 that the science of an immovable substance would be primary and “universal in this way, by being primitive” (καθόλου οὕτως ὅτι πρώτη, 1026a30–31), that is, universal not merely because it makes general claims, but because it provides explanations that are prior to those of other sciences (see also *APo* A4 73b33ff and *APo* A24 85b23–27, in a similar vein).

it's *because* of their skill that skillful people are good at their work. Note that induction need not *always* be taken yield such explanatory knowledge; my claim is only that it's natural to read it this way in the context of *APo*, where universal knowledge is often identified with a knowledge of universal *explanations*.<sup>58</sup>

One last objection.<sup>59</sup> The kind of induction described in B19 seems to involve a rise from the less to the more *general*—recall the progression from “such-and-such an animal,” to “animal,” to “something partless and universal” (100b1–3). Even granting that induction leads to a grasp of these more general universals in some explanatory role, one might worry that this will leave out key cases of explanatory priority. For instance, suppose triangles are essentially three-sided rectilinear figures—so that “triangles are three-sided rectilinear figures” is an explanatorily primitive geometrical principle. One of the properties we would want to explain about triangles is their angular sum, and it's a key part of Aristotle's view that their angular sum be *explained* by their three-sidedness, rather than the other way around. But in this case *all and only* three-sided rectilinear figures have angles equal to two right angles. If induction requires a progression through more *general* universals, it isn't clear how it would allow us to see the three-sidedness of triangles as explanatorily prior to their angular sum.

I think the best reply here is to deny that the increasing generality of the universals described in B19 is an important part of Aristotle's account. I've already argued above (p.9) that the structure of Aristotle's *argument* in this passage doesn't depend on the increasing generality of the universals Aristotle describes. But there's also some independent philosophical motivation to think generality unimportant. The motivation is simply that it should be possible for an *infima species* to be a first principle: the definition “human beings are rational animals” is

58. There are exceptions: at *APo* A13, induction is said to establish that “what doesn't twinkle is near” (78a34–35), in an example specifically meant to illustrate the premise of a *non-explanatory* demonstration. My claim is only that knowing something καθόλου, in *APo*, is *typically* knowing something in an explanatorily-sensitive way.

59. Thanks to Ben Morison for bringing this issue to my attention.

presumably a zoological principle, even though it appears at the lowest rung of the universals mentioned by Aristotle. For what counts as a scientific first principle is determined by some given set of explananda, and we would expect the definitions of various kinds of animals to be explanatorily basic relative to some set of zoological phenomena. If this is correct, the progression through higher genera in our passage may simply reflect a decision to illustrate our inductive progress for an especially broad set of explananda—perhaps the broadest possible set of explananda, if we interpret the “partless and universal” things as the basic categories of being.<sup>60</sup>

Our inductive progress should therefore not be taken to yield a *definition* of some kind of animal, a further *definition* of animal, and further *definitions* of more general universals.<sup>61</sup> As I read Aristotle's description of our ascent, definitions only emerge when our inductive progress ends—that is, when induction fails to yield an explanation for some candidate explanandum. When this takes place will depend on the facts at our disposal. To someone considering animal behavior, the fact that animals *perceive* will be basic (see *e.g.* *DA* Γ13 435b16). To someone considering the behavior of living organisms, it will not: animal perception is further explained by the fact that living beings are *self-preserving*, that is, that living organisms seek to preserve their form of life (see *e.g.* *GA* A23 731a24–b8). Induction will in either case be the process responsible for bringing about our grasp of explanations for the facts under consideration—definitions if the explanations are basic, non-definitional universals if they are not.

60. As Ross (1949: 678) suggests. On this reading, Aristotle would be portraying someone interested, in general, in the ways things can be said to *be*. Induction is responsible for yielding an explanatorily-sensitive grasp of the ways various animal species *are*, and of the ways animals in general *are*, and of the ways living beings *are*, and so on (see Bronstein [2012: 59] for a sketch of how this sort of inquiry might develop). The increase in generality here merely reflects the order in which we might expand our inquiry—it isn't itself what makes our progress inductive.

61. Thanks to an anonymous reviewer for pushing me to clarify this point.

To sum up, then, I think there's good reason to think of induction in the context of *APo* as the process by which we move from a grasp of a set of particular facts to a unified explanation thereof. The facts in question need not be expressed in propositions with a specific logical form, and the universals involved in their explanation need not apply more generally, to facts distinct from those whose explanation we sought. But induction in this sense does yield a grasp of something *universal* in precisely the sense in which the term is used in the *APo*, that is, a grasp of some universal which essentially involves its explanatory role.

### 7. Conclusion

*APo* B19 describes how we come to learn the first principles that serve as an explanatory bedrock for our scientific understanding. Aristotle's account focuses on the capacities involved in our cognitive development from perception to νοῦς—a form of development he characterizes as *inductive* in nature. My main aim in this paper has been to make sense of the claim that induction is the key process driving our cognitive development, and to argue that this isn't a hopeless response, even taking into consideration the very demanding constraints placed on our knowledge of scientific first principles.

I've presented myself as opposing certain *deflationary* readings of B19, on which induction is only responsible for *part* of our cognitive development. But I want to end on a more conciliatory note. Part of the motivation behind deflationary readings is that they leave room for some of Aristotle's remarks in the second book of *APo*, which give us some insight into the sorts of methods one might use to best discover principles—the thought is that induction is merely a prerequisite for the use of such methods (methods like *division* or *collection*), and that the complete account of our learning first principles involves both these methods *and* induction. I think deflationists are right to emphasize Aristotle's methodological remarks. Where I think they go wrong is in thinking of induction as a mere prerequisite to their use: as I read Aristotle, certain methods are a good way for us to *realize* an inductive advance, in the same way a geometry lesson with Socrates is a good

way for Meno's slave to recollect. Far from *competing* with induction, methods like division and collection are ways to bring it about.

There remain some difficulties in interpreting Aristotle's discussion of these methods, and the use to which he puts them—in particular concerning their ability to correctly determine explanatory priority. But these are difficulties anyone must face who seeks to make sense of Aristotle's epistemology (and indeed, difficulties epistemologists still face today in some form or another). My hope is only to have made some room for an interpretation of *APo* B19 which takes seriously Aristotle's claim that we come to know first principles—in a theoretically-sensitive way—by induction.<sup>62</sup>

### References

- Adamson, Peter (2010). "Posterior Analytics II.19: A Dialogue with Plato?" In *Aristotle and the Stoics Reading Plato* (Verity Harte, Mary M. McCabe, Robert W. Sharples, and Anne Sheppard, eds.), 1–19, Institute of Classical Studies.
- Barnes, Jonathan (1993). *Aristotle's Posterior Analytics*. Clarendon Press.
- Bayer, Greg (1997). "Coming to Know Principles in *Posterior Analytics* II 19." *Apeiron*, 30, 109–142.
- Bolton, Robert (1991). "Aristotle's Method in Natural Science: *Physics* I." In *Aristotle's Physics: A Collection of Essays* (Lindsay Judson, ed.), 1–29, Clarendon Press.
- Bostock, David (1986). *Plato's Phaedo*. Clarendon Press.
- Bronstein, David (2012). "The Origin and Aim of Posterior Analytics II.19." *Phronesis*, 57, 29–62.
- Caujolle-Zaslavsky, Françoise (1987). "Etude préparatoire à une interprétation du sens aristotélicien d'ἐπαγωγῆ." In *Biologie, logique*
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- et métaphysique chez Aristote* (Daniel Devereux and Pierre Pellegrin, eds.), 365–387.
- Charles, David (2003). *Aristotle on Meaning and Essence*. Oxford University Press.
- Engberg-Pedersen, Troels (1979). “More on Aristotelian Epagoge.” *Phronesis*, 24, 301–319.
- Fine, Gail (2003). *Plato on Knowledge and Forms*. Clarendon Press.
- Frede, Michael (1996). “Aristotle’s Rationalism.” In *Rationality in Greek Thought* (Michael Frede and Gisela Striker, eds.), 157–173, Oxford University Press.
- Gregorić, Pavel and Filip Grgić (2006). “Aristotle’s Notion of Experience.” *Archiv für Geschichte der Philosophie*, 88, 1–30.
- Hamlyn, David W. (1976). “Aristotelian Epagoge.” *Phronesis*, 21, 167–184.
- Hankinson, Robert J. (2011). “Avant nous le Déluge: Aristotle’s Notion of Intellectual Grasp.” In *Episteme, etc.* (Benjamin Morison and Katerina Ierodiakonou, eds.), 30–59, Oxford University Press.
- Hasper, Pieter Sjoerd and Joel Yurdin (2014). “Between Perception and Scientific Knowledge: Aristotle’s Account of Experience.” *Oxford Studies in Ancient Philosophy*, 47, 119–150.
- Hintikka, Jaakko (1980). “Aristotelian Induction.” *Revue internationale de philosophie*, 34, 422–439.
- Irwin, Terence (1988). *Aristotle’s First Principles*. Clarendon Press.
- Kahn, Charles (1981). “Aristotle on Understanding Knowledge.” In *Aristotle on Science: The Posterior Analytics, Proceedings of the Eighth Symposium Aristotelicum* (Enrico Berti, ed.), 385–414, Editrice Antenore.
- Kosman, Louis A. (1973). “Understanding, Explanation and Insight in the Posterior Analytics.” In *Exegesis and Argument; Phronesis supplementary volume I* (Edward N. Lee, Alexander P. D. Mourelatos, and Richard M. Rorty, eds.), 374–392, Van Gorcum.
- LaBarge, Scott (2006). “Aristotle on Empeiria.” *Ancient Philosophy*, 26, 23–44.
- Le Blond, Jean-Marie (1939). *Logique et Méthode chez Aristote*. Vrin.
- Lennox, James G. (1987). “Divide and Explain: The *Posterior Analytics* in Practice.” In *Philosophical Issues in Aristotle’s Biology* (Allan Gotthelf and James G. Lennox, eds.), 90–119, Cambridge University Press.
- Leshner, James H. (1973). “The Meaning of NOUS in the *Posterior Analytics*.” *Phronesis*, 18, 44–68.
- . (2010). “‘Just as in Battle’: The Simile of the Rout in Aristotle’s *Posterior Analytics* II 19.” *Ancient Philosophy*, 30, 95–105.
- McKirahan, Richard D. (1983). “Aristotelian Epagoge in *Prior Analytics* 2.21 and *Posterior Analytics* 1.1.” *Journal of the History of Philosophy*, 21, 1–13.
- . (1992). *Principles and Proofs: Aristotle’s Theory of Demonstrative Science*. Princeton University Press.
- Mignucci, Mario (1975). *L’Argomentazione Dimostrativa in Aristotele*. Padua.
- Modrak, Deborah (1987). *Aristotle: The Power of Perception*. University of Chicago Press.
- Nehamas, Alexander (1985). “Meno’s Paradox and Socrates as a Teacher.” *Oxford Studies in Ancient Philosophy*, 3, 1–30.
- Ross, William D. (1949). *Aristotle’s Prior and Posterior Analytics*. Clarendon Press.
- Salmieri, Gregory, David Bronstein, David Charles, and James G. Lennox (2013). “*Episteme*, Demonstration, and Explanation: A Fresh Look at Aristotle’s *Posterior Analytics*.” *Metascience*, 23, 1–35.
- Scott, Dominic (1995). *Recollection and Experience*. Cambridge University Press.
- Tuominen, Miira (2010). “Back to *Posterior Analytics* II 19: Aristotle on the Knowledge of Principles.” *Apeiron*, 43, 115–144.