

# **Aristotle on Epistemic Justification and Embodied Understanding**

**By Griffin Stevens**

Respectfully submitted in partial fulfillment of the  
requirements for the Degree of Bachelor of the Arts  
in Philosophy at Haverford College

**Danielle Macbeth, first reader**  
**Jerry Miller, second reader**

April 21<sup>st</sup>, 2017

### **Acknowledgments:**

In thinking about everything that went into writing this paper, I feel that there are many people to whom I am very grateful; I will try my best to name them all here.

First, I want to thank my thesis advisors, Professors Macbeth and Miller. I have great respect for Danielle Macbeth's philosophical intelligence and pedagogy—they have made a lasting impact on me. Thank you, Danielle, for helping me grow as a philosopher and always challenging me to think hard. Jerry Miller's philosophical perspectives and valuable feedback have gone a long way towards figuring out what to say in this paper and how to structure it. Further, I want to acknowledge two other professors who helped me greatly: Joel Yurdin and Steve Salkever. Joel's knowledge of Ancient Greek philosophy, and even more so his tremendous skills as an educator, is most directly responsible for my strong interest in Aristotelian philosophy. Thank you, Joel, for being such an inspiring teacher; I hope your influence is clearly visible in this paper. Steve Salkever's willingness to share his time, enthusiasm, supportiveness, and especially his Aristotelian expertise with me is something I won't soon forget. Thank you very much, Steve.

To my dear friends and fellow students, Andrew Dalke, Luke Jensen, Paul Mundell, Philip Nega, and Dylan Reichman: while I am saddened that I couldn't complete this part of my intellectual journey while you all were completing yours, you have all been role models for me, both academically and personally. Thank you for being such great friends.

Finally, I want to acknowledge Dave Stevens, Cathy Felgar, and Marina Simon. Thank you so very much for your love, care, and support. It means so much to me.

**Abstract:**

This paper seeks to dissolve the apparent epistemological tension posed in Aristotle's *Posterior Analytics* between, on the one hand, the infallibility of the knowledge-state we are in when we know scientific first principles, and on the other, the fallibility of the inductive process by which we are supposed to arrive at such knowledge. I claim that the tension feels especially pressing because it seems to us as modern philosophical readers to cast doubt on the very possibility of having scientific knowledge. The skeptic wants to press this point and claim that because we *can* in principle be mistaken when we think we know something scientifically, we may not be able to know scientifically at all. But for Aristotle, because his fundamental scientific conceptions of *episteme* and *nous* are about having explanatory knowledge, the justificatory sense in which *nous* is required has to do with *understanding* the knowledge we already have, rather than certifying the truth of our knowledge of particulars. Induction, based on embodied experience and perception, already gives us particular knowledge, which we are capable of transforming into understanding when we develop the right 'why' explanations of our particular knowledge. In interpreting Aristotle's epistemology in this way, my hope is that we may reexamine and subsequently broaden our epistemological conceptions of our modes of intentional directedness and knowing with respect to the scientifically knowable world.

## 1. Introduction

One way of understanding what Aristotle is doing philosophically in his last chapter of the *Posterior Analytics* (2.19) is responding to a traditional and ubiquitous skeptical puzzle in the history of western epistemology: how do we epistemically guarantee that our knowledge of the sciences is true? Or, what justifies our true beliefs about scientifically knowable reality? For Aristotle, the primary mode of scientific knowing (*episteme*, in Ancient Greek)<sup>1</sup> is constitutively explanatory: we *epistatai* a science when we can explain why its *particular* objects and their features are the way they are, by reference to the science's *general* laws—its first principles. Only, how can we have explanatory *episteme* of the first principles if they are what most fundamentally explain everything else? If our knowledge of general first principles serves as the justificatory foundation of our knowledge of particular scientific facts, what then justifies our knowledge of first principles? Clearly, if they are to justify, we must know them with equal or greater certainty than we *epistatai* particular facts; yet we cannot know them by *episteme*, on pain of infinite regress or justificatory circularity, both of which Aristotle rejects. Aristotle thinks that we have *infallible* knowledge of first principles, but in a different way than *episteme*. This different way is *nous*, variously translated as 'intellect,' or 'rational insight.'

However, a pressing interpretive problem arises in light of Aristotle's claim that we have *nous* of first principles. Aristotle is clear that the *process* by which we come to

---

<sup>1</sup> I will, at various points in the paper, contrast *episteme* with scientific knowledge 'more broadly,' that is, encompassing both *nous* and *episteme*. Since I use the Mure translation of *Posterior Analytics*, which translates *episteme* as 'scientific knowledge,' I will try to be as clear as possible about how I mean the term when I use it in the different contexts.

know first principles is essentially inductive: we generalize about what the explanatory rules or laws of a science are based on the particular scientific phenomena we encounter. Given the notorious epistemological weakness of induction as a means of justifying knowledge (which Aristotle seems, at least to some degree, to recognize), how can we arrive at infallible knowledge of first principles through a fallible process? Given this setup of the apparent puzzles, one interpretive response (which I call the orthodox view) is to read Aristotle as thinking that induction is divorced from *nous* with respect to justifying our knowledge of first principles. That is, the inductive process is thought to merely lay the grounds for what amounts to a power of rational insight, a sort of ‘mental seeing’, to infallibly grasp first principles. On this sort of view, Aristotle thinks that we simply do have such a power, and this is basically what, for Aristotle, justifies the possibility of our being able to know scientifically.

I contend that this way of understanding Aristotle’s philosophical agenda in 2.19, and accordingly its interpretive response to the apparent puzzle posed by induction and our *noetic* grasp of first principles, is mistaken. In thinking that Aristotle’s intention in bringing *nous* into the picture of scientific knowledge is primarily to have it justify how scientific knowledge is possible *at all*, the orthodox view reads into Aristotelian epistemology an anachronistic concern with responding with full-force to the modern skeptic. The skeptical idea that, if we have no consistent means by which to justify the truth of our beliefs, then it is in principle possible that none of our beliefs are true (and therefore that we may not be able to know scientifically at all)<sup>2</sup> is simply not a primary

---

<sup>2</sup> A prime example of this sort of philosophically modern skeptical worry is made by Descartes in his *Meditations*. He writes: “Whatever I have up till now accepted as most true I have acquired either from the senses or through the senses. But from time to time I have found that the senses deceive, and it is prudent never to trust completely those who have deceived us even once” (1996, p. 12). That is,

concern in Aristotelian epistemology. Aristotle certainly does acknowledge the weakness of induction, as well as the possibility that we can think we have scientific knowledge when in fact we do not (i.e. that there is an Aristotelian difference between true belief and knowledge). However, he does not take these to threaten the possibility of scientific knowledge in general. Aristotle's primary philosophical motivation is rather theorizing about the nature of *having* scientific knowledge, and what having it is like for us.

Accordingly, I subscribe to a version of what I call the 'empiricist' view of *nous*: as opposed to divorcing the process of coming to know scientifically from *nous*, the primary empiricist move is to understand this process *as* justifying, where justification is understood in a much different sense. On an empiricist view, epistemic justification is required to show how we go from moving from *knowledge already won* of particular scientific facts to unqualified *episteme*, where this means having *understanding* of our previous knowledge. In making this empiricist move explicit, I seek to dissolve the tension of the interpretive problem of *nous*: on my view, his account of *nous* is rather just an explanation of what it is like for us to have attained such knowledge, something that is moreover very difficult to do, as seen through Burnyeat's idea that unqualified *episteme* is what the scientific expert has (1978, p 105). Even so, the tension between Aristotle's views about, on the one hand, induction and mere scientific belief, and on the other, the infallibility of *nous*, may still feel present even after explaining things the way I do. I address will address this by appealing to the notion that *nous* is a *state* of knowing rather than a *power* to know; therefore, its infallibility is unproblematic because, for Aristotle,

---

because the senses *can* be deceptive, we should not trust them as a means of furnishing us with knowledge at all. Descartes thinks it follows from this that it is in principle possible that all of our supposed knowledge acquired through the senses is subject to doubt, necessitating an entirely new means of justifying our knowledge with certainty.

we are only in an infallible state of knowing *when we are*. That is, Aristotle can allow that the inductive process leading to knowledge of first principles and scientific understanding is fallible, without this implying that it *always* or *consistently* fails.<sup>3</sup> As Kosman (1973) usefully analogizes, “If the eye is to see, it must be a certain sort of organ, fashioned within constraints set by the nature of light and body. And so with the mind, if it is to understand” (p. 202).

The structure of the paper going forward is the following: in the next section (Section 2), I give an overview of Aristotle’s conception of scientific knowledge. I primarily discuss the fundamental nature of Aristotelian scientific knowledge: its being explanatory, its contents, and the relationship between these ideas and ‘by nature’ causal primacy. In Section 3, I spell out the specific conditions required for scientific knowledge to count as such, in light of the discussion in Section 2. These conditions are captured most succinctly by Aristotle’s notion of demonstration, insofar as we scientifically know by demonstration (*APo.* 1.2, 71b17). This discussion will serve to show where Aristotle sees the first principles and *nous* fitting into his conception of scientific knowledge more broadly. In Section 4, I go through the two primary sorts of interpretive responses in light of the apparent problem posed by induction and *nous*, and in Section 5 I develop some possible solutions before giving my own. In the concluding

---

<sup>3</sup> Aydede (1998) gives an account that is quite similar to mine, and indeed I am very intellectually indebted to him, both for organizing the various lines of interpretation in the literature on these particular Aristotelian issues in the way he does, as well as for his instructive argument itself. He very carefully and technically reconstructs Aristotelian definitions of *episteme* and *nous*, and I admit I find it difficult to understand exactly what he concludes and how he gets there. However, his distinction between an internalist justification of one’s knowledge and the conditions for scientific knowledge generally is very useful for my purposes. I originally got the idea that certain interpretations of Aristotle’s epistemology anachronistically defend his views against the modern skeptic from Vasilou (1996), and have been aided greatly by Aydede’s ideas about this as well. However, ultimately, my philosophical conclusions about precisely how this works in *Posterior Analytics* and what I take the broader significance of it to be are my own.

Section 6, I end with some reflections on the broader philosophical import of having interpreted Aristotle's scientific epistemology in the way that I do.

## 2. *The Nature of Aristotelian Scientific Knowledge and Content: an Overview*

Aristotle thinks we only have unqualified *episteme* of  $X^4$  when the following is true: we understand the reason *why*  $X$  is as it is—i.e. we know what the true cause or explanation ( $Y$ ) of  $X$ 's being the case is—know *that*  $Y$  explains  $X$  (as opposed to merely knowing  $Y$  as an independent fact), and know that the explanation could not (of necessity) be otherwise: “We suppose ourselves to possess unqualified scientific knowledge of a thing...when we think that we know the cause on which the fact depends, as the cause of that fact and of no other, and, further, that the fact could not be other than it is” (*APo.* 1.2, 71b9-11). It thus clear that what is essentially involved in having unqualified *episteme* for Aristotle is being able to *give the reason why* something is as it is<sup>5</sup>—e.g. to *explain why*<sup>6</sup> the angles of a triangle sum to two right angles, or why the stars

---

<sup>4</sup> As I have alluded to already, the sorts of things about which we can properly have scientific knowledge for Aristotle are things like objects (as kinds) and their essential features. Therefore, I mean  $X$  to stand for a given item of knowledge within a particular domain of scientific inquiry, where the Aristotelian sciences are things like astronomy, physics, biology, mathematics, zoology, etc. (For very clear and helpful explanations of the differences between the Aristotelian sciences, see Distelzweig (2013) and Modrak (1989). I go on to use  $Y$  to stand for a universal law (as we will see, in the form of a middle term in a demonstration) that explains why a particular feature obtains in a kind of object, or why the object is the way it is.

<sup>5</sup> Patterson (2011) helpfully says that for Aristotle “Science does not aim primarily at justified true belief, or certainty that a body of propositions is true, but at *understanding why* things are as they are” (p. 667).

<sup>6</sup> Kosman (1973, p. 178) describes the giving of causal explanations for Aristotle as being able to show “what’s responsible” for something being the case. I think this is useful because it makes clear that the way Aristotle is thinking about causality and explanation in this epistemological context is broader than how we might think of it today, say with respect to modern science.

do not twinkle. Knowing the fact *that* a triangle's angles sum to two right angles, or *that* the stars do not twinkle is a kind of scientific knowledge, though not, as Burnyeat (1978) puts it, "the favored kind" (p. 101). Unqualified *episteme*, the 'favored kind' of scientific knowledge, essentially involves knowing not only the fact but also the *why*—e.g. we unqualifiedly *epistatai* the stars' non-twinkling when we know the cause upon which the fact of their non-twinkling depends (the stars' being near). However, knowing *that* the stars' non-twinkling is explained by their being near, and near things not twinkling, is not quite enough for Aristotle. We must further know *why* the cause is explanatory of the fact—the nearness of the planets explains their non-twinkling *because* what is near does not twinkle, as an astronomical rule. When we come to know the explanatory connections obtaining between pieces of scientific knowledge in this way, and *understand why* and *how* these explanations work the way they do together, we gain, in Burnyeat's terms, the sort of "systematic and synoptic" (1978, p. 112) understanding of the sciences that Aristotle really means by unqualified *episteme*.

Further, because scientific knowledge must of course be of what is true, and because for Aristotle "there is real [explanatory/causal] priority and posteriority in nature" (Burnyeat 1978, p. 126), Aristotle's explanatory conception of scientific understanding entails that the explanations we have really do show, in a metaphysical sense, the whole truth of what is going on with respect to the objects and features of the sciences. For Aristotle the *real reason* why the stars do not twinkle is because they are near, and what is near does not twinkle. When we have this explanation, we have grasped everything true and knowable about the stars' property of non-twinkling; we have not missed anything. This is what motivates Burnyeat's claim that, insofar as our

scientific explanations can be axiomatized according to Aristotle,<sup>7</sup> “an axiomatic system is not just a preferred ordering of humanely constructed knowledge, but a mapping of the structure of the real” (Burnyeat 1978, p. 126). That is, when we have a systematic, axiomatized body of scientific explanations, we have a map ‘of the structure of the real’ insofar as our explanations *really* explain the truth of their subjects, at least so long as our explanations meet the requisite conditions to count as scientific, as bits of *episteme*.

And indeed, to a large extent owing to the uniqueness of his explanatory conception of scientific knowledge and his apparent metaphysical commitments, Aristotle spends a great deal of time spelling out these conditions in detail. Much of his philosophical work in the *Prior* and *Posterior Analytics* involves expounding on what I categorize as the three kinds of conditions required for a causal explanation to count as unqualified *episteme*: one set of conditions (primarily in *APr.*) depends on the *form* of the logical syllogism, and the latter two on the *contents* and *explanatory primacy* of demonstration (in *APo.*). For Aristotle, explanation (indeed, not just scientific explanation) requires deductive inference to prove that something is the cause of something else. Let us now explore these in detail, with an eye towards the conception and role of the first principles and *nous* within Aristotle’s picture, and more broadly to the significance of the apparent problem posed by induction and *nous*.

### 3. Formal, Content-Dependent, and Explanatory Conditions on Demonstration

---

<sup>7</sup> Burnyeat goes on to describe this thought as “metaphysically vertiginous” (p. 126) with good reason: the issue for Aristotle of how, whether, or to what extent scientific explanations structurally cohere or persist ontologically apart from our knowledge of them is very tricky. For my purposes however, suffice it to say that in accordance with the by nature/for us distinction, our explanatory scientific knowledge is a more or less direct reflection of the ontologically true explanations persisting by nature, and that this matters for Aristotle’s theory of demonstration, and its connection to *nous* and first principles.

### 3A: Formal Conditions

Aristotle makes very clear in the very beginning of *Prior Analytics* that his purpose in examining the syllogism---what its basic units and concepts are, how they relate to each other in constituting valid and invalid arguments, etc.---is for the sake of understanding, and being able to do, demonstrative science (*APr.* 1.1, 24a10-12). However, while all demonstrations are (formally) syllogisms, not all syllogisms are demonstrative; syllogism is broader notion than demonstration, because demonstration is only one kind of syllogism<sup>8</sup> (*APo.* 1.2, 71b18-25). We will see that the differences between them are basically of two kinds: the possible kinds of content for which they are apt, and the nature of how explanation of conclusions works in each. In the interest of clarifying these points---with an eye towards properly laying the grounds for a discussion of the more specific conditions for demonstration to count as being productive of scientific knowledge---I will first discuss the basic notions involved in syllogism in a non-demonstrative context.<sup>9</sup>

---

<sup>8</sup> More specifically: demonstrations are syllogisms of the first figure, which means that the major premise takes the form of a general law-like relation or principle containing the middle term, in accordance with Aristotle's demonstrative conception of first principles. An example of a first figure syllogism is the following: 'All men are mortal, Socrates is a man; therefore, Socrates is mortal.'

<sup>9</sup> Aristotle goes into much detail in *Prior Analytics*, giving a whole theory of syllogistic reasoning encompassing conversion rules, the different figures of syllogisms, and much more. However, for my purposes of contrasting syllogistic with demonstrative reasoning with a view to scientific knowledge, I chose to only briefly explain certain basic elements of syllogistic reasoning. Here are some of the more basic ideas behind important syllogistic concepts: a syllogism is typically comprised of three terms. As Macbeth (2014, p. 100) points out, Aristotle's logic "is a term logic in which no logical distinction is drawn between referring and predicative expressions". That is, terms, even when predicative, are basically objects: i.e. rational (thing) or bipedal (thing). Syllogisms typically have two premises, a major and minor, in addition to a conclusion. A premise is "a sentence affirming or denying one thing of another" which can be either universal, particular or indefinite (*APr.* 1.1, 24a15-16). For more detailed information on the basic concepts involved with syllogisms, see the early chapters of Book I of *APr.*

A syllogism “is a discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so”,<sup>10</sup> which is to say: the formal relationship between syllogistic terms articulated by the connections given in the premises provide, of self-contained logical necessity, the grounds for a deductive inference to a conclusion (*APr.* 1.1, 24b17-21). Proving “an attribute of a subject through the middle term” is the explanatory work that is constitutive of syllogistic reasoning (*APr.* 2.4, 91a15): this work enables the inferential deduction from premises to conclusion to happen. That is, proving the conclusion (that a given property [the middle term] obtains in a subject) is possible in virtue of the middle term’s connection to the other (typically, two other) terms in the premises.

One of the most basic purely formal examples of a syllogism is the following: ‘All *A*’s are *B*’s, all *B*’s are *C*’s; therefore, all *A*’s are *C*’s.’ One need not know anything about the objects or attributes to which *A*, *B*, and *C* refer in order to infer the conclusion; it is revealed through the relationships between the terms and basic logical rules of inference. In this example, *B* is the middle term, because it is by appeal to *B*, insofar as *B* has relationships to both *A* and *C*, that we infer *A*’s necessary relationship to *C*. In a word then, the syllogism is most fundamentally a formal representation of self-contained, logically necessary reasoning that proves a conclusion about the relationship between terms on the basis of accepted premises.

---

<sup>10</sup> In *Topics* 1.1, Aristotle describes reasoning more generally in very similar terms: “reasoning is an argument in which, certain things being laid down, something other than these necessarily comes about through them” (100a25-27). This speaks to the sense in which the form of the syllogism for Aristotle is reflective of the form of our reasoning in relation to all sorts of content, not just scientific content.

### 3B: Content-Dependent Conditions

Although the significance of the formal syllogism may ultimately be to furnish demonstrative science with a rigorous theory of proper reasoning, Aristotle thinks that syllogisms are apt to other kinds of reasoning (and accordingly, other kinds of content) besides just the scientific kind—for example, a syllogism can be dialectical, which “reasons from opinions that are generally accepted” (*Top.* 1.1, 100a30-31). For example, insofar as Aristotelian ethical virtues “admit of much variety and fluctuation of opinion, so that they may be thought to exist only by convention, and not by nature” (*NE* 1.3, 1094b15-16), syllogisms involving matters of ethical reasoning are of the dialectical sort. Two specific cases of dialectical syllogisms like this are the following: “Pittacus is generous, since ambitious men are generous and Pittacus is ambitious’...[and] ‘Wise men are good, since Pittacus is not only good but wise’” (*APr.* 2.27, 69b25-28). Because the subject matter of these syllogisms (i.e. wisdom, generosity, goodness, and ambitiousness) are matters of opinion, they *cannot count* as demonstrative, about which Aristotle is quite explicit (*APo.* 1.8, 75b23-30).<sup>11</sup>

The proper subject matter of demonstration, on the other hand, is of scientific facts rather than of opinions: “the proper object of unqualified scientific knowledge is something which cannot be other than it is” (*APo.* 1.2, 71b15). Further, this subject matter “does not admit of being otherwise...[it] exists of necessity. Therefore, it is eternal, for the things that exist of necessity in an unqualified sense are all eternal, and

---

<sup>11</sup> He writes here that “no attribute can be demonstrated nor known by strictly scientific knowledge to inhere in perishable things. The proof can only be accidental, because the attribute’s connection with its perishable subject is...temporary and special...so that the conclusion can only be that a fact is true at the moment—not commensurately and universally.” We will see more about the significance of the content of demonstrative reasoning shortly.

eternal things are not subject to generation and do not perish” (*NE* 6.3, 1139b20-26).

Thus we have seen that dialectical matters of opinion can be reasoned about only syllogistically, since the form of syllogistic reasoning is apt to scientific as well as non-scientific content, to matters of opinion as well as fact. We have also seen how a requirement of demonstrative reasoning is that its subject matter can only be matters of fact. What then about the fact that scientific content is of necessary and unchanging matters of fact makes it apt to specifically demonstrative reasoning? We will be able to get clear on this by looking to Aristotle’s aforementioned astronomical example, and to his contrast between reasoning that is still syllogistic despite aiming at the appropriate kind of content, vs. demonstrative reasoning that meets the proper explanatory conditions.

Aristotle’s example of a merely syllogistic, non-demonstrative proof regarding the stars’ properties of being near and non-twinkling is the following:

let *C* be the planets, *B* not twinkling, *A* proximity. Then *B* is predicable of *C*; for the planets do not twinkle. But *A* is also predicable of *C*; since that which does not twinkle is near...Therefore *A* is a necessary predicate of *C*; so that we have demonstrated that the planets are near. (*APo.* 1.13, 78a31-39)

That is, 1) The planets do not twinkle; 2) that which is near does not twinkle; therefore 3) the planets are near. First, although Aristotle says that we have ‘demonstrated’ that the planets are near, the reader should not take this to mean demonstration in the strict sense. Aristotle means by demonstration something more like ‘proof’ in this context: we have successfully proved, by means of valid syllogistic deductive inference, that the planets are near in virtue of the facts that what is near does not twinkle and the planets do not twinkle. However, consider Aristotle’s distinction that “Knowledge of the fact differs from knowledge of the reasoned fact” (*APo* 1.13, 78a22). In this case, we have only

*proved 'the fact'* that the planets are near; we have not *demonstrated the reasoned fact* that obtains between these relationships amongst terms. What then determines what the true reasoned fact is, in this case and more generally, with respect to demonstrations? To clarify this, I will move to Aristotle's example of the proper demonstration of the stars' non-twinkling, and show how it is reflective of the theoretical conditions he supplies with respect to the premises of demonstration, in order for a demonstration to count as being properly productive of scientific knowledge.

### *3C: Explanatory Conditions*

[this] demonstration will be of the reasoned fact...let *C* be the planets, *B* proximity, *A* not twinkling. Then *B* is an attribute of *C*, and *A*—not twinkling—of *B*. Consequently, *A* is predicable of *C*, and the syllogism proves the reasoned fact, since the middle term is the proximate cause. (*APo.* 1.13, 78b1-4)

This proof is properly demonstrative and of the reasoned fact because it makes explanatory use of the 'proximate cause' that what is near does not twinkle to demonstrate that the planets do not twinkle from the fact that they are near. But what does Aristotle mean exactly by causal proximity? Let us look to his distinction between what is explanatorily prior and better known for us vs. by nature, and his specific ideas regarding first principles.

Since causal explanation is the driving principle behind Aristotle's conception not only of what makes something count as scientific knowledge for us, but also what truly makes something the way it is in the fullest sense metaphysically, the idea of something's being better known 'in the order of being' means that it has causal primacy over other things, particularly those things which typically present themselves more readily to us:

there is a difference between what is prior and better known in the order of being and what is prior and better known to man; I mean that objects nearer to sense are prior and better known to man; objects without qualification prior and better known are those further from sense. Now the most universal causes are furthest from sense and particular causes are nearest to sense, and they are exactly opposed to one another (*APo.*, 71b34-72a5).

Insofar as perception “is of the particular” (*APo.* 2.19, 100a17)<sup>12</sup> and is the capacity which most readily and immediately furnishes us with knowledge about the world,<sup>13</sup> it does not, at least right away, lead to knowledge of the ‘most universal causes’ and ‘objects without qualification,’ which are most causally primary in the order of being.

These are what Aristotle specifically considers the first principles of the sciences:

When the objects of an inquiry, in any department, have principles, conditions, or elements, it is through acquaintance with these that knowledge, that is to say scientific knowledge, is attained. For we do not think that we know a thing until we are acquainted with its primary conditions or first principles, and have carried our analysis as far as its simplest elements (*Physics* 1.1, 184a9-13).

Examples of first principles are, to use Patterson’s characterizations,

basic definitions (odd and even number, things existing ‘by nature,’ animate thing) and further non-definitional assumptions (e.g., the Law of Non-contradiction in First Philosophy, ‘Equals added to equals...’ in mathematics, ‘Nature does nothing in vain’ in the natural sciences)” (p. 667)

As Kosman puts the point, first principles offer “the most comprehensive explanatory coverage” because they are first within an overall body of scientific knowledge, which is to say: they are that which are most explanatorily fundamental and primary. Aristotle makes this clear in saying “primary premisses are more knowable than

---

<sup>12</sup> Aristotle’s views on perception are complicated and nuanced. For he goes on to say in *Posterior Analytics* 2.19 that the content of perception is universal, and in *Physics* that “we must advance from generalities to particulars; for it is a whole that is best known to sense-perception” (1.1, 184a24-25). However, Aristotle is clear at least in the context of his theory of scientific knowledge that the most causally primary universal laws in nature’s order are least accessible to perception, because they are most general.

<sup>13</sup> See Yuridin and Hasper (2014) that for Aristotle “the only original source of information about the world is perception” for Aristotle (p. 119).

demonstrations...[therefore] the originative source of science grasps the original basic premises, while science as a whole is similarly related as originative source to the whole body of fact” (*APo.* 2.19, 100b9-18). The fact that what is near does not twinkle, i.e. a universal law serving as the major premise in the demonstration, is an astronomical first principle—it is the kind of thing upon which the basis of other astronomical features, essences, etc. are most fundamentally explained. If we are to have the richest—that is, most explanatorily powerful—knowledge of a science possible for us, then despite first principles’ being farthest from our immediate perceptual knowledge, we must come to understand them in order to ground the rest of our scientific knowledge according to the explanatory conditions expressed through demonstration. Aristotle thinks this happens in virtue of ‘the originative source of science.’

However, a distinct problem arises regarding this ‘originative source’ of science: “either the basic premisses will be demonstrable and will depend on prior premisses, and the regress will be endless; or the primary truths will be indemonstrable definitions” (*APo.* 2.3, 90b25-26). That is, if the first principles of a science, serving as the primary premises of the most causally primary demonstrations, are themselves demonstrable, we face an infinite regress, which Aristotle wants to avoid. So, he argues, “we must possess a capacity of some sort” (*APo.* 2.19, 99b32-33)—namely, *nous*, about which Aristotle confirms that “no other kind of thought except intuition [*nous*] is more accurate than scientific knowledge” (*APo.* 2.19, 100b8-9). Indeed, *nous* gives the sort of knowledge that is infallible (*APo.* 2.19, 100b6).

To summarize the progress up till now, because scientific knowledge is essentially explanatory according to the formal, content-dependent, and strict causal

conditions laid bare by demonstration, and the primary premises of demonstrations (i.e. the first principles of the relevant science) cannot themselves be demonstrated on pain of an infinite regress, Aristotle thinks we must know the first principles in a different sort of way (*nous*). *Nous* does the work of apprehending the first principles, and, it must apprehend them as being appropriately explanatory, if it is to serve as the basis of demonstrative explanation and knowledge. However, Aristotle thinks we must “get to know the primary premisses by induction” (*Apo* 2.19, 100b4). How is this supposed to work? Now it is time to address the key interpretations of this issue.

### 3. The ‘Orthodox’ view of *nous*<sup>14</sup>

Aydede (1998) helpfully outlines the sense in which the orthodox interpretation of the puzzle posed by *nous* and induction can be seen as an Aristotelian skeptical defense:

the orthodox view is that Aristotle in the *Posterior Analytics* defines scientific knowledge so strongly and rigidly that, at the end, seeing that normal inductive procedures will of necessity fall short of guaranteeing it, he is forced to postulate some sort of infallible and intuitive mental faculty, *nous*, that would epistemically secure the possibility that we have scientific knowledge so defined. (p. 5)

The prime example in the literature of this sort of interpretation of *nous* is Irwin (1988), which he outlines in his first chapter:

[Aristotle] insists that the first principles of demonstrative science must be grasped in some way that guarantees their objective truth. Since Aristotle holds a foundationalist conception of knowledge and justification...he concludes that first principles must be grasped by some form of intuition guaranteeing their objective truth. (p. 18)

---

<sup>14</sup> I owe great intellectual debts to Professors Joel Yurdin and Danielle Macbeth, both for pointing me in the right direction with respect to my research of the relevant academic literature and for the many productive philosophical conversations about Aristotle’s epistemological philosophy that have gone a long way towards shaping my own thinking. Further, I want to take the opportunity to thank Professor Barbara Hall for her many helpful edits and suggestions in writing this paper.

Irwin's concludes from his idea that Aristotle is committed to a foundationalist conception of knowledge and justification to the thought that we *must* according to Aristotle have an intuitive way of grasping objective first principles with epistemic certainty. This is an example of what Aydede means by the orthodox idea that because Aristotle's definition of scientific knowledge is so strict, we require *nous* to guarantee that our beliefs about first principles are true. I will thus discuss Irwin's ideas about why our beliefs about first principles for Aristotle require strict justification, and how *nous* furnishes this.

First, *that* these beliefs may be false and therefore in need of epistemic justification is a consequence, Irwin thinks, of the Aristotelian idea that inquiry proceeds from what is best known for us to what is best known by nature: "In claiming that progress is required, he [Aristotle] assumes...that a reasonable question arises about whether any of our initial beliefs is an objective first principle or not." (1988, p. 7) That is, Irwin emphasizes that, for Aristotle, we can be and often are initially wrong when we think we know a scientific explanation, i.e. have a demonstration of it from first principles. This thought can be reinforced by other textual examples from Aristotle's work as well. Aristotle says that "It is hard to be sure whether one knows or not; for it is hard to be sure whether one's knowledge is based on the basic truths appropriate to each attribute" (*Apo.* 1.9, 76a26-28). Further, specifically regarding induction, he warns the scientist in *Generation of Animals* against hasty generalizations from 'a few cases', and says that this can lead to thinking that one knows when in fact one does not (3.5, 756a2-6).

The reason why Irwin thinks this justification of our beliefs for Aristotle is

foundationalist comes from his idea that Aristotle's conception of demonstration itself "embodies a foundationalist conception of justification (p. 134)" This is to say that because demonstrative premises must be explanatorily prior to and better known naturally than the conclusion, it must be for Aristotle that knowledge of first principles epistemically confirms knowledge of other scientific beliefs, insofar as first principles are best known and most explanatorily primary by nature. Within the theoretical structure of a body of science then, first principles known with certainty constitute the epistemological foundation on which subsequent beliefs are confirmed as true and appropriately explanatory.

On Irwin's view, since first principles cannot be known demonstratively,<sup>15</sup> and since Aristotle rejects coherence and infinite regression, it must be the case that, according to Aristotle, first principles are grasped by the intuitive capacity of *nous*. While Irwin acknowledges that induction plays a strong role in acquiring first principles, he maintains that "The product...cannot depend for its warrant on the induction that has produced it; for such warrant would not explain how a proposition grasped by *nous* could be naturally prior to the demonstrated propositions derived from it."(p. 135) The thought is that induction cannot provide such a warrant because of Aristotle's explicit doubts about it as a mode of certifying beliefs as knowledge.<sup>16</sup> It must instead be *nous* alone that does this, since it is infallible. The sense in which Irwin's central idea that the requirements for justifying knowledge *must* come from the *nous*, insofar as it is non-demonstrative and infallible, matches with Aydede's characterization of the orthodox

---

<sup>15</sup> As Irwin points out, "An attempt to prove them would be a form of begging the question (APr 64b28–38)" (p. 132) because they must of necessity not be demonstrable, on pain of an infinite regress.

<sup>16</sup> Aydede points to several examples of this: (APo 2.5, 91b15–16, 92a38–b3.) p. 5.

view's treatment of the problem of *nous*.<sup>17</sup>

Aydede argues that Irwin's and the orthodox interpretation of this problem reflects an anachronistic epistemological concern in responding to the modern skeptic, who questions whether scientific knowledge is possible at all (1998, p. 10, 17). The orthodox interpretation places such a heavy emphasis on the Aristotelian difference between mere belief and knowledge and the importance of trying to conform beliefs as knowledge, and accordingly assign such a heavy justificatory role to *nous*, because the skeptical worry implicitly feels so serious. As Aydede characterizes it, (p. 12) more 'empiricist' readings of *nous* in the context of grasping first principles seem to account better for the empirical nature of Aristotelian scientific methodology and practice.

#### 4. Empiricist view of *nous*

The common theme in these studies is to examine in some detail those passages where Aristotle discusses the role of the senses and phenomena in general in the inductive process in reaching the universal and explanatory principles, and then to find a naturalistic role for *nous* to play (Aydede, p. 12).

Kosman (1973) attention to the distinction between the two aforementioned questions in *Posterior Analytics* 2.19 regarding *nous*: "(1) what is the process by which we come to grasp first principles and (2) what is the nature of this grasp" (p. 193) In the interest of clarifying to which question *nous* is properly addressed, Kosman thinks *nous*

---

<sup>17</sup> I think Goldin's (2013) analysis of Aristotle's epistemology is also an example of the orthodox view. For, he takes it as a starting point that Aristotle is an epistemological foundationalist (p. 195) and even goes so far as to argue that Aristotle accepts a coherentist picture of justification of beliefs. That it might be the case for Aristotle that he is not interested in such a strict notion of justification is not on the table.

is not the process which we come to know the [first principles] but the state we are in when we have, by whatever means, come to know them. It is of course *by nous* that we know principles, just as it is, for example, by *sight* that we see what we are looking for; but *nous* is no more the *process by which* we gain knowledge of these principles than sight the *process by which* we find what we are looking for. (p. 194)

He acknowledges as part of this analogy that sight and *nous* can be understood as being both A) *enabling, qua* capacities, of the processes of attempting to find what we are ‘looking’ for or understanding the principles, and B) the *goal* of these processes—i.e. that we are in a state of *nous* or something like ‘proper vision’ when we have found what we are looking for: the grasping of a principle. However, presumably with the orthodox-type view in mind, Kosman warns that we should not mistake the sense in which *nous qua* capacity enables the process of grasping first principles as “some immediate act of mental seeing which in itself is the source of or validates our knowledge of principles.” (p. 194) That is, *nous* should *not* be understood as the whole answer to (1). Rather, this is *epagoge* (induction), though *epagoge* as understood in close connection with Kosman’s conception of Aristotelian ‘scientific activity’:

Earlier I asked whether the understanding of principles might be made clear by considering the process which leads us to that understanding. That will be a misleading way to pose the problem if it leads us to suppose that there is some independent mode of coming to know the principles of scientific understanding *distinct* from the enterprise of formulating explanations. (p. 199)

The intellectual activity we engage in with respect to the process of grasping first principles “is *epagoge*; but it is not an activity radically independent of demonstration”(p. 199) which is to say: the activity of *epagoge* is “the act of *insight*, of seeing in revealed particulars these more fundamental natures that are their principles and explanations,” or that recognizing principles as principles “just is the act of explaining.”(p. 199) In arguing for translating *episteme* as ‘Understanding’ as opposed to ‘Scientific Knowledge,’

Kosman emphasizes the importance of the difference between knowing *that* and knowing *why*, especially significant in light of the requirement that like the premises of demonstrations, the first principles grasped in a state of *nous* must be known-as-explanatory. Thus, on Kosman's picture, what is supposed to confirm that we know a principle as a principle is its ability to actually explain, testable through our activities of formulating demonstrations on the basis of them.

Somewhat similarly, Burnyeat groups Aristotle's arguments and claims regarding the conditions for demonstration into two:

there is a theory of the structure of a science, an account of the conditions for a proposition to belong to a body of systematic knowledge... [there is also] an account of the cognitive state of the individual person who has mastered a body of systematic knowledge" (p. 97).

On Burnyeat's view, we can think of the epistemic requirements on demonstration as being relevant to the former, which is to say the structural or theoretical requirements as opposed to the epistemic requirements for an individual knower. That is, "Aristotle both knows and emphasizes that his requirement that demonstration proceed from first principles is not a requirement of justification but of scientific explanation" (p. 101).

Burnyeat gets more explicit on this point:

It sounds natural enough to say that a proposition counts as an item of scientific knowledge...only if it is demonstrable from the first principles of a science. It seems less credible that a person has knowledge of the proposition only if he has derived it from first principles. By that demanding standard most of us who are not professional mathematicians do not know simple truths of arithmetic or Pythagoras' theorem (p. 99-100)

The significance of Burnyeat's view is that in a practical sense, someone can count for Aristotle as having scientific knowledge even if they cannot supply a thorough justification going back to first principles that shows how they know what they do. It is

not a requirement according to Aristotle that someone need be able to do this in order to count as a scientific knower---having scientific understanding is possible without rigorous justification from first principles.

Aydede thinks the empiricist view is far closer to the ‘truth’ of Aristotle’s conception of *nous* and its significance within the overall epistemological picture of Aristotelian science (p. 12, 17). However, he claims that it too is somewhat problematic, ultimately owing to the way it frames the problem of *nous* and accordingly what it takes the philosophical ambitions of the *Posterior Analytics* to be. The main problem stems from entirely reducing the justificatory significance of *nous*<sup>18</sup> and instead ascribing this significance to *epagoge*: in doing so, the empiricists fail to properly acknowledge Aristotle’s views on the frailty of induction as a means of providing epistemic certainty. Aydede points to several passages in which Aristotle expresses this,<sup>19</sup> including this one: “Nor...is the method of division a process of inference at all, since at no point does the characterization of the subject follow necessarily from the premising of certain other facts: division demonstrates as little as does induction” (APo 2.5 91b15–17). It might be objected that Aristotle is speaking here about the efficacy of induction only in the specific context of the method of division, and therefore that he could still think it possesses

---

<sup>18</sup> Like Burnyeat and Kosman, Barnes thinks that we need to pay special attention to the difference between first the process by which we come to know first principles and second the nature of our grasp of them: “the answer Aristotle gives to the first question is whole-heartedly empiricist; and only a failure to distinguish between the two questions of B 19 will permit a rationalistic interpretation. *Nous* is an answer to the second question, not a rival, rationalistic, answer to the first: ‘intuition’ as a mode of discovery is absent from *APst*” (Barnes 1994, p. 270). Thus the nature of our grasp of *nous* on Barnes’ view is, contrary to the orthodox position, strictly non-intuitive. Thus Barnes’ comment, which Aydede also refers to (on Aydede’s p 16), that “*Nous* has no philosophical importance in *APst*” (Barnes p. 270) is consistent with his view.

<sup>19</sup> Aydede merely refers to the passages in a footnote; the explanations of them in this paper are my own.

strong justificatory power in other contexts. However, he expresses further doubt about induction in the context of inquiring into essence and substance as well:

How then by definition shall we *prove* substance or essential nature?...we may not proceed as by induction to establish a universal on the evidence of groups of particulars which offer no exception, because induction proves not what the essential nature of a thing is but that it has or has not some attribute (*APo* 2.7, 92a38–b3).

In order to be epistemically certain in its grasp of first principles as meeting the explanatory conditions of demonstration, induction clearly needs to go beyond merely proving that a first principle ‘has or has not some attribute’---it needs to be able to understand first principles as being explanatory of the phenomena, the ‘that’s’, that we already know. So, when Burnyeat claims that for Aristotle, the process by which we come to know first principles’ being inductive is unproblematic because

Aristotle sees no Humean problem about a leap from inductive evidence to *knowledge*...as *he* sees the problem of our grasp of first principles, the difficulty is not a lack of evidence to transform inductive belief into certain knowledge. That inductive belief is already knowledge (Burnyeat, p. 131)

Burnyeat, on Aydede’s view, makes the empiricist mistake of ascribing to Aristotle too simplistic a view of the epistemic certainty afforded by *epagoge*. Further, Aydede points to Kosman’s declining to address 2.19 explicitly in his account of *nous* and *episteme* (Aydede, p. 14-15) as a significant weakness

### 5. Possible solutions

Aydede gives his own account of *nous* in light of the perceived inadequacies of the orthodox and empiricist views. In a similar vein to Burnyeat, Aydede distinguishes between two distinct lenses through which we can view the question about inductive

justification for Aristotle. The first involves “establishing one’s claims to knowledge which has primarily to do with internal epistemic justification,” and the second involves Aristotle’s “explicative account of the nature of knowledge which has to do with capturing those conditions whose satisfaction is both necessary and sufficient for one to have knowledge”(p. 18). For Aydede, like Burnyeat, one’s being able to “*conclusively defend*”(p. 18) one’s inductively formulated knowledge claims is not a necessary condition on the possibility of having scientific knowledge at all, according to Aristotle.<sup>20</sup> That is, the necessary and sufficient conditions for scientific knowledge to count as such are thought not to depend on an individual knower’s ability to justify her knowledge. Aydede gives an analysis of Aristotle’s conditions for scientific knowledge generally, ultimately claiming that we have “*nous* of the universal so that we can demonstrate the particular phenomenon we originally began with” only when

we see the particular middle appropriate to the case at hand as an instance of a general universal connection, or when we generalize from the particular cause to a universal connection that is independently confirmable on inductive observable grounds (p. 40)

The conditions Aydede gives

all confine more or less to the justified true belief analysis of knowledge, where justification is obviously empirical and inductive and thus typically incomplete. Is this a sort of philosophical anachronism? I do not think so. As long as the JTB analysis can be seen to capture our most basic intuitions about what knowledge should be like, it is in a sense unavoidable that we seek to understand Aristotle in these terms (p. 42).

So, Aydede’s primary move away from the empiricists is to give an account of the conditions of *nous* and its precise definition, while explaining the justificatory role of

---

<sup>20</sup> Aydede writes: “is there any evidence that Aristotle assumes, or requires, or even makes an attempt to show, that the satisfaction of the conditions he specifies for scientific knowledge are accessible in this way to one who has scientific knowledge? I do not think that there is” (p. 18-19).

induction as a requirement on the theory of science overall that meets JTB (justified true belief) criteria. I think this view is basically right, though I want to recast some of it in a different light, and explain how the resources the empiricist view gives allow for a specific way of accounting, on Aristotle's behalf, for the lingering difficulty of the infallibility of *nous* squaring with the fallibility of the inductive process of reaching first principles.

By paying special attention to the distinction between the inductive process of arriving at knowledge of first principles and the *noetic* state we are in when know them, Kosman is able to make explicit Aristotle's conception of what it is actually like for us to engage in explanatory scientific activity. Aristotle is clear that experience is essential for this (*Apo* 2.19, 100a5), even though he also thinks that learning a science is aided by the help of teachers (*Met* 1.1 and 1.2, 981b7 and 982a12. This last point suggests that Aristotle might think it in principle possible for one to be told what a demonstration of something is and be expected to understand it. He seems to think this is true with respect to mathematics, anyways: in contrasting the role of experience with respect to mathematics and ethical prudence, he thinks that young people

become skilled in geometry and mathematics, and are wise in such things, but a young person does not seem to be prudent. The cause is that prudence is also of particulars, which come to be known as a result of experience, but a young person is inexperienced: a long period of time creates experience...on account of what indeed might a boy become skilled in mathematics, but not wise or well versed in nature...is it because the former subjects exist through abstraction, whereas the principles of the latter come from experience (*NE* 6.8, 1142a10-17)

If Aristotle thinks that mathematics is knowable without experience, then, to the extent that mathematics is representative of scientific knowledge more broadly, how can he also think experience is necessary for finding first principles of sciences? I think this

mathematics example is the exception that proves the rule: its subject matter is presumably the most abstract of any of the Aristotelian sciences, and therefore is the science least requiring of experience. A more holistic and accurate picture for Aristotle of what it is like to do science is one that considers the perceptual and experiential processes that Aristotle says are involved with knowing first principles. How does this relate to ideas about *episteme*-as-understanding, and the distinction between internalist justification and the external conditions on demonstrative, scientific knowledge?

I think these three notions are related for Aristotle in the following way: basically, Aristotle can allow that we can be wrong when we think we are in a *noetic* condition because the inductive process of coming to know first principles can be mistaken. That is, we can think we have understanding when we in fact do not---we can think we have gotten, through our experience, an explanation of why something is the way it is, when it turns out really to be, say, syllogistic, because it fails to demonstrate on the basis of true, by nature causal primacy. But the fact that experience can be wrong about having understood something is not a detriment to the possibility of us having scientific understanding, because it is by its nature the kind of capacity that does allow us to form explanations about what we know. Our ability to generate experiences the relate kinds of things together and generalize on the basis of experience is part of the natural order of doing scientific inquiry for Aristotle: to start with what is perceptually apparent to us, develop it into systems, and try to explain these on the basis of rules or principles. This I think is the kind of naturalistic picture Aristotle has in mind by the process of coming to know first principles. As to whether this is made problematic by *nous*'s infallibility, I think it is not, because in talking about the natural progression of inquiry, and our

abilities to perceive and generate experiences of as part of this process, Aristotle thinks that when we do this correctly, we do infallibly know, and when we do not, then we simply do not. But, he is clear that it works for the most part, since the soul is naturally suited to the process of generating knowledge inductively (*Apo.* 2.19, 100a12), and therefore that the need to justify should not feel so pressing after all.

### 6. Concluding Remarks

In this paper, I have advanced the thesis that, properly understood, Aristotle's conception of the need for epistemic justification of our scientific knowledge is of a more restricted nature than has been sometimes thought. Aristotle conceives of scientific knowledge as what we would think of as understanding, in virtue of *episteme's* and *nous'* being about giving 'why' explanations---he assumes that knowledge of particular 'that's' is already available. Therefore, the sense in which he requires epistemic justification is to show how the move from 'that's' to 'why's'---the most significant and favorable kind of knowledge---is possible, rather than to show how our knowledge of 'that's' is possible. Despite that induction is fallible, and that there are situations in which it is unclear for us whether we have in fact understood something correctly or not, Aristotle does not take this as a serious threat to the possibility of us being able to scientifically understand. It is permissible on his view that we can be mistaken when we think we have scientific understanding, i.e. that we think we are in an infallible *noetic* state when in fact we are not. The purpose of our rational faculties is to be able to understand, and when the conditions are right, we are more often than not capable of doing so. I want to conclude

by saying a few words about what I take to be the broader philosophical significance of having interpreted Aristotle this way.

First, it is plainly value from an intellectual-historical perspective: getting clear on Aristotelian epistemology is worthwhile just because understanding crucial developments in epistemological thinking can give insight into new directions this should take.

Understanding the relationships between theories of science and theories of scientific knowledge, and the ways these have changed in light of paradigm-shifts in scientific thinking, is important. However, owing to the drastic differences in philosophical paradigms between, on the one hand, Aristotelian (and more broadly, Ancient Greek) epistemology, and on the other hand, modern and contemporary epistemology, one might think that we should entirely dismiss Aristotle's views on the relationship between our knowledge and scientifically knowable reality as irrelevant for us now. After all, we know now that what immediately appears to us to be going on in the world is most often at odds with the true scientific story of what is really going on. *There are* very real doubts about our ability to acquire scientific knowledge of what is really going on scientifically. While it may be true that Aristotelian science is obsolete and even mostly wrong, this does not have to mean that we need discard altogether his views on the *epistemic relationship* between our capacities for knowledge and what is knowable. That there is good reason for thinking that we might be the kind of beings for whom perceptual experiences---rather than, say, pure reason--- result in knowledge about the world is philosophically significant because it compels us to reexamine what we take to be our primary modes of knowing. For example, Kosman calls *episteme* "the explanatory art" (p. 178), indicating that scientific activity for Aristotle is quite similar to the activities

involved in skills and productive crafts. If studying Aristotelian epistemology causes us to strongly consider the ways in which doing theoretical or scientific activity draws on our experiences and embodied skills, in stark opposition to trying to know only through the mind, then perhaps we have broadened our epistemological conceptions and done something quite philosophically useful.

### Works Cited

Aristotle. *The Basic Works of Aristotle*. Ed. Richard McKeon. Modern Library Classics. Modern Library, 2009.

Aristotle. *Aristotle's Nicomachean Ethics*. Trans. Robert C. Bartlett and Susan D. Collins. The University of Chicago Press, 2011.

Aydede, Murat. "Aristotle on *Episteme* and *Nous*: The *Posterior Analytics*." *Southern Journal of Philosophy*, (1998), Vol. 36, No. 1, pp. 15–46.

Barnes, Jonathan. *Aristotle: Posterior Analytics*. Oxford University Press, 1993

Burnyeat, M. F. "Aristotle on Understanding Knowledge." *Aristotle on Science: The Posterior Analytics*. Ed. Enrico Berti. Italy: Editrice Antenore, 1978. Proceedings of the Eight Symposium Aristotelicum Held in Padua from September 7 to 15, 1978.

Descartes, Rene. *Meditations on First Philosophy*. Ed. John Cottingham. Cambridge: Cambridge University Press, 1996.

Distelzweig, Peter M. "The Intersection of the Mathematical and Natural Sciences: The Subordinate Sciences in Aristotle." *Apeiron*. 2013; 46(2): 85–105

Goldin, Owen. "Circular Justification and Explanation in Aristotle." *Phronesis* 58.3 (2013): 195–214.

Hasper, Pieter Sjoerd, and Joel Yurdin. "Between Perception and Scientific Knowledge: Aristotle's Account of Experience." *Oxford Studies in Ancient Philosophy*. Vol. 47. Oxford University Press, 2014.

Irwin, Terrence. *Aristotle's First Principles*. New York: Oxford University Press, 1988.

Kosman, A. "Understanding, Explanation, and Insight in the Posterior Analytics." *Exegesis and Argument: Studies in Greek Philosophy Presented to Gregory Vlastos*, edited by Lee, Mourelatos and Rorty, Assen: Van Gorcum, 1973.

Macbeth, Danielle. *Realizing Reason: A Narrative of Truth and Knowing*, first edition (New York: Oxford University Press, 2014)

Modrak, D. K. W. "Aristotle on the Difference between Mathematics and Physics and First Philosophy." *Apeiron* 22.4 (1989): 121–139.

Patterson, Richard. "Aristotle." *The Routledge Companion to Epistemology*. New York: Taylor & Francis, 2011.

Vasiliou, Iakovos. "Perception, Knowledge, and the Skeptic in Aristotle." *Oxford Studies in Ancient Philosophy*. Vol. 14. Oxford University Press, 1996. 83–131.

