

## Comprehension, Demonstration, and Accuracy in Aristotle

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**Abstract:** This paper discusses the relation between νοῦς (the knowledge of scientific principles) and ἐπιστήμη ἀποδεικτική (the knowledge of demonstrable truths) in Aristotle’s philosophy of science. I argue against “rationalist” interpretations, dominant in the secondary literature, which claim that the principles can be known as such independently of their causal connections to demonstrable truths. However, alternative interpretations imply that νοῦς and ἐπιστήμη ἀποδεικτική are somehow interdependent, a view that seems in conflict with the fact that νοῦς is, according to Aristotle, more “accurate” than ἐπιστήμη ἀποδεικτική. Thus, I offer a construal of the relation between these two cognitive states and explain in which sense they can be taken as interdependent without contradicting Aristotle’s claim about their “accuracy” or rendering his theory viciously circular.

**Keywords:** Aristotle, demonstration, knowledge, science.

### 1. Introduction

For Aristotle, scientific expertise is composed of two different cognitive dispositions. Some propositions in the domain can be scientifically explained, which means they are known by “demonstration” (ἀπόδειξις), a deductive argument in which the premises are explanatory of the conclusion. Thus, the kind of cognition that apprehends those propositions is called “demonstrative knowledge” (ἐπιστήμη ἀποδεικτική).<sup>1</sup> However, not all propositions in a scientific domain are demonstrable. Demonstrations are ultimately based on indemonstrable principles, whose knowledge is called “comprehension” (νοῦς).<sup>2</sup> If the knowledge of all scientific propositions were demonstrative, demonstrations would either (i) be extended *ad infinitum* or (ii) proceed “in a circle and reciprocally” (*An. Post.* 1.3. 72b17–18). The first

option would make scientific knowledge impossible, since an infinite series of premises could not “be surveyed with thought.”<sup>3</sup> The second alternative depends on scientific truths being mutually explanatory, a solution Aristotle rejects (*An. Post.* 1.3, 72b25–73a20).<sup>4</sup>

Aristotle also affirms that νοῦς is the most “accurate” (ἀκριβές) of all cognitive states, including demonstrative knowledge (*An. Post.* 2.19, 110b5–14)—hereafter, I shall refer to this thesis as the “Accuracy Claim.”<sup>5</sup> This claim is motivated by the fact that the principles are “better known” (γνωριμώτεροι) than the respective conclusions (*An. Post.* 2.19, 100b9–10). In other passages, Aristotle also describes them as “prior” (πρότερα)<sup>6</sup> and “more convincing” (*An. Pr.* 2.16, 64b32–33). His reason to speak in these terms seems to be an asymmetrical dependence relation between νοῦς and ἐπιστήμη ἀποδεικτική: while the principles are “known” and “convincing” in themselves, demonstrable truths only become “known” and “convincing” because the principles from which they are explained are themselves “known” and “convincing” (*Top.* 1.1, 100b20–21; *An. Pr.* 2.16, 64b35–36). If so, Aristotle argues, we must say that the principles are “better known” and “more convincing” than the conclusions they explain (*An. Post.* 1.2, 72a29–32).

The most natural reaction to this picture is to take Aristotle as advancing a foundationalist doctrine and, more specifically, a rationalist theory of epistemic justification. A demonstration would be an inference that allows us to determine the truth-value of problematic propositions from premises previously known to be truths.<sup>7</sup> Ultimately, demonstrable propositions are deductively derived from immediate truths that have been grasped in advance and in some independent way.<sup>8</sup> Whereas ἐπιστήμη ἀποδεικτική is an inference-based knowledge of non-evident truths, νοῦς is an intuitive and non-inferential recognition of self-evident propositions, which are obtained independently of their explanatory connections to other propositions in the domain.<sup>9</sup> Since our knowledge of the principles cannot depend “upon the confirmation by what deductively follows from them, let alone upon their confirmation by what we observe,” we can think of Aristotle as “the paradigm of an extreme rationalist.”<sup>10</sup>

This dominant interpretation, which I shall refer to as the “Rationalist Account,” has been criticised by another group of interpreters that formulates Aristotle’s notion of scientific

knowledge in terms of “interrelatedness.” Knowing a proposition scientifically is understanding how it fits into a web of interrelated truths, either as an indemonstrable principle (noetic knowledge) or as a demonstrable fact (demonstrative knowledge).<sup>11</sup> To have comprehension (νοῦς) of a first principle involves recognizing it as a first principle, which means that a scientist does not have noetic knowledge of a principle  $p$  unless she knows that there are other propositions in the domain that can be demonstrated from  $p$ , while there are no propositions from which  $p$  could be demonstrated.<sup>12</sup> In this “Interrelational Account,” as I shall call it, the acquisition of scientific knowledge does not consist in inferring non-evident facts from self-evident principles so much as in organizing in terms of explanatory priority propositions *previously recognized as truths*.

However, the Interrelational Account must face an objection against which the Rationalist Account seems fully protected. If we cannot achieve comprehension unless we grasp the principles *as explanations* of demonstrable truths, there is a sense in which noetic and demonstrative knowledge are interdependent cognitive states.<sup>13</sup> If both kinds of knowledge are obtained only when a complex body of truths has been collected and organized in terms of explanatory connections, then, as David Bronstein puts it, “when we finally acquire demonstrative and non-demonstrative (noetic) scientific knowledge, we acquire them at the same time and by the same activity.”<sup>14</sup> This view is challenged by Aristotle’s Accuracy Claim, which states that comprehension is “more accurate” than (and in a certain way independent of) demonstrative knowledge. In contrast, the proponent of the Rationalist Account can easily explain this claim as the recognition of an asymmetrical dependence relation between the two cognitive states. The evidence of the theorems (of which we have demonstrative knowledge) depends on the evidence of the principles (of which we have noetic knowledge), but not vice-versa. After all, if noetic and demonstrative knowledge are interdependent cognitive dispositions, what does it mean to say that the former is “more accurate” than the latter?

My main aim in this article is to argue for an interpretation of the Accuracy Claim that is compatible with the Interrelational Account—at least in the way I shall frame it below. However, this goal requires a preliminary discussion. The explanation of the Accuracy Claim

provided by the Rationalist Account is almost an immediate consequence of the way it interprets Aristotle's theory of demonstration as a whole. If so, rejecting this explanation amounts to rejecting the Rationalist Account altogether. For this reason, in section 2 below, I discuss passages that might be used to support the Rationalist Account and its explanation of the Accuracy Claim. Then, in section 3, I argue that this reading is not in tune with the way Aristotle describes the grasp of first principles and present my reasons for preferring the Interrelational Account. More specifically, I shall point out a drawback that often goes unnoticed even by critics of rationalist interpretations: the initial temptation to characterize Aristotle as a rationalist is due to a confusion between two different kinds of infinite regress that threaten the acquisition of scientific knowledge. Finally, in section 4, I argue for a new way of understanding the Accuracy Claim. Additionally, I try to specify in which sense noetic and demonstrative knowledge can be taken as interdependent without rendering Aristotle's theory viciously circular. Section 5 closes the discussion with some concluding remarks.

## 2. Considering the Rationalist Account

One of Aristotle's claims in *An. Post.* 2.19 is that our intellectual journey towards the principles begins with perception (αἴσθησις [*An. Post.* 2.19, 99b34–35]). Making use of inductive reasoning (*An. Post.* 2.19, 100b3–5), in alliance with other capacities such as memory (μνήμη [*An. Post.* 2.19, 100a3–4]) and experience (ἐμπειρία [*An. Post.* 2.19, 100a4–6]), we end up acquiring comprehension (νοῦς) of indemonstrable premises and, consequently, demonstrative knowledge of the facts that can be proved from them. One could affirm that Aristotle is offering an empiricist account of the acquisition of scientific principles, which would be by itself sufficient to reject any interpretation that depicts him as a rationalist. However, it has been persuasively argued in the literature that, even though Aristotle ascribes some role to perception in the process, he could not be saying that sensible experience alone works as the *foundation* of noetic knowledge.<sup>15</sup> If sensible experience were the foundation of our knowledge of the principles, the truths known by perception and

induction would have to be “more convincing” and “better known” than the principles themselves (*An. Post.* 1.2, 72a25–b4). If so, sensible experience would be more accurate than noetic knowledge, which is impossible given the Accuracy Claim.<sup>16</sup> If we cannot use sensible experience to *justify* scientific knowledge, Aristotle cannot be an empiricist in the strict sense of the term. On the contrary, he seems to believe that νοῦς, understood as a sort of “intuition” or “mental vision,” has to intervene and complete the job that sensible experience alone is not able to accomplish.<sup>17</sup>

Proponents of the Rationalist Account have argued that Aristotle appeals to this intuitive faculty in *An. Post.* 2.19 in order to protect scientific knowledge from the threat of infinite regress. In fact, this worry seems to be present in the very first lines of the treatise:

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[T1] All teaching [διδασκαλία] and all learning [μάθησις] of a rational kind [διανοητική] proceed from pre-existent knowledge [ἐκ προϋπαρχούσης γίνεται γνώσεως]. . . . Similarly with arguments, both deductive and inductive: they effect their teaching through what we already know. (*An. Post.* 1.1, 71a1–7, translation modified)

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This passage has been described as “anti-foundationalist in spirit.”<sup>18</sup> In fact, one may think that T1 implies that every piece of knowledge depends on some pre-existent knowledge<sup>19</sup>, a statement that gives rise to infinite regress. However, what Aristotle actually says is that every “rational learning” (μάθησις διανοητική) is based on previous knowledge. Therefore, a problem of infinite regress arises only if we assume that every “rational learning” depends on pre-existing knowledge whose acquisition is itself “rational.”

The brief note about arguments in T1 strongly suggests that by μάθησις διανοητική Aristotle means inference-based learning, since we learn by argument when the knowledge of the conclusion is somehow based on previous knowledge of the premises. If so, all Aristotle needs in order to protect his theory against infinite regress is to identify a non-inferential cognitive state that allows us to start off the process of rational learning without depending on

pre-existent knowledge.<sup>20</sup> The proponents of the Rationalist Account may argue that this is precisely the task Aristotle takes on in *An. Post.* 1.3.<sup>21</sup> In this chapter, he argues that demonstrative sciences do not run the risk of infinite regress because there are basic propositions in their domains (the first principles) from which other propositions can be demonstrated, but which are not themselves known by demonstration. Of those principles the scientist has not ἐπιστήμη ἀποδεικτική, but νοῦς. If noetic knowledge is the kind of cognition that protects Aristotle’s theory against the infinite regress diagnosed in T1, it must be “some sort of non-inferential intuition” of “self-evident principles,” which “must be grasped as true and necessary when considered in themselves, with no reference to anything else.”<sup>22</sup>

This picture allows the Rationalist Account to offer a perfectly simple explanation for the Accuracy Claim, according to which comprehension is “more accurate” (ἀκριβέστερον) than demonstrative knowledge. In fact, Aristotle takes ἀκριβές as a synonym for σαφές (*Top.* 2.4, 111a8–10), which indicates that noetic knowledge is “more accurate” than demonstrative knowledge in the sense of having a higher degree of clarity or certainty. In addition, Aristotle associates the Accuracy Claim with the fact the principles are “more familiar” or “better known” than the conclusion:

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[T2] Again, the principles of demonstrations are better known [γνωριμώτεραι], and all [demonstrative] knowledge involves an account [μετὰ λόγου]. Hence there will not be [demonstrative] knowledge of the principles; and since nothing apart from comprehension can be truer than [demonstrative] knowledge, there will be comprehension of the principles. (*An. Post.* 2.19, 100b9–12, translation modified)

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Of course, one may argue that the principles are “better known” and “more clear” *by nature* (τῇ φύσει) and not *to us* (πρὸς ἡμᾶς [*An. Post.* 1.2, 71b33–72a5; *Ph.* I 1, 184a16–21]). However, Aristotle also says that a demonstration proceeds from things that are “more convincing” (πιστοτέρων [*An. Pr.* 2.16, 64b32–33]), a feature he explicitly associates with the

fact that the premises are “better known than” and “prior to” the conclusion (*An. Post.* 1.25, 86b27–30). Even if what makes a proposition an indemonstrable principle is how things are ordered in the world, each principle must be “convincing itself in its own right,” whereas the theorems become convincing only “through other things” (*Top.* 1.1, 100b20–21; cf. *An. Post.* 1.2, 72a25–b4).

The other remark associated with the Accuracy Claim in T2 is that demonstrative knowledge is μετὰ λόγου (*An. Post.* 2.19, 100b10). One might plausibly argue that Aristotle is contrasting the accuracy of noetic knowledge with the inferential nature of demonstrative knowledge: knowing a demonstrable fact requires inference from previously known principles, while knowing the principles does not involve inferring them from more basic premises.<sup>23</sup> In *An. Post.* 1.27, 87b34–35, Aristotle affirms that sciences requiring a smaller number of premises in order to demonstrate their theorems are “more accurate.” The idea behind this statement might be that the more complex is an inference to prove  $p$ , the less “accurate” is the knowledge of  $p$ . In virtue of being non-inferential, noetic knowledge is the most accurate of all cognitive states, since the principles require zero premises in order to be known. For all these reasons, we might think that the Accuracy Claim is just Aristotle’s way of pointing out that his foundationalist project would fail if comprehension were not an intuitive apprehension of self-evident truths that can be grasped independently of their explanatory connections to other propositions.<sup>24</sup> In other words, the Accuracy Claim is meant to recognize an asymmetrical dependence relation between noetic and demonstrative knowledge. Let me now spell out why, despite all these reasons, I think the Rationalist Account is untenable.

### 3. The Advantages of the Interrelational Account over the Rationalist Account

The main reasons set out against the Rationalist Account are well known. First of all, it seems inadequate to take Aristotle’s theory of demonstration as a doctrine on epistemic justification. According to the philosopher, we cannot ask *why* (διὰ τί) a proposition is true unless we

already known *that* (ὄτι) it is true (*An. Post.* 2.1, 89b23–35; 2.8, 93a26–27). If a demonstration is meant to explain the conclusion, the scientist must already *know* that the conclusion is true before she enters the demonstrative stage of the scientific enterprise. In fact, the distinction between τὸ ὄτι and τὸ διὰ τί should not be explained in terms of unjustified *versus* justified beliefs (*An. Post.* 1.13, 78a22–b4). Justifications are answers to questions such as “why do I believe that *p*?” whereas Aristotelian demonstrations address questions such as “why is it the case that *p*?”<sup>25</sup> All I need to justify my belief that *p* is true is to set out reasons for believing that *p* is true. On the other hand, to present a demonstration of *p* is to identify a real-world factor that is responsible for *p* being true, and not a subjective factor responsible for my belief that *p* is true.<sup>26</sup> After all, the principles are prior to and more familiar than the theorems “by nature” and not “to us,” which means that what determines the role of a given truth in a demonstrative science is not how accessible to us is the evidence for it, but how fundamental it is in the causal order of reality (*An. Post.* 1.2, 71b30–72a5).<sup>27</sup> If what makes a proposition a principle is that it stands for a causally fundamental fact, knowing a principle as such involves grasping its explanatory connections to other truths in the domain, as argued by the Interrelational Account.

Still, even the critics of the Rationalist Account sometimes neglect what I believe to be the main reason to reject its explanation of the Accuracy Claim. In *An. Post.* 2.19, Aristotle considers two different hypotheses about the origin of our knowledge of the principles:

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[T3] As for knowledge of the immediates, one might wonder . . . whether the states, not being present in us, come about in us or rather are present in us without being noticed. It is absurd to suppose that we possess such states; for then we should possess pieces of knowledge more accurate than demonstration without its being noticed. (*An. Post.* 2.19, 99b23–27, translation modified)

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The first hypothesis is that our knowledge of them is already present in us without being



noticed (ἐνοῦσαι λελήθασιν [*An. Post.* 2.19, 99b25–26]). Here, it must be stressed that Aristotle does not even consider the possibility of the first principles being immediately accessible to us, as one might expect if they were self-evident propositions requiring no previous heuristic procedure. Therefore, as in Plato’s theory of recollection, if the principles are somehow known to us, we are not completely aware of them.<sup>28</sup> Aristotle rejects this first hypothesis based on the fact that comprehension is the “most accurate” of all cognitive states. The degree of accuracy of noetic knowledge—whatever ‘accuracy’ means in this context—excludes the possibility of possessing it without its possession being noticed.

If our knowledge of principles is not already in us, it must “come about” (ἐγγίνονται [*An. Post.* 2.19, 99b25]) in one way or another. In the sequence of *An. Post.* 2.19, this second hypothesis is formulated in terms of learning:

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[T4] But if we get them [the states] without possessing them earlier, how could we come to acquire knowledge and to learn except from pre-existing knowledge? This is impossible, as I said in connection with demonstration. (*An. Post.* 2.19, 99b28–30, translation modified)

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In T4, Aristotle reminds us of T1, where he states that every “rational learning” (μάθησις διανοητική) depends on pre-existing knowledge, insofar as an inference-based knowledge of a given truth depends on previous knowledge of the premises from which it is derived. Aristotle is explicitly claiming that our knowledge of the principles is itself the result of rational learning, and therefore depends on previously obtained knowledge. As a result, noetic knowledge *cannot* be the cognitive state that interrupts the infinite regress in T1. For that reason, one of Aristotle’s aims in *An. Post.* 2.19 is to identify a primitive cognitive capacity—namely, perception—that, being innate (σύμφυτον [*An. Post.* 2.19, 99b35]) and therefore independent of pre-existing knowledge, allows us to start off the process of μάθησις διανοητική towards superior forms of cognition.

Therefore, the cognitive disposition that interrupts the infinite regress in T1 is

perception, not comprehension. The crucial mistake here is to take Aristotle as offering in *An. Post.* 1.3 a solution to the kind of infinite regress that can be extracted from T1. In *An. Post.* 1.3, as well as in other chapters such as *An. Post.* 1.19–22, Aristotle is discussing whether every scientific proposition is demonstrable. If we exclude the possibility of demonstrations proceeding in a circle—as Aristotle does in *An. Post.* 1.3, 72b25–73a20—, this question is equivalent to asking whether there can be infinite chains of explanatory connections in the world, which would entail that demonstrations would have to proceed *ad infinitum*. In *An. Post.* 2.19, in turn, Aristotle is not considering infinite chains of explanatory connections, but “rational learning” in general. The kind of regress that can be extracted from T1 is one in which every proposition that is (rationally) learned is obtained from premises that are themselves (rationally) learned. A different sort of regress is discussed in *An. Post.* 1.3, which occurs if every demonstrable truth is *demonstrated* from propositions that are themselves *known by demonstration*. Thus, we can distinguish two questions, each of which corresponds to a different kind of infinite regress:

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(Q1) Is it the case that every “rational” (inference-based) learning depends on pre-existing knowledge whose acquisition is itself “rational” (inference-based)?

(Q2) Is it the case that every demonstration depends on premises that are themselves known by demonstration?

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(Q1) is answered negatively in *An. Post.* 2.19, and perception is the innate cognitive capacity that interrupts the regress. (Q2) is answered negatively in *An. Post.* 1.3, a proper proof being offered in *An. Post.* 1.19–22.<sup>29</sup> Here, we are allowed to say that comprehension interrupts the regress, since it prevents demonstrations from proceeding *ad infinitum*. However, this answer to (Q2) is compatible with the fact that noetic knowledge is itself the result of μάθησις διανοητική and depends on pre-existing knowledge.

Again, the proponent of the Rationalist Account could object that, even if

comprehension is the result of “rational learning” based on pre-existing perceptual knowledge, no cognitive content provided by sensible experience can justify our comprehension of the principles, since comprehension is “more accurate” than perception and experience themselves. However, it is perfectly possible to affirm that sensible experience can be used to justify some knowledge of the principles and nonetheless deny that it could justify our *comprehension* of them. As the Interrelational Account argues, comprehension is knowing the principles as principles, that is, as premises from which other propositions can be demonstrated, but which are not themselves demonstrated from other propositions. In that sense, comprehension presupposes (without being reduced to) the knowledge that the principles are true. As we know from *An. Post.* 2.19, perception is an innate capacity that, together with memory, gives rise to experience and the grasp of universal truths (*An. Post.* 2.19, 99b34–100b 5).<sup>30</sup> Our knowledge of these universal truths is justified by induction (*An. Post.* 2.19, 100b3–5) as, for instance, Aristotle’s knowledge of the facts reported in the *Historia Animalium* (*HA*) is empirically and inductively justified. As has been noted, the treatise does not distinguish causally fundamental facts from derivative facts that can be explained from them, a task Aristotle undertakes only in proper demonstrative treatises such as *de Partibus Animalium* (*PA*) or *de Generatione Animalium* (*GA*).<sup>31</sup> In other words, sensible experience gives us justified knowledge of the *truth* of the principles in the exact same way as it gives us justified knowledge of the *truth* of the theorems. However, for this very reason, it cannot give us *comprehension* of the principles, which involves not only recognizing them as truths, but also distinguishing them from the demonstrable propositions they explain. If so, the role Aristotle assigns to perception in *An. Post.* 2.19 does not contradict the Accuracy Claim, since he is not arguing that sensible experience alone can work as the foundation of noetic knowledge.

If sensible experience and induction allow us to know only that the principles are true, what gives us proper noetic knowledge of them? As has been argued, *An. Post.* 2.19 does not offer a clear-cut answer to this question: for the reasons we have seen in the last paragraph, there must be a gap between the inductive grasp of universal truths and the acquisition of indemonstrable principles as such.<sup>32</sup> In an intuitionist reading of the chapter, *voũç* appears as

a *deus ex machina* at *An. Post.* 2.19, 100b5–7, to fill this gap. The proponents of the Interrelational Account, in turn, are allowed to offer a much simpler and less arbitrary solution to this problem. Aristotle does not specify the missing step between the grasp of universal truths and proper noetic knowledge because this step has been previously discussed in the treatise.<sup>33</sup> Let me spell this out.

According to the Interrelational Account, comprehension is the knowledge of principles as principles, that is, as indemonstrable premises from which other truths are explained. Therefore, we cannot identify the principles as such independently of any demonstrative practice. In fact, a great part of Aristotle’s efforts in *An. Post.* 2 is focused on establishing this result. The philosopher affirms that definitions, understood as accounts of essence (τὸ τί ἐστίν), are the “principles of demonstration,” and restates that “there will not be demonstrations of principles,” since otherwise demonstrative syllogisms would proceed *ad infinitum* (*An. Post.* 2.3, 90b24–27). Therefore, the impossibility of demonstrating definitions is a crucial part of Aristotle’s foundationalism. For this reason, he discusses at length in *An. Post.* 2 whether or not definitions can be demonstrated. In *An. Post.* 2.8, he gives his final answer: a syllogism with a definitional sentence occurring as conclusion is merely “logical” (λογικὸς) and not a demonstration in the strict sense of the term, a result strong enough to block the threat of infinite regress. Nevertheless, Aristotle intends to show “in what way a demonstration [of what something is] is possible” (*An. Post.* 2.8, 93a15–16). In the rest of the chapter, he argues for a strict correspondence between the definition of a predicate P and the demonstration of a certain subject S being P. For instance, we explain why the noise we call “thunder” occurs in the clouds through the middle term “extinction of fire” (*An. Post.* 2.8, 93a7–b14). The definition of thunder, in turn, is “noise of fire being extinguished in the clouds” (*An. Post.* 2.10, 94a5–6). Aristotle makes it clear that this correspondence is not just a coincidence between the results of two independent activities (defining and explaining).<sup>34</sup> Actually, says he, “without a demonstration you cannot get to know what something is” (*An. Post.* 2.8, 93b18): that is to say, producing demonstrations is precisely the way we come to know the essence of things.<sup>35</sup> Since definitions are not properly demonstrated, our knowledge of them is not demonstrative, but noetic. Nevertheless, noetic and demonstrative knowledge

are interdependent cognitive states in the same way as defining and explaining are interdependent scientific practices.

If essences are nothing more than ultimate causes, the missing step between the grasp of universal truths and noetic knowledge is the very practice of demonstrating, that is to say, the act of organizing a given body of truths based on their explanatory connections. In fact, Aristotle embraces this result quite explicitly in *An. Pr.* 1.30:

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[T5] The majority of principles for each science are peculiar to it. Consequently, it is for our experiences concerning each subject to provide the principles. I mean, for instance, that it is for astronomical experience to provide the principles of the science of astronomy (for when the phenomena had been sufficiently grasped, in this way astronomical demonstrations were discovered; and it is also similar concerning any other art or science whatsoever).

Consequently, if the facts concerning each thing have been grasped we are already prepared to bring the demonstrations readily to light. For if nothing that truly belongs to things has been left out of the collection of facts, then concerning every fact of which there is a demonstration, we will be able to find that demonstration and demonstrate, while if it does not naturally have a demonstration, we will be able to make that evident. (*An. Pr.* 1.30, 46a17–27)

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Along the lines of *An. Post.* 2.19, T5 also claims that it is the job of experience to give us the proper principles of each science (τὰς μὲν ἀρχὰς τὰς περὶ ἕκαστον ἐμπειρίας ἐστὶ παραδοῦναι [*An. Pr.* 1.30, 46a17–19]). Again, we do not need to read this text as committing Aristotle to a strictly empiricist account of the acquisition of scientific knowledge. Actually, the passage seems to imply that experience is what allows us to know that the principles are true, whereas demonstration (i.e. explaining) is what makes us know that they are principles: only after all relevant facts in the domain have been grasped by experience do we become ready to make explanatory relations clear (ἡμέτερον ἤδη τὰς ἀποδείξεις ἐτοίμως ἐμφανίζειν [*An. Pr.* 1.30,

46a23–24]) and, therefore, distinguish demonstrable truths from indemonstrable ones.

Thus, in comparison to its rationalist alternative, the Interrelational Account avoids an internal conflict between *An. Post.* 2.19 and other important passages of the *Analytics* that also concern the grasp of indemonstrable principles (more importantly, *An. Post.* 2.8 and *An. Pr.* 1.30). Additional evidence—but perhaps not decisive, we must admit—can be found in Aristotle’s own scientific practice. His biological treatises, for instance, seem to follow quite strictly the script laid down in T5. As we have seen, the well-articulated explanations in *PA* or in *GA* presuppose the vast collection of (previously obtained) facts presented in *HA*. For instance, being blooded is never recognized in *HA* as part of the essence of sanguineous animals.<sup>36</sup> However, in *PA*, one of the ultimate reasons for fishes having fins and not feet, or birds being two-footed, or deer and dolphins being long-lived, is their being blooded, which makes Aristotle take this property as part of their essences.<sup>37</sup> If so, Aristotle can confidently state: “that some animals are blooded while some are bloodless will be in the account defining their essence.”<sup>38</sup> The reason why such a confident statement appears in *PA*, but not in *HA*, is that we cannot know that birds and dolphins are essentially sanguineous until we realize that their being blooded is a causally fundamental fact about them.<sup>39</sup>

Strong textual evidence seems to corroborate the thesis that comprehension and demonstrative knowledge are somehow interdependent cognitive states: on one hand, demonstrative knowledge requires noetic knowledge of indemonstrable premises; on the other, the acquisition of noetic knowledge involves some demonstrative practice. However, we still need to spell out how exactly (and to what extent) these states are interdependent. A special difficulty makes this task even more pressing. Aristotle affirms that comprehension is “more accurate” than demonstrative knowledge, a claim that is motivated by the fact that the principles are “better known” than the conclusions and “convincing in their own right,” while demonstrable truths become “known” and “convincing” only through the principles (*An. Post.* 1.2, 72a25–b4; *Top.* 1.1, 100b20–21). In other words, the Accuracy Claim suggests that demonstrative knowledge is asymmetrically dependent on the knowledge of indemonstrable premises. Interpreters advocating the Interrelational Account may claim that this asymmetry is only the reflection of the fact that the explanatory relation between principles and

demonstrable truths is asymmetrical: the principles are explanatory of the theorems and not vice-versa—even though noetic knowledge involves understanding how principles explain other propositions. However, despite being true, this reply seems too simple and unsatisfying, since it does not explain why Aristotle speaks in terms of “accuracy,” or why he describes causally fundamental truths (truths prior in nature) as “better known” and “more convincing” than demonstrable truths (truths posterior in nature).

#### 4. Reinterpreting the Accuracy Claim.

As we have seen in section 2, one of the meanings of *ἀκριβέες* that has been associated with the Accuracy Claim is that of certainty, clarity or trustworthiness. However, the term can be used in other ways. As has been noted, *ἀκριβέες* denotes quite generally whatever is of “good epistemic quality.”<sup>40</sup> In some contexts, the relevant quality is precision. Explanations or definitions that are not at the proper level of generality, for being either too general or too specific, should be discharged as “inaccurate.”<sup>41</sup> The notion of precision might be useful to compare alternative accounts *of the same item*, as, for instance, alternative definitions of the same concept or alternative explanations of the same *explanandum*. However, the Accuracy Claim compares different kinds of cognitive states (noetic and demonstrative knowledge) which admit different kinds of objects (principles and demonstrable truths, respectively). It does not make sense to claim that the (noetic) knowledge a scientist has of a definition is more “precise” (in the sense of being at the right level of generality) than the (demonstrative) knowledge she has of a demonstrable proposition.

I would like to explore another option. According to the Liddell–Scott–Jones Lexicon, *ἀκριβέες* often refers to what is in “perfect condition” or “consummate,” while the verb *ἀκριβόω* can mean “to be or become perfect” (in the passive voice) or “to understand thoroughly” (in the active). As Zabarella notes, *ἀκριβέες* denotes not only certainty, but also “perfection” or “completeness.”<sup>42</sup> Aristotle uses the term in this sense as well.<sup>43</sup> One occurrence is particularly relevant to our present discussion:

<ext>

[T6] To demonstrate something more universally is to demonstrate it through a middle term which is nearer to the principles. Immediates are nearest—indeed they are principles. Thus, if a demonstration which proceeds from a principle is more accurate [ἀκριβεστέρα] than one which does not proceed from a principle, then a demonstration which proceeds more from a principle is more accurate than one which is less so. But a more universal demonstration is of this type. Hence universal demonstrations will be superior. (*An. Post.* 1.24, 86a14–19, translation modified)

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For Aristotle, a universal demonstration that explains, for instance, why all triangles have the sum of internal angles equal to two right angles (hereafter, 2R) is superior to a syllogism that explains only why isosceles triangles have 2R. After all, triangles have 2R *not in virtue of being isosceles or equilateral, but in virtue of being triangles*.<sup>44</sup> If so, as argued in T6, attempts to demonstrate the 2R-theorem about all triangles universally are more likely to reach the relevant explanatory principles.<sup>45</sup> Aristotle also claims that demonstrations proceeding from a principle are “more accurate” (ἀκριβεστέρα) than demonstrations that only involve premises that are themselves demonstrable. Thus, he argues, a demonstration which proceeds “more” from a principle is more accurate than a demonstration that is “less” so: the closer a demonstrative chain gets to reaching the immediate premises that block the regress, the more accurate is the knowledge it produces. If “interrelational” interpretations are correct, noetic and demonstrative knowledge are better described as types of *understanding*, since they involve identifying the place of a given proposition in a web of causally connected truths. If so, demonstrations containing only demonstrable premises are incomplete or “inaccurate,” since a complete and “accurate” understanding of a conclusion requires connecting it to the appropriate principles.

It might be relevant to point out that this notion of ἀκρίβεια as completeness is not technical or exclusive to the *Analytics*. In *De Caelo* 2.5, 287b22–288a2, for instance,



Aristotle asks why does the heaven of fixed stars moves in one direction rather than the other, and states: “either this is itself a principle or there is a principle for it.” If principles can be recognized as such in themselves, how could Aristotle be in doubt about whether this fact is a principle or a demonstrable truth? The philosopher often complains about the lack of empirical evidence in the domain of astronomy—especially in comparison to biological sciences (*PA* 1.5, 644b22–645a4; *Cael.* 2.3, 286a3–6). It is precisely the lack of evidence that prevents Aristotle from determining whether the heavens moving in the direction they do is a principle or not. As we have seen in T5, the identification of principles as such involves realizing that there are no other truths from which they could be explained, a task which requires previous apprehension of all the other facts in the domain. Further on, Aristotle affirms that we should be grateful if anyone succeeds in finding “more accurate necessities” (*ἀκριβεστέρας ἀνάγκας* [*Cael.* 2.5, 287b34–288a1]). It is hard to determine what ‘necessities’ means here<sup>46</sup>, but the context strongly indicates that the relevant meaning of ‘accurate’ is the one I have suggested. Aristotle’s predicament in this passage is the incapacity to decide whether or not a given truth is a principle. He can neither explain why the proposition at stake is true nor determine whether it is an indemonstrable premise. Therefore, his understanding of this truth and of all the other truths that are explained from it is *incomplete* and, in this sense, *inaccurate*.

But how could this use of *ἀκριβές* help us understand the Accuracy Claim? First of all, we need to distinguish two different types of *ἐπιστήμη ἀποδεικτική*, or two different levels in which one can possess demonstrative knowledge:<sup>47</sup>

<ext>

1. The cognitive state of someone who demonstrates *a given conclusion* from appropriate principles.
2. The cognitive state of someone who has demonstrative knowledge (of type 1) of the totality (or a significant number) of demonstrable truths in a given domain, including noetic knowledge of the corresponding principles—i.e. *ἐπιστήμη* as a scientific expertise.

</ext>

My suggestion is that the Accuracy Claim is comparing the degree of ἀκρίβεια (understood as completeness or comprehensiveness) of the demonstrative knowledge a scientist has of a given conclusion  $c$  (type 1 of ἐπιστήμη ἀποδεικτική), on one hand, and the noetic knowledge she has of a principle  $p$  from which  $c$  is demonstrated, on the other. By acquiring demonstrative knowledge of  $c$ , the scientist becomes able to connect  $c$  to a set of indemonstrable principles,  $p$  among them. However, it is the noetic knowledge of  $p$  (and of other principles used in the demonstration) that allows her to connect  $c$  to *the body of science as a whole*: as T5 indicates, having noetic knowledge of  $p$  involves grasping a complex web of interrelated truths and verifying that  $p$  cannot be explained by any of them. For example, a demonstration of the theorem that triangles have 2R is relatively easy to follow. If so, even a non-geometer can see that this theorem is grounded, among other things, in the fact that triangles are three-sided rectilinear figures. Only the geometer, however, has the holistic outlook that allows her to know that triangles are *essentially* three-sided rectilinear figures, that is to say, that this is a truth about triangles that explains other truths about them, but which is not explained by more basic truths. Therefore, having noetic knowledge of the fact that triangles are three-sided rectilinear figures is what makes the geometer's understanding of the theorem part of a holistic apprehension of geometrical truths in general. It might be useful to consider one of Aristotle's own scientific explanations. Absence of bile is the reason why deer and dolphins (among other animals) are long-lived, for bile, says Aristotle, is a residue of impure blood affecting the state of the liver, which is a vital organ to blooded animals (*PA* 4.2, 677a30–b10). Anyone reading this particular passage becomes aware of the connection between the longevity of dolphins and the fact that they are blooded animals. However, a complete and “accurate” understanding of dolphins being long-lived requires knowing that they are, as we have seen, *essentially* blooded. Acquiring noetic knowledge of this indemonstrable fact involves grasping the fundamental causal role that blood plays in the whole body of truths presented in *PA*. If so, the reason why the biologist has a comprehensive understanding of the longevity of dolphins, as a part of biology as a whole, is her comprehensive understanding of the fact that dolphins are essentially sanguineous.

In sum, the demonstrative knowledge of a conclusion *c* is “accurate,” in the sense of being comprehensive or complete, *because* the noetic knowledge of *p* (a principle from which *c* is demonstrated) is “accurate” in the same sense. Now, if this is the case, noetic knowledge of *p* is “more accurate” than demonstrative knowledge of *c*, at least according to Aristotle. In *An. Post.* 1.2, 72a25–32, the philosopher states the following rule: if *x* is *F because y* is *F*, then *y* is “more *F*” than *x*—for instance, if I love London only because I love its museums, then I love its museums more than I love London. In this passage, Aristotle uses this rule to justify his claim that the principles are “more convincing” than the theorems. If I am right, the relevant πίστις should not be understood as our “conviction” about the truth-value of principles and theorems, but our “conviction” about their roles within an organized body of truths.<sup>48</sup> We can explain in similar terms the claim that the principles are “better known” (γνωριμώτερα) than the respective conclusions: demonstrable truths become “known” *because* the principles are “known,” the relevant γνώσις being not mere knowledge, but scientific understanding, that is, grasping the place of a given proposition in a web of explanatorily connected truths.<sup>49</sup>

With this interpretation of the Accuracy Claim, it becomes easier to specify in which sense demonstrative and noetic knowledge can be taken as interdependent. Acquiring comprehension of a principle involves the practice of demonstrating, that is to say, displaying causal connections among previously obtained truths. This procedure, however, does not require pre-established comprehension of the principles, so there is no vicious circularity in Aristotle’s theory. What does require proper comprehension of the principles is the more robust understanding that *expert scientists* have of any theorem in their field. When a scientist exhibits this kind of understanding through a demonstration, she is not just displaying isolated causal relations, but connecting a demonstrable proposition to a set of principles of which she already has noetic knowledge, which amounts to connecting it to the science as whole.<sup>50</sup> On the other hand, the inquirer, in her way to become a scientist, engages in a kind of demonstrative activity that is incomplete—and, in this sense, “inaccurate”—in comparison to the full-fledged demonstrative understanding she acquires once she has grasped the principles and distinguished them from demonstrable truths.

Nevertheless, if our explanation of the Accuracy Claim is correct, there is a sense in which comprehension is *not* more accurate than demonstrative knowledge, since noetic knowledge cannot be more complete than the scientific expertise as a whole (type 2 of ἐπιστήμη ἀποδεικτική). In fact, Aristotle seems to have acknowledged this result in the very last (and obscure) lines of the *An. Post.*:

<ext>

[T7] And yet, the principle of science [i.e. comprehension] is related to the principle in the same way as the [demonstrative] science as a whole is related to the subject matter as a whole [καὶ ἡ μὲν ἀρχὴ [ἐπιστήμης] τῆς ἀρχῆς εἶη ἅν, ἡ δὲ [ἐπιστήμη] πᾶσα ὁμοίως ἔχει πρὸς τὸ πᾶν πρᾶγμα.] (*An. Post.* 2.19, 100b15–17, translation modified)

</ext>

Of course, there is nothing forcing us to read T7 as part of the discussion about accuracy. Aristotle might be saying something quite simple: if comprehension gives us the principles or starting points from which we formulate demonstrations, we might take comprehension itself as the principle or starting-point of demonstrative sciences. There are reasons to prefer another reading, though. First, Aristotle had already characterised νοῦς as ἐπιστήμης ἀρχὴ in the preceding lines (*An. Post.* 2.19, 100b14–15; see *An. Post.* 1.3, 72b23–25), so, in this reading, T7 would be just a repetition of what has been just said. Second, T7 immediately follows the statement and defence of the Accuracy Claim (*An. Post.* 2.19, 100b5–15), which suggests that Aristotle is still discussing the accuracy of scientific cognitive states. More importantly, why does he make it clear that he is talking about ἐπιστήμη and its πρᾶγμα *as a whole* (πᾶσα)? I believe Aristotle is relying on the distinction between the two types of ἐπιστήμη ἀποδεικτική I have discriminated above. Ross paraphrases the passage in the following way: “science as a whole grasps its objects with the same certainty with which intuitive reason grasps the first principles” (Ross in *An. Post.* 678). If we replace Ross’s intuitionist vocabulary, Aristotle’s words in T7 can be interpreted as follows: noetic knowledge grasps a principle with the same degree of accuracy (understood as

comprehensiveness and completeness) as demonstrative science *as a whole* (type 2 of ἐπιστήμη ἀποδεικτική) grasps its subject matter *as whole* (not one particular theorem, but the entire body of scientific propositions). If this reading is correct, we can provide a coherent reading of the last paragraph of *An. Post.* 2.19 (100b5–17). First, Aristotle argues that the comprehension of a given principle is *more accurate* than the demonstrative knowledge of the corresponding conclusion (type 1 of ἐπιστήμη ἀποδεικτική). Yet, he continues in T7 (reading an adversative *καὶ* in *An. Post.* 2.19, 100b15), comprehension is *as accurate as* demonstrative knowledge, understood as the mastery of a scientific discipline (type 2 of ἐπιστήμη ἀποδεικτική).

## 5. Concluding Remarks

Perhaps the main source of resistance against the Interrelational Account, despite all the textual evidence in its favour, is that it recognizes some sort of interdependence between comprehension and demonstrative knowledge. This interdependence seems to turn the attainment of scientific knowledge into a viciously circular process, an outcome that Aristotle explicitly tried to avoid. After all, he argues that we get to know a theorem scientifically by demonstrating it from principles that are “better known” than the theorem itself, which leads him to claim that comprehension is “more accurate” than demonstrative knowledge. I have attempted to show in which way these two cognitive states can be taken as interdependent without contradicting Aristotle’s reasons for advancing the Accuracy Claim. The acquisition of noetic knowledge depends on demonstration in the sense of requiring the apprehension of causal connections among previously obtained truths. Nevertheless, a proper demonstrative understanding of a given proposition is incomplete—and, in this sense, “inaccurate”—without noetic knowledge of the appropriate principles. Even if we know the demonstrations explaining why triangles have  $2R$  or why dolphins are long-lived, our knowledge of them does not make us geometers or biologists. For us, these demonstrations do nothing more than connect a given conclusion to a set of premises that explain why it is the case. On the

other hand, proper geometers or biologists have noetic knowledge of the corresponding principles: they not only know that triangles are rectilinear figures and dolphins are blooded animals, but they also understand why they are *essentially* so. Expert scientists recognize principles as principles after having apprehended all the truths in the relevant domain and organized them based on their causal relations. For them, the demonstration is the vehicle by which they connect a given conclusion not only to a set of premises from which it is deductively derived, but to the body of science in its entirety.<sup>51</sup>

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<sup>1</sup> Myles Burnyeat, “Aristotle on Understanding Knowledge,” argues that the term *ἐπιστήμη* is better translated as ‘understanding.’ I accept most of the reasons Burnyeat sets out in favour of this translation, but I agree with David Bronstein, *Knowledge and Learning*, 18–20, that we must emphasize that *ἐπιστήμη* is a kind of knowledge (the kind of knowledge expert scientists have). Thus, I shall translate *ἐπιστήμη* as ‘scientific knowledge’ and *ἐπιστήμη*

ἀποδεικτική as ‘demonstrative knowledge.’ See James H. Lesher, “Aristotle on ἐπιστήμη as understanding,” for a more detailed discussion.

<sup>2</sup> For the same reasons I explain in n. 1, I will sometimes follow Bronstein, *Knowledge and Learning*, 9n18, and use the expression ‘noetic knowledge’ to refer to the kind of cognition Aristotle calls νοῦς. In this paper, my discussion of noetic knowledge is restricted to the so-called “proper principles,” not the “common principles” such as the Principle of Non-Contradiction or the Law of the Excluded Middle. See *An. Post.* 1.10, 76a37–b2.

<sup>3</sup> *An. Post.* 1.3, 72b7–15; 1.22, 82b37–83a1; 83b6–7, 83b32–84a6.

<sup>4</sup> According to Aristotle, if  $p_1$  is explanatory of  $p_2$ ,  $p_1$  is prior to  $p_2$  in some sense (τὸ γὰρ αἴτιον πρότερον οὐ αἴτιον [*An. Post.* 2.16, 98b17]), and priority is an asymmetrical relation (*Cat.* 12, 14a29–35; 14b11–22; *Metaph.* 5.11, 1019a1–4; 7.10, 1034b30–32; 1035b6–7). See also *An. Post.* 1.13, 78a22–b13.

<sup>5</sup> Since I am discussing the meaning of ἀκριβής in section 3, I shall use ‘accurate’ as a vague and uncommitted translation.

<sup>6</sup> *An. Post.* 1.2, 71b22; 71b29–72a5; 1.25, 86b27–30; *An. Pr.* 2.16, 64b33.

<sup>7</sup> According to John Corcoran, “Aristotle presented a general truth-and-consequence conception of demonstration meant to apply to all demonstrations. According to him, a demonstration, which normally proves a conclusion not previously known to be true, is an extended argumentation beginning with premises known to be truths and containing a chain of reasoning showing by deductively evident steps that its conclusion is a consequence of its premises” (“Aristotle’s Demonstrative Logic,” 1).

<sup>8</sup> Michael Ferejohn states that demonstrable facts “follow from, and are *thus* explained by, general scientific principles *already in hand*” (*Origins*, 2, emphasis added). He also argues that the principles are “more intelligible in themselves” in the sense that their “intelligibility is grounded on certain non-relational features of the principles themselves that are not dependent in any way on how (or even whether) they are actually deployed in scientific demonstrations” (Ferejohn, “Empiricism,” 78).

<sup>9</sup> Terence Irwin affirms that “the demand for a conclusive display of grounds leads us to demand first principles that are grasped as true independently of the further propositions they

justify” and that “non-inferentially justified first principles allow us to claim knowledge without facing an infinite regress or a circle” (*Aristotle’s First Principles*, 130–31).

<sup>10</sup> Michael Frede, “Aristotle’s Rationalism,” 157–58.

<sup>11</sup> See Burnyeat, “Aristotle on Understanding Knowledge.” Richard McKirahan formulates it in helpful terms: “to grasp something as a principle is to understand how the things of which it is a principle depend on it. . . . Thus, knowing principles entails appropriate knowledge of nonprinciples, and this amounts to possessing the whole demonstrative science” (*Principles and Proofs*, 243–44). See also Bronstein, who affirms that “for Aristotle a science is a network of inter-connected truths, such that a complete understanding of the explanation of any one fact requires seeing its place within the broader network in which it belongs” (*Knowledge and Learning*, 125–26). See also Leshner, “Aristotle on ἐπιστήμη as understanding,” 50.

<sup>12</sup> “The noetic grasp we have of them [first principles] as principles concerns our ability to use them in explaining and making intelligible the world of phenomena. Νοῦς therefore is a feature of our understanding of all explanatory principles or premises . . . just insofar as we understand them in the act of explaining by them, i.e. just insofar as we understand them *qua* principles and not *qua explicanda*” (Aryeh Kosman, “Understanding,” 389). See David Charles, *Aristotle on Meaning and Essence*, 266–67; and Miira Tuominen, “Back to II 19,” 141.

<sup>13</sup> See Charles, *Aristotle on Meaning and Essence*, 265–73 and Breno A. Zuppolini, “Aristotle’s Foundationalism.”

<sup>14</sup> Bronstein, *Knowledge and Learning*, 79.

<sup>15</sup> Frede, “Aristotle’s Rationalism”; Greg Bayer, “Coming to Know”; Ferejohn, “Empiricism”; cf. Irwin, *Aristotle’s First Principles*, 136–37.

<sup>16</sup> See Jonathan Barnes in *An. Post.* 261–62.

<sup>17</sup> For intuitionist readings, see David Ross in *An. Post.* 49, 85; Charles Kahn, “The Role of *Nous*”; Irwin, *Aristotle’s First Principles*, 134–37; Bayer, “Coming to Know.” For other interpretations, see Leshner, “The Meaning of ΝΟΥΣ”; Barnes in *An. Post.* 267–70; Charles, *Aristotle on Meaning and Essence*, 265–73; Bronstein, “Origin and Aim”; Bronstein,

*Knowledge and Learning*, 225–47; Breno A. Zuppolini, “Aristotle’s Foundationalism.” It is worth noticing that Ferejohn, despite defending several claims that are along the lines of what I am calling the Rationalist Account, rejects interpretations that describe νοῦς as “intuition” or “mental vision,” as if it were a faculty that “generates flashes of ‘insight’ concurrently with, but independently of, the operation of the perceptual faculties” (Ferejohn, “Empiricism,” 79).

<sup>18</sup> Ferejohn, “Empiricism,” 66.

<sup>19</sup> This is precisely how Ferejohn, “Empiricism,” 66, formulates Aristotle’s statement in *An. Post.* 1.1, 71a1–2.

<sup>20</sup> See Barnes’s discussion on the distinction between *διανοητικός* and *νοητικός* (Barnes in *An. Post.* 81).

<sup>21</sup> Ferejohn affirms: “In *Posterior Analytics* I.3, Aristotle considers the implications of (P1) for his theory of demonstrative knowledge,” where (P1) is “every piece of knowledge arises out of some pre-existent knowledge” (“Empiricism,” 66). See also Barnes in *An. Post.* 104.

<sup>22</sup> Irwin, *Aristotle’s First Principles*, 134.

<sup>23</sup> Instead, the proponents of the Interrelational Account may argue that Aristotle, by using the expression *μετὰ λόγου*, is just stressing that demonstrative knowledge of a given conclusion *c* involves an explanation (*λόγος*) of *c*.

<sup>24</sup> Irwin, for instance, affirms: “His [Aristotle’s] conception of demonstration embodies a foundationalist conception of justification. The right sort of foundation must avoid both infinite regress and vicious circle; and Aristotle can meet this requirement *only if* he recognizes self-evident first principles grasped by intuition” (Irwin, *Aristotle’s First Principles*, 134, emphasis added).

<sup>25</sup> See Owen Goldin, “Circular,” 200.

<sup>26</sup> For other interpretations that distinguish Aristotelian explanation from mere justification, see Burnyeat, “Aristotle on Understanding Knowledge,” 101; Kosman, “Understanding”; C.C.W. Taylor, “Aristotle’s Epistemology,” 120; McKirahan, *Principles and Proofs*, 209–31; Leshner, “Aristotle on ἐπιστήμη as understanding,” 46; Oswaldo Porchat Pereira, *Ciência e dialética em Aristóteles*, 93–8; Lucas Angioni, “Necessary Principles”; Angioni,

“Definition”; Bronstein, *Knowledge and Learning*; Goldin, “Circular,” 200; Salmieri, “Aristotelian *epistêmê*,” 2–3; Zuppolini, “Aristotle’s Foundationalism,” 192.

<sup>27</sup> See Burnyeat “Aristotle on Understanding Knowledge,” 127–28; R.J. Hankinson, *Cause and Explanation*, 161.

<sup>28</sup> Barnes in *An. Post.* 261; Bronstein, “Origin and Aim,” 38–9; Bronstein *Knowledge and Learning*, 234; Bronstein, “Aristotle’s Critique”; Zuppolini, “Aristotle’s Foundationalism,” 193.

<sup>29</sup> On this proof, see D.W. Hamlyn, “Aristotle on Predication”; Jonathan Lear, *Aristotle and Logical Theory*, 15–33; Michael Scanlan, “Compactness”; Adam Crager, *Meta-logic*.

<sup>30</sup> I have argued in “Aristotle’s Foundationalism,” 195–99, that the role of induction in *An. Post.* 2.19 goes beyond a process of concept-formation. On this debate, see Ross in *An. Post.* 675–76; Kahn, “The Role of *Nous*,” 391–95; McKirahan, *Principles and Proofs*, 246; Barnes in *An. Post.* 264–65; Charles, *Aristotle on Meaning and Essence*, 264n37; Bronstein, “Origin and Aim,” 58n67; Bronstein, *Knowledge and Learning*, 246n63.

<sup>31</sup> See James G. Lennox, “Divide and Explain”; Lennox, *Philosophy of Biology*, 39–71; Bronstein, *Knowledge and Learning*, 126–27. For a detailed discussion and *status quaestionis* about the role of *HA* in Aristotle’s biology, see Allan Gotthelf, *Teleology*, 261–92.

<sup>32</sup> See Kahn, “The Role of *Nous*,” 396–97; Bronstein, “Origin and Aim”; Bronstein, *Knowledge and Learning*, 225–47.

<sup>33</sup> See Bronstein, “Origin and Aim,” and Bronstein, *Knowledge and Learning*, 225–47, for a detailed defense of this claim, to which I am very much indebted. However, he believes that the essences of attributes and processes (such as thunder or eclipse) are revealed by demonstrations (as argued in *An. Post.* 2.8–10), whereas the essences of subject-kinds (such as man or horse) are grasped by induction and division (*An. Post.* 2.13). In other words, Bronstein argues that at least the essences of subject-kinds can be known as such independently of their explanatory role in demonstrations (I have objected to this aspect of Bronstein’s interpretation in Zuppolini, “Aristotle’s Foundationalism,” 203–4, and Zuppolini, “Review,” 182–85). Still, Bronstein also claims that this non-explanatory grasp of the essence is “non-noetic,” which allows us to classify him as a member of the Interrelational school.

<sup>34</sup> For a systematic defence of this thesis, see Charles, *Aristotle on Meaning and Essence*. See also Kung, “Aristotle on Essence and Explanation,” 168–72; Charles, “Definition and Explanation”; Williams & Charles, “Essence, Modality”; Peramatzis, *Priority*, 180–88; Peramatzis, “Science and Metaphysics”; Angioni, “Necessary Principles”; Zuppolini, “Aristotle’s Foundationalism,” 201–4.

<sup>35</sup> I believe that this relation between definition and demonstration is true not only for attributes and processes such as thunder, but also for subject-kinds, *pace* Ross in *An. Post.* 633; Bronstein, *Knowledge and Learning*, 131–43. In *Metaph.* 7.17 and 8.2–4, for instance, Aristotle explicitly extends the model presented in the *Analytics* to include hylomorphic substances. See Charles, *Aristotle on Meaning and Essence*, 274–309; Peramatzis, *Priority*, 180–88; Peramatzis, “Science and Metaphysics.” As I argued in Zuppolini, “Aristotle’s Foundationalism,” 204, there is a sense in which the “interdependence” thesis holds good even for subjects that are not analysable as compounds of form and matter: in *De Anima* 1.1, e.g. Aristotle states that the definition of a substance is “dialectical and empty” if it does not lead us to know the substance’s derivative properties (402b16–403a2). In other words, knowing the essence of substances involves grasping its explanatory connections to their demonstrable attributes.

<sup>36</sup> The closest we get to this recognition is the affirmation that the nature (φύσις) of the blood and the veins “looks like a starting point” (ἀρχὴ ἔοικεν [*HA* 3.2, 511b11–12]), in a context in which Aristotle seems concerned with exposition of facts, not explanation.

<sup>37</sup> *PA* 4.2, 677a30–b1; 4.12 693b5–8; 4.13, 695b17–22.

<sup>38</sup> *PA* 4.5, 678a33–34; cf. 1.3, 643a1–5; 2.4, 651a11–14.

<sup>39</sup> It goes beyond the purpose of this paper to discuss whether or not material features such as being blooded can be taken as explanatorily primitive. Lennox states: “if Aristotle is inclined to decide what is in the account of a thing’s being on the basis of explanatory primitiveness, and if he is willing, in natural science, to include matter in definitions, then we could expect that being blooded or being bloodless would indeed be in the substantial being of animals identified at a sufficiently general level” (*Philosophy of Biology*, 202n11). For other

references on this topic and for a criticism of the view that matter can be explanatorily basic, see Gelber, “Facts about Matter.”

<sup>40</sup> Barnes in *An. Post.* 189.

<sup>41</sup> See *EN* 8.7, 1159a3–4; *Metaph.* 13.5, 1080a9–11 (in contrast to *λογικωτέρων*); *Pol.* 3.4, 1276b24–25; *GC* 2.6, 333b22–26 (in contrast to *ἀπλῶς* and *μαλακῶς*); *Rh.* 1.4, 1359b2–5; 3.8, 1408b30–32. As Lesher, “*Saphêneia*,” 145–48, has argued, this is a meaning that *ἀκριβές* shares with *σαφές*. Thus, the fact that Aristotle takes the two expressions as synonyms (see *Top.* 2.4, 111a8–10) does not count as strong evidence in favour of a “rationalist” reading of the Accuracy Claim. Moreover, Lesher claims that *σαφές* also refers to “the attainment of full scientific knowledge” (“*Saphêneia*,” 148–56). If he is correct, this is a meaning that *σαφές* shares with *ἀκριβές* as well—the meaning according to which the Accuracy Claim should be interpreted, as I argue below.

<sup>42</sup> “akribeiam, quae non solam certitudinem significat, sed cum perfectione” (Zabarella, *In Post. Anal.*, 168B).

<sup>43</sup> E.g. our understanding of a given subject is said to be *ἀκριβές* when it is detailed, complex and meticulous (*Top.* 6.4, 141b12–14; cf. *Rh.* 3.12, 1414a7–13). In *EN* 6.7, 1141a12–20, Aristotle affirms that wisdom (*σοφία*), understood as a combination of *νοῦς* and *ἐπιστήμη*, is *ἀκριβεστάτη* in the sense of not being a partial or restricted knowledge (*κατὰ μέρος*), but complete and consummate (*κεφαλῆν*).

<sup>44</sup> *An. Pr.* 1.35, 48a33–36; *An. Post.* 1.4, 73b25–74a3; 1.5, 74b2–4; 1.24, 85b5–13

<sup>45</sup> In *An. Post.* 1.24, 86a19–21, Aristotle clarifies the point schematically: a demonstration that explains why a given figure (D) has 2R (A) through a middle term (C) that applies exclusively to isosceles triangles is inferior to a demonstration that contains a middle term (B) applying to all triangles. I believe the relevant concept of universality here is the one discussed in *An. Post.* 1.4, 73b25–74a3 (see also *An. Post.* 1.5, 74a16–b4; 1.24, 85b4–15; b23–27; 85b38–86a3; 2.17, 99a30–b7). I have dealt with this subject in Zuppolini, “Aristotle on *Per se* Accidents,” 130–32.

<sup>46</sup> Angioni, “Progresso,” 323–28, convincingly argues that what is at stake here is not the necessity of logical consequence, but the necessity of explaining phenomena from

appropriate principles, i.e. “necessities” are the principles *required* to explain a given phenomenon appropriately. He also claims that “accuracy” is the property of explanations that “hit the target,” in the sense of being correct or appropriate. Although I do not disagree with this reading, I believe it must be stressed that the relevant “correction” or “appropriateness” depends on either (i) connecting the fact under investigation to a principle that is recognized *as such* or (ii) recognizing the fact itself *as a principle*. See *An. Post.* 1.2, 71b19–32, where Aristotle says that demonstrative premises are “appropriate” (οἰκεῖται) when “true, primary, immediate, more familiar than, prior to and explanatory of the conclusion.” As I have been arguing, neither (i) or (ii) can be accomplished by analysing the proposition in itself, isolated from other truths.

<sup>47</sup> Cf. Leshner, “Aristotle on ἐπιστήμη as understanding,” 47–50; Salmieri, “Aristotelian *epistêmê*,” 2.

<sup>48</sup> See Goldin, “Circular,” 212–13; Berrón, “Claves,” 17–18.

<sup>49</sup> See Burnyeat, “Aristotle on Understanding Knowledge,” 127–32.

<sup>50</sup> One can argue that these are two meanings of ‘demonstrating’ and ‘demonstration.’ Hence, there would not be an interdependence relation properly speaking, since the “demonstration” on which comprehension depends is not the same “demonstration” that depends on comprehension. I have myself explored the distinction between two meanings of ‘demonstration’ before (Zuppolini, “Aristotle’s Foundationalism,” 198–99; cf. Bronstein, *Knowledge and Learning*, 41). However, I no longer think that there is a difference between *meanings*, but only between incomplete (or inaccurate) demonstrations, i.e. the grasp of isolated causal relations, and complete (or accurate) demonstrations, which involves comprehension of the principles.

<sup>51</sup> I presented drafts of this paper at the University of Campinas, the Federal University of Goiás, and the Federal University of Uberlândia. Many thanks to all participants, including Daniel Devereux, Lucas Angioni, Raphael Zillig, Fernando Mendonça, Rubens Sobrinho, Marco Zingano, Rodrigo Guerizoli, Wellington Damasceno de Almeida, Vitor Mauro Bragança, Manuel Berrón, Adam Crager, Fabian Mié, Jorge Mittelman, and Roberto Grasso. I am also grateful to the Sao Paulo Research Foundation (FAPESP), for financial support, and



two anonymous referees for helpful remarks.