Posterior Analytics: Epistemology and Philosophy of Science

Aristotelian Explanations

1. **Sciences**

   a. Aristotle's aim in this work is to set out the structure of an *epistêmê*, i.e., a structured body of scientific knowledge, or a science, for short.

   b. For Aristotle, the sciences are independent of one another; they are not arranged hierarchically. There is no "universal science" under which all the special sciences fall.

   c. *Epistêmê* is often (and correctly) translated as 'knowledge' (and *epistasthai* as 'know'). But we must distinguish it from two other verbs that also can be translated as 'know': *gignoskein* and *eidenai*. See the Glossary in *Selections* (under 'knowledge') for more on this distinction.

   d. A science is portrayed as a deductive system. It begins with undemonstrated first principles (*archai*). Some of these are common axioms, shared by all sciences; some are axioms that are proper to the science in question. Axioms cannot be deduced from anything more basic.

2. ***Archai***

   a. *Archai* are **first principles**, things that "cannot be otherwise." Aristotle sets out some characteristics of *archai* at $71^{b}19$-25:

      1. **true**
      2. **primary** (primitive, *prôton*)
      3. **immediate** (unmediated, *amesos*)
      4. **better known** (more familiar) [than what we derive from them]
      5. **prior** [to what we derive from them]
      6. **explanatory** [of what we derive from them] "causes" = *aitia*

   b. Comments on these characteristics.

      1. **True**: This is obvious; what is necessary ("cannot be otherwise") is, *a fortiori*, true.
      2. **Primitive**: a principle is primitive iff there is no prior principle from which it can be derived.

3. **Immediate**: a connection (between terms) is immediate iff there is no middle term that explains their connection.

   These are equivalent conditions, given Aristotle's conceptions of proof and explanation. The proposition to be proved is of subject-predicate form; a proof is a deduction from principles; a deduction requires a middle term linking subject to predicate. So conditions (2) and (3) amount to the same thing.

4. **Better Known**

5. **Prior**

   It is crucial to note Aristotle's distinction (71b32) between two senses in which one thing can be *better known than* or *prior to* another:

   - Better known (or prior) "in itself" ("by nature"). It is universals, which are "further from perception," that are better known or prior in themselves.

   - Better known (or prior) "to us." It is particulars, which are "closer to perception," that are better known or prior to us.

6. **Explanatory**: Apart from a somewhat perfunctory discussion in II.11 (not in *Selections*) Aristotle does not tell us much in *An. Pst.* about what *aitiai* (i.e., causes, explanations) are. He says more in the *Physics*, which we'll turn to later.

c. **Propositions or Concepts?**

It is not always clear whether Aristotle has **basic propositions** (i.e., a class of necessary truths) or **primitive concepts** in mind by *archai*.

But even if he sometimes thinks of *archai* as concepts, it is the **definitions** of those concepts that will ultimately figure in demonstrations. So for our purposes we can think of the *archai* as basic propositions—axioms. (More about *archai* and how we know them can be found below under "*Nous* and First Principles.")

3. **Scientific Proof and Truth**

A science is thus a deductive system. The truths of a science are the **theorems** of such a system—the propositions that we can deduce from the *archai* by means of syllogistic reasoning.

Scientific proof or demonstration (*apodeixis*): deriving a conclusion syllogistically from more basic truths (i.e., ones closer to the *archai*).

4. Explanation and Demonstration

Explanation is a mirror-image of demonstration. To explain why it is the case that *p* is to deduce *p* from more basic principles.

Cf. Hempelian "covering law" model of explanation: to explain something is to subsume it under a general law.

The differences: the Hempelian *explanandum* is an **event**, the Aristotelian *explanandum* is a **fact**. On the covering law model, to explain an event, *E*, is to find a law, *L*, such that from *L* + the initial conditions, *I*, one can deduce the occurrence of *E*.

5. The Connecting Term Model

Aristotle's "Connecting Term" (CT) model of explanation has the following features:

a. A fact is explained by being derived in a given science from the first principles of that science.

b. First principles are necessary truths.

c. Hence what is explained (an *explanandum*) must also be a necessary truth.

d. An *explanandum* has a subject-predicate form: *A* belongs to *C*.

e. An explanation is a way of **connecting** *A* to *C* by means of a middle term that belongs necessarily to *C*.

f. Thus, we can explain why *necessarily*, *every C is A* by finding a middle term, *B*, such that:

$$\Box\, A\boldsymbol{a}B \;\&\; \Box\, B\boldsymbol{a}C$$

Example: Why are whales (*C*) warm-blooded (*A*)? Because: necessarily, mammals (*B*) are warm-blooded, and necessarily, whales are mammals.

7. Some illustrative passages:

I.6, 74^{b}5: "We have found that demonstrative knowledge$_e$ is derived from necessary principles (since what is known cannot be otherwise) and that what belongs to things in their own right is necessary …."

I.4, 73^{a}23: "Since what is known$_e$ without qualification cannot be otherwise, what is known by demonstrative knowledge will be necessary."

I.22, 84^{a}36-37: "… we demonstrate by inserting a term <between two terms>, not by adding another <from outside> …."

I.6, 75a5: “… whenever the middle is necessary, the conclusion will also be necessary, just as truths always result in truth. (For let A be said of B necessarily, and B of C <necessarily>; it is also necessary, then, for A to belong to C <necessarily>.)”

I.6, 75a13: “Since what we know demonstratively must belong necessarily, it is clear that we must demonstrate through a middle that is necessary.”

II.3, 90a35: “It is clear that all questions are a search for a middle.” (not in *Selections*)

8. Problems with the Connecting Term Model

a. Notice the importance of the **necessity** operator in CT. Without it, it would be easy to think of counter-examples to the CT model.

   Suppose we see a bus full of Husky basketball players, and we want to explain why they are all tall. Since we have this syllogism:

   All the Husky basketball players are on the bus.
   Everyone on the bus is tall.
   Therefore, all the Husky basketball players are tall.

   Obviously, their being on the bus does not explain why they are tall.

b. So we must rule out **accidental** connections. But Aristotle’s requirements for CT do this, since he requires that the middle term be **necessary** (i.e., necessarily connected to both of the extremes).

c. But it is still possible to have necessary connections that are irrelevant. Cf. geometry: a triangle’s being *equiangular* does not explain why it is *equilateral*, even though, necessarily, all equiangular triangles are equilateral.

9. Explanations and Necessity

As we have seen above (§5) an *explanandum* in an Aristotelian science is a **necessary truth**. That is, we can prove that *C* belongs to *A* only if *C* belongs **necessarily** to *A*.

The reason: since the *archai* are all necessary truths (axioms and definitions), anything we deduce from them will also be a necessary truth. The facts that get explained in an Aristotelian explanation are not contingent facts.

Similarly, as Aristotle points out, the middle term that explains why a predicate attaches to a subject must also attach **necessarily** to the subject. *B* explains the fact that *C* belongs to *A* only if *B* belongs necessarily to *A*.

10. **Things that cannot be explained**

An important feature of the “connecting term” model of explanation: it holds that **some things cannot be explained** (i.e., demonstrated):

a. **First principles**: there is nothing prior to them from which they can be derived.

b. **Immediate connections**:. if $\Box A(C)$ and there is no middle term connecting A to C—i.e., a (distinct term) B such that $\Box A(B)$ & $\Box B(C)$—then it can’t be demonstrated that $A(C)$. Cf. I.15 and I.22 (and I.19-21, chapters not included in *Selections*).

Aristotle insists on indemonstrable first principles because he feels that without them, he has only three alternatives:

1) infinitely long explanations
2) circular reasoning
3) skepticism

These are all unacceptable. But the argument for skepticism seems powerful. How can you know anything at all? If to know something is to be able to prove it (the “knowledge requires proof” assumption), and to prove it is to be able to deduce it from something that you know (the “proof requires deducibility” assumption), this seems to yield the result that you can’t know anything. The argument Aristotle sets out at 72^b7-14 can be put something like this:

1.	You know something only if you can prove it.	Assumption
2.	To prove something is to deduce it from something else that you know.	Assumption
3.	Suppose you know something, viz., that p_1.	Assumption
4.	Then you can prove that p_1.	3, 1
5.	So you can deduce p_1 from something else that you know, say p_2.	4, 2
6.	Then you can prove p_2, etc.	5, 1
7.	If there are no first principles, then the proof of p_1 is infinitely long.	1 – 6
8.	But no proof is infinitely long.	Assumption
9.	So there is some first principle p_n such that we prove p_1 by deducing it from from p_n but we cannot prove p_n.	8, 7
10.	So we do not know that p_n.	9, 1

11. So we cannot prove p_1. 10, 2

12. So we do not know that p_1. 11, 1

(12) contradicts (3). So there is no knowledge.

Aristotle accepts assumption (8):

> Cf. 72b10: “it is impossible to go through an infinite series.” Indeed, Aristotle argues at length in I.19-22 that explanations cannot be infinitely long.

But there may still be a way out of the argument. One might reject (7) by claiming that it does not follow from (1) – (6). That is, one might hold that there are no first principles but our proof of p_1 still comes to an end.

How would this be possible? If the premise p_n from which our proof begins is itself something that can be proved. In that case we could know that p_n and our alleged non-knowledge of p_n would not infect all of its consequences.

But from what would we deduce p_n? The only possibility seems to be: something else that we can also prove. That is, we must allow **circular reasoning**.

So Aristotle addresses this response at 72b25: if circular reasoning is acceptable, then something will have to be **prior to and more familiar than itself**, which is impossible.

So Aristotle’s response to the skeptical argument must be to reject one of the other two assumptions:

1. You know something only if you can prove it. (“knowledge requires proof”)

2. To prove something is to deduce it from something else that you know. (“proof requires deducibility”)

Aristotle gives his solution at 72b19:

> We reply that not all knowledge is demonstrative, and in fact knowledge of the immediate premises is indemonstrable. Indeed, it is evident that this must be so.

That is, Aristotle accepts (2) (“proof requires deducibility”) but rejects (1) (“knowledge requires proof”). He thinks that first principles can be known, but not proven. This leaves him with the problem of explaining what this kind of knowledge is; not all knowledge can consist in deducibility from **other** knowledge.

[The beginnings of foundationalism in epistemology.]

11. **Demonstrations and Causes**

We know that every **demonstration** (*apodeixis*) is syllogism whose premises (and conclusion) are necessary. But not every such syllogism is a demonstration. In order for a syllogism to be a demonstration (*apodeixis*), the middle term must be **explanatory**—in Aristotle's terms, it must be an *aition*—a cause or explanation.

(Cf. 85b22 [not in *Selections*]: "A demonstration is a deduction that reveals (lit., 'shows', *deiktikos*) the explanation.")

That is, the middle term must **explain** the connection between the two terms it connects; it must provide not merely the "that" but the "why". Aristotle sets this out in I.13, an important chapter. (This chapter is not included in *Selections*. You will find a copy under *Readings* on the course web site.)

> 78a22: "Understanding the fact and the reason why differ." (This is better than the older Mure translation: "Knowledge of the fact differs from knowledge of the reasoned fact.")

Aristotle means to distinguish between knowing **that** something is the case (*hoti*) from knowing **why** something is the case (*dioti*). The idea is that you may be able to establish syllogistically that something is the case without being able to explain why it is the case. Aristotle's example makes clear what he means:

Why do the planets not twinkle? Because they are near. Near is a middle term that provides the why—it explains why the planets don't twinkle. For Aristotle, this takes the form of a syllogism:

Every planet is near.
Everything near is a non-twinkler.
Therefore, every planet is a non-twinkler.

[Note how Aristotle chooses the values for *A*, *B*, and *C* in such a way that the syllogism is *Barbara*—his favorite syllogism.]

But this is also a valid syllogism:

Every planet is a non-twinkler.
Every non-twinkler is near.
Therefore, every planet is near.

Here, the middle term is **non-twinkler**. But although the syllogism proves that the planets are near, it does not explain **why** the planets are near. The reason is that being near is a cause of non-twinkling, whereas non-twinkling is not a cause of being near.

This leaves open the question of what makes a middle term explanatory, which Aristotle does not answer here.

Another idea that Aristotle develops in this chapter is that, to be explanatory, the middle term must not be "**positioned outside**." What does he mean?

His example: you can't explain why a wall doesn't breathe by saying that it's not an animal. His reason is that this explanation would work only if you can explain why something **does** breathe by saying that it **is** an animal. But clearly you can't do this, since not all animals breathe.

The syllogism that Aristotle says is not explanatory is this second figure syllogism (*Camestres*):

Everything that breathes is an animal	$A\boldsymbol{a}B$
No wall is an animal	$\underline{A\boldsymbol{e}W}$
Therefore, no wall breathes	$\therefore B\boldsymbol{e}W$

This is, as we know, valid; but Aristotle claims it is not an explanation of why walls don't breathe. The reason he gives is that the middle term is "positioned outside." This means that the middle term (A) has a **wider** extension than the major term (B). That is to say, everything that breathes is an animal, but not every animal breathes.

Aristotle insists that the correct explanation why a wall doesn't breathe has to be one that would explain why **any** non-breather doesn't breathe. And the explanation that Aristotle criticizes could not explain why **snails**, e.g., don't breathe.

The correct explanation (although Aristotle doesn't say so) might be that walls don't breathe because they don't have lungs. The relevant syllogism would be:

Everything that breathes has lungs	$L\boldsymbol{a}B$
No wall has lungs	$\underline{L\boldsymbol{e}W}$
Therefore, no wall breathes	$\therefore B\boldsymbol{e}W$

Now we have an explanation that explains the non-breathing of **any** non-breather. The correct positioning of the middle (explanatory) term L seems to require that it not have a wider extension than the major term B (the predicate of the *explanandum*).

That is, Aristotle is insisting that the major and middle terms be **coextensive**. An adequate CT explanation must give both **necessary** and **sufficient** conditions:

> To explain the fact that C belongs to A, we need a connecting term, B, such that B's belonging to A is **both necessary and sufficient** for C's belonging to A:

$\forall x\, \Box\, (C \text{ belongs to } x \leftrightarrow B \text{ belongs to } x)$

[Thus, *animal* provides only a necessary, but not a sufficient condition, for *breathing*.]

This leads to the doctrine (often attributed to Aristotle) of the "commensurate universal":

> The universal, *B*, that connects the predicate *C* to the subject *A* in an explanatory way must be co-extensive with *C*.

[Note that our example satisfies this condition: the terms *lungless* and *non-breather* are co-extensive.]

12. Questions about the CT Model

Here are some important questions about the "connecting term" model of explanation.

1. What is non-demonstrative knowledge, and how do we acquire it? How do we come to know first principles or immediate connections?
2. How does this view of a science as an axiomatic system square with real science, as it's actually practiced?
3. How do we know when the middle term in a syllogism states the *why* and not merely the *that*? How do we know, that is to say, when a syllogism is demonstrative, i.e., explains something?

Of these three questions:

(1) Aristotle explicitly considers this, and tries (II.19) to give an account of how we arrive at first principles. [We will look at this later.]

(2) This may seem like the hardest question, but Aristotle is defensible here if we understand him correctly.

(3) This question goes deep; it centers on a tension in Aristotle's thought in *APst.* and is reflected in his subsequent attempts to deal with "why" questions.

Re (2): Aristotle's view of a science seems wildly off:

a. Science is **empirical**; Aristotle's version is *a priori*.

b. Science explains **contingent** facts; in Aristotelian science, all propositions are necessary.

c. Science is **inductive**; Aristotelian science is deductive. That is, in "real" science, we begin with observations and work toward general principles. Aristotelian science seems to go the other way round.

d. What's more, when Aristotle is actually doing science (e.g., in the *Physics*, or *De Caelo*), as opposed to philosophizing about it, he doesn't proceed in the deductive manner that is prescribed in *APst.*

But these discrepancies can be minimized by the following considerations:

- The workshop vs. the showroom: The picture in *APst.* is not of the discovery of scientific knowledge, but of its orderly presentation. As Jonathan Barnes puts it, "*apodeixis* was never intended as a research technique." Rather, it is a way of showing, with respect to a completed science (or at least a large mass of collected scientific data) how it all hangs together.

- Since Aristotle is not seeking to explain particular **events**, his ruling out contingency is less objectionable than it seems. Aristotle seeks to explain **regularities**, i.e., things that happen "always or for the most part," as he puts it. Since Aristotle links necessity with universality (i.e., what's necessary is what always happens) his commitment to the necessity of the conclusion of a scientific syllogism is less bizarre than it seems at first.

Re (3): When does a middle term give the "why" (and so yield a demonstrative syllogism) and not merely the "that"?

The problem Aristotle faces is that not every middle term truly and necessarily interposible between an attribute, *C*, and a subject, *A*, **explains** why *C* belongs to *A*.

There may be a sequence of "middle" terms:

$$\langle B_1, B_2, B_3, \ldots, B_k \rangle$$

every one of which necessarily links *C* to *A*. I.e., for every one of the *B*'s there is a (valid) syllogism with necessary premises:

$$\mathrm{C}\boldsymbol{a}\mathrm{B}_i \text{ and } \mathrm{B}_i\boldsymbol{a}\mathrm{A}, \text{ so } \mathrm{C}\boldsymbol{a}\mathrm{A}.$$

But only **one** of these is, presumably, **the** explanation of *C*'s belonging to *A*. Aristotle seems to want (although he doesn't make this very clear or explicit) to maintain a uniqueness thesis about causes:

If there is a cause of $C*A$, there is a **unique** cause of $C*A$.

And only the unique B that is the cause can explain **why** C belongs to A—the others can only be used to show **that** it does.

Aristotle makes some suggestions about how to find the right middle, B:

1) It must be the "first subject" to which C belongs (73^b33)

2) Whatever C belongs to, it belongs to *qua B* (i.e., in so far as it is B).

Gloss:

1) "First subject": B is the first subject to which C belongs (alt: C belongs "primitively" to B) iff C belongs to every B and there is no M (distinct from both B and C) such that necessarily, $C\boldsymbol{a}M$ and $M\boldsymbol{a}B$. That is, the connection between C and B must be **unmediated**.

   Example: being a 180º figure belongs primitively to triangle, but not to isosceles.

2) "Qua": C belongs to x qua B iff C belongs to x and it is only in so far as x is a B that C belongs to x. (I do not know how to put "only in so far as" into canonical notation.)

   Same example: suppose that x is an isosceles triangle. Then being a 180º figure belongs to x qua triangle, but not qua isosceles.

It seems to be a consequence of the uniqueness thesis, with its requirement that the **explanatory** middle is the term qua which the attribute belongs to the subject, that the explanatory middle and the predicate of the *explanandum* be **convertible**.

That is: if B is the explanatory middle linking C to A, then the proposition

$$\Box\ C\boldsymbol{a}B$$

is convertible. That is, the proposition:

$$\Box\ B\boldsymbol{a}C$$

will also be true. (This is the notorious doctrine of the "commensurate universal," for the terms B and C in this case are said to be commensurate universals. Commensurate universals are universals which are **necessarily coextensive**.)

13. **Problems with convertibility:**

If the statement linking the explanatory middle to the term of which it is predicated in the *explanandum* is convertible, then it will become difficult to establish which of the two commensurate universals is the **cause**. For consider the following two syllogisms:

(I) $\Box C\boldsymbol{a}B$ & $\Box B\boldsymbol{a}A$, so $\Box C\boldsymbol{a}A$.

(II) $\Box B\boldsymbol{a}C$ & $\Box C\boldsymbol{a}A$, so $\Box B\boldsymbol{a}A$.

(I) is supposed to establish *B* as the cause of *C*'s belonging to *A*. But if *B* and *C* are necessarily co-extensive, it will be hard to show that (II) hasn't just as much right as (I) to be a demonstrative syllogism. That is, how will one show that *B* is the first subject to which *C* belongs, rather than the other way around? Why isn't *C* the first subject to which *B* belongs? After all, *B* belongs to every *C*, and there is no middle term between the two.

One might hope that the "qua" condition will help, but that is a very obscure notion. The idea would be this: *C* belongs to *x* qua *B*, but not the other way around. It is qua triangle that *x* is a 180º figure; it is not qua 180º figure that *x* is a triangle.

But why not? One wants to say that *triangle* and *180º figure* are different properties. But this raises a familiar can of worms: different properties can certainly be co-extensive (if it just happens that they apply to exactly the same instances), but how can they be **necessarily** co-extensive? It just happens that they **necessarily** have the same instances?

At any rate, Aristotle cannot avoid convertibility in at least some cases. One cannot hope to find a narrower term than *triangle* to cite as the cause of something's being a 180º figure. For all triangles are 180º figures.

And in the most important case of all, convertibility is crucial: that is, the case in which the explanatory proposition is a **definition**.

Consider the following example (Barnes, *Aristotle*, p. 34):

> Why do cows have horns? Because they are deficient in teeth (the matter that would have gone into teeth goes into horns, instead). Why are they deficient in teeth? Because they have four stomachs (and don't need to chew their food). Why do they have four stomachs? Because they are ruminants (they chew their cud). Why are they ruminants? Because they are cows—"there is no further feature, apart from their being cows, which explains why cows are ruminants; the cause of a cow's being a ruminant is just its being a cow."

That is, at some point, a question of the form "Why does *C* belong to *A*?" will be answered by appealing to a middle term, *B*, that is the definition of *A*. (When one then asks, "But why does *B* belong to *A*?" the answer is: "That's what *A* is." This is what Hintikka ("Ingredients … " p. 59) calls a "discussion stopper.")

In our example, *ruminant* is only **part** of the definition of a cow; but if one were to give the full definition, it would be convertible with the term it's a definition of. Definitions are the first principles at which explanatory chains end; so every explanatory chain is going to feature a commensurate universal.

Aristotelian Definitions

1. **Discussion Stoppers**

   How can Aristotle make definitions play such a crucial role in a science? How can definitions be discussion stoppers? Doesn't this make science *a priori*? Doesn't it reduce scientific questions to **verbal** ones? Are substantive scientific questions really, on Aristotle's account, questions of **meaning**?

   No, Aristotle has not reduced science to lexicography.

   a. An Aristotelian definition is not merely verbal. The *definiendum* is not a linguistic item, not a word or a name, but some extralinguistic reality. (Aristotle makes it sound linguistic when he calls the *definiendum* a **term** (*horos*)—but terms are extra-linguistic.)

   b. A definition is a formula which states the **essence** of something (cf. *Top*. 101^b38). And this is (in Locke's terminology) a "real" essence, not a "nominal" essence. The essence of something is independent of language and thought.

   c. Definitions are discovered, not stipulated. So science doesn't become *a priori*.

2. **Some Texts**

   So, one cannot do science armed with nothing but a dictionary. Understanding what Aristotle means by "definition" will help us as we examine his treatment of the topic of definitions in *APst*. II. We'll start with chapters 1 - 2.

   APst. II.1-2:

   Aristotle lists four questions we can ask, corresponding to four kinds of things we can know:

1) the "that"	(*hoti*)
2) the "why"	(*dioti*)
3) whether it is	(*ei esti*)
4) what it is	(*ti esti*)

Presumably, these are questions that can be asked about a subject: i.e., a kind, a species—something that would show up as a term in a syllogism:

1a) Is it the case that *S* is *P*?
2a) Why does *P* belong to *S*?
3a) Are there *S*'s (= does *S* exist?)
4a) What is *S*?

Aristotle gives these examples:

1b) Is the sun eclipsed?
2b) Why is the sun eclipsed?
3b) Do centaurs exist? Is there a god?
4b) What is a god? What is man?

Aristotle clearly thinks that our even asking question (2) presupposes that we have an affirmative answer to question (1). Likewise for the second pair: asking (4) presupposes an affirmative answer to (3).

In the case of the first pair [(1) and (2)], this seems obviously correct: there can be no **explanation** of solar eclipses unless there **are** solar eclipses; in general, there can be no reason why *S* is *P* unless *S* is *P*.

But the case of (3) and (4) seems quite different: surely one can ask what some kind is without knowing whether there are any things of that kind. Consider the following questions:

4c) What is electromagnetism?
4d) What is a dodo?
4e) What is a unicorn?
4f) What is self-deception?

Here one might say not only that these questions can be answered without first answering their corresponding type-(3) existence questions, but that the dependence is the other way around. That is, it seems plausible to insist that none of the questions:

3c) Does electromagnetism exist?
3d) Are there dodos?

3e) Do unicorns exist?
3f) Is there such a thing as self-deception?

can even be meaningfully raised unless some prior answer to its corresponding type-(4) "what is it" question has been provided. [Cf. Socrates on the primacy of the "what is it?" question.] For example, how can one even try to determine whether there is such a thing as self-deception unless one has been told **what it is** that he has been asked to determine the existence of?

In a way, this is right—but what it shows is that Aristotle's "what is it?" question is not the one that gets presupposed by existence questions. The "what is it?" question that does get presupposed is a request for a nominal definition, that is, a question that has the force of:

what do you mean by " … "?

If I suggest to you that you should go out and try to determine whether snarks exist, you have every right to complain that you cannot reasonably be expected even to try to answer unless you have been told what a snark is, i.e., what I **mean** by "snark".

3. Definitions and Essences

Aristotle's "what is it?" question is not a request for the meaning of a name or word. This is what he says at 92^b26-32 (not included in *Selections*):

Quote: ". . . if a definition has nothing at all to do with what a thing is, it will be an account signifying the same as a name. But that is absurd. For, first, there would be definitions even of non-substances, and of things that are not—for one can signify even things that are not. Again, all accounts would be definitions; for one could posit a name for any account whatever, so that we would all talk definitions and the *Iliad* would be a definition."

Gloss: if a definition involves nothing more than one word abbreviating a longer string of words (the longer string providing the definition of the other), then we could have definitions of things that don't even exist; indeed, any string of words could be considered a definition.

The definitions Aristotle is talking about are not merely formulas that we arbitrarily and stipulatively attach to linguistic expressions ("names"). His "what is it?" question is not one of the **meaning** of an **expression** in a language but about the **nature** or **essence** of something.

A **definition**, then, is a **formula that states the essence** of something (*Top.* I.5, 101^b38) and is given **by genus and differentia** (*Top.* VI.4, 141^b26). E.g., "man is a rational animal."

One term (“man”) is the *definiendum*; the other term (“rational animal”) is the *definiens*. The *definiendum* term denotes some natural kind, or species (in this case, humankind): a universal. The *definiens* denotes the **essence** of that kind.

A diagram may help:

Language:	*definiendum*: ‘horse’	*definiens*: the formula defining ‘horse’
	↓ denotes	↓ denotes
The World:	*definiendum*: the (universal) species, *horse*	the essence of horse; what-it-is-to-be-a-horse

An essence is thus the ontological counterpart of the *definiens* in a definition. The terms in the *definiens* (the genus and differentia) are “in themselves” (i.e., without qualification) better known and prior to those in the *definiendum*, although the *definiendum* may be better known and prior “to us” (cf. *Top.* VI.4, 141^{a}26- ^{b}34).

4. **Essence and Necessity**

a. **Necessary properties**

A thing has a property necessarily iff it cannot exist without that property.

$$x \text{ has } \varphi \text{ necessarily } =_{df} x \text{ cannot exist without having } \varphi$$

If *x* is necessarily *F*, then if *x* were to cease to be *F*, *x* would cease to exist.

b. **Modal Essentialism**

A modal essentialist hold that that is all there is to the notion of essence. A thing’s essential properties are precisely the properties it has necessarily:

$$\varphi \text{ is an essential property of } x \leftrightarrow x \text{ has } \varphi \text{ necessarily}$$

To put it another way, a thing’s essential properties are just those that it cannot lose on pain of going out of existence. Most contemporary versions of **essentialism** are modal—they do not distinguish between necessary and essential properties.

c. **Aristotelian Essentialism**

Aristotle’s essentialism is more robust than modal essentialism. This is part and parcel of his view about the connection between definition and essence. For not every property that a thing has necessarily gets mentioned in its definition; hence, not every property that a thing has necessarily is part of its essence. For Aristotle:

$$\varphi \text{ is an essential property of } x \rightarrow x \text{ has } \varphi \text{ necessarily}$$

but **the converse does not hold**. Some of a thing's necessary properties are not part of its essence. Aristotle calls such necessary but non-essential properties *idia* (*propria*). Cf. *Topics* 102a18-30. E.g., what Aristotle calls "grammaticality" (language-using ability) is a property that a human being has necessarily, but not essentially. *Grammatical* does not enter into the definition of *human being*; rather, *rational* is part of the definition, and it is because humans are rational that they are language users. So rationality explains grammaticality, and it is because rationality is **explanatorily more basic** than grammaticality that it (rather than grammaticality) enters into the definition (and therefore the essence) of humans.

So Aristotelian essentialism has two components: necessity and explanatoriness:

φ is an essential property of $x \leftrightarrow$ (i) x has φ necessarily, and
(ii) φ is an explanatorily basic feature of x.

5. Nominal and Real Definitions

[See Robert Bolton, *Phil. Rev.* 1976, re *APst.* II.7-10]

Nominal definition: "an account of what a name or some other name-like account signifies" (93^b31).

Real definition: "an account revealing why something is" (93^b34).

But "signifies" (*sêmainei*) here does not mean "connotes" or "gives the sense of"; rather, it means "denotes" or "refers to". It is a word-thing, not a word-word, relation.

On this interpretation, Aristotle is not contrasting the (nominal) definitions of *words* with the (real) definitions of *things* (i.e., natural kinds in the world). Rather, both nominal and real definitions are of *things*.

The difference between them is this: whereas the *definiens* of a nominal definition only *signifies* (i.e., refers to, or picks out) an essence, the *definiens* of a real definition *displays* (i.e., reveals, or articulates) the essence:

> "Hence the first type of definition signifies but does not display, whereas the second type will clearly be a sort of demonstration of what something is . . ." (94^a1).

[Aristotle's word here translated "display" is *deiknunai*, lit. "show" and misleadingly translated by Fine & Irwin as "prove"—see their glossary entry on "prove".]

Some examples from Aristotle:

a. "Thunder is extinguishing of fire in a cloud" (93^b9). [Real definition]

b. "Thunder is a noise of fire being extinguished in the clouds" (94^a6).

c. "Thunder is some sort of noise in the clouds" (93^a23). [Nominal definition]

These correspond (in order) to the three sorts of definition Aristotle describes at 94^a10:

> "(a) One sort of definition, then, is an indemonstrable account of the what-it-is; (b) a second is a deduction of the what-it-is, differing in arrangement from a demonstration; and (c) a third is the conclusion of a demonstration of the what-it-is."

The idea is this: the nominal definition of thunder is *a certain kind of noise in the clouds*. This does not just give us the meaning of the word 'thunder', which would still leave us with the question whether there *is* such a thing as thunder. Rather, we begin by observing a certain familiar kind of noise, and we apply the name 'thunder' to that. So thunder exists. The question remains: what is thunder? We cannot answer this question by repeating the nominal definition. For what we want to know is: what is the real nature of that noise we call 'thunder'? For Aristotle, the question amounts to this: what is the explanation of the noise? I.e., the question "what is (the real definition of) thunder?" amounts to this: "what is the cause of *x*?" (where we replace '*x*' with the *definiens* of the nominal definition of thunder).

According to the meteorological theory Aristotle accepts, the noise in the clouds is caused by the extinguishing of fire in the clouds. So that is the real nature of thunder, and the correct answer to **both** the questions "What is thunder?" and "Why does it thunder?"

Now we can see why nominal definitions are the conclusions of demonstrations (cf. 94^a13): The major premise of a demonstration will be a real definition of a natural kind, e.g., "Thunder is the extinguishing of fire in the clouds." The minor premise will link the *definiens* of the real definition to the *definiens* of the nominal definition, e.g., "the extinguishing of fire in a cloud is (produces?) a certain kind of noise." The conclusion is the nominal definition of the kind in question, e.g., "Thunder is some sort of noise in the clouds."

The upshot is this: we identify the kinds we want to investigate, and whose natures we wish to discover, by their observable characteristics. We then try to discover their essences, i.e., the non-manifest (perhaps unobservable) causes of those observable characteristics. (How we do this is not clear in Aristotle's account.) Presumably, an adequacy condition on the real definitions we arrive at as first principles is that they should yield our observations (i.e., our nominal definitions) as deductive consequences.

To put it another (albeit somewhat anachronistic) way: the real definition of a natural kind is the best explanation of the presence of the observable features of that kind. We arrive at a real definition not as the conclusion of a deductive inference (demonstration), but as an **inference to the best explanation**.

6. Essence and Existence

As the passage at $92^{b}26$-32 makes clear, Aristotle makes the following claim about essences:

Only what exists has an essence or nature.

[Existentialists like to say that their view that existence precedes essence is a reversal of the essentialist's notion that essence precedes existence. In passages like this, Aristotle sounds more like an existentialist.]

This means that we can inquire into the nature of tigers (and ask Aristotle's question "What is a tiger?")—because there **are** tigers whose nature can be studied. What about dodos? There are no dodos (any more)—does that mean that there is no such thing as the nature or essence of a dodo, and that we can't raise the question "What is a dodo?" I think not. There are **no longer** any dodos—the species is extinct—but at least there **have been** dodos. So if we take "exists" to mean "now exists or has existed," we can allow for inquiry into the essence of dodos.

But how can one study the nature of unicorns if there are none and never have been any? Clearly, this is the sort of case Aristotle means to rule out. For the centaur—a mythical beast, not an extinct one—occurs in Aristotle's examples of type-(3) existence questions, but does not turn up in the corresponding type-(4) essence question. One can ask whether there are centaurs, but when one gets a negative answer, one is blocked from going on to ask what a centaur is, in Aristotle's favored sense of that question.

The biologist can tell you what a tiger is, or what a dodo is, but he can't tell you what a unicorn is. Cf. $92^{b}4$-8 (not in *Selections*):

> "Anyone who knows what a man or anything else is must know too *that* it is (for of that which is not, no one knows what it is—you may know what the account or the name signifies when I say goatstag, but it is impossible to know what a goatstag is)."

> (Cf. Kripke, *Naming and Necessity*, pp. 24, 156-7.)

So it's not as if essences are conceptual roadblocks to scientific investigation. Rather, knowledge of essences is what should emerge from a scientific investigation:

> It is the business of a science to discover the essence of the (natural) kinds of things that actually exist.

On this account, Aristotle is **not** making science an *a priori* enterprise when he characterizes it as a search for essence, culminating in definitions. Rather, he is making questions about definition and essence depend on facts that are independent of us (as conceptualizers), that is, upon the way things **actually** are. This is not to make science *a priori*, but to make essence and definition (in a way) empirical—things to be discovered, not stipulated.

7. **Objections to Aristotelian essences**

According to Aristotle, a thing's essence belongs to it **of necessity**, and yet it is the job of a science to discover essences. To this it may well be objected that the way things actually are is a **contingent** matter. But Aristotle treats the truths of a science as necessary—they "cannot be otherwise." So how does this square with the account above, according to which the discovery of essence is an empirical matter?"

In making the discovery of necessary truths an empirical matter, Aristotle is certainly far from the tradition of logical empiricism, according to which necessity is a matter of convention and stipulation. But it is in just this respect that he is most up-to-date. Recently Kripke has given a brilliant (and basically Aristotelian) account along just these lines. A scientific study may be empirical—*a posteriori*—although the truths it discovers may be "necessary in the highest degree." (Cf. his *Naming and Necessity*.) And Putnam's ideas about the meaning of natural kind terms (they aren't "in the head" but out in the world, determined not by the qualitative properties we use to identify instances but by the actual characteristics of their stereotypes) are similarly Aristotelian in character.

What Aristotle actually provides us by way of a procedure for discovering essences is terribly abstract. On the one hand, there is the discussion of the discovery of *archai* in II.19 (and definitions are *archai*). But much of the earlier part of book II concerns the discovery of definitions. II.13 gives a general characterization of the procedure:

He assumes that what is being defined is a species, S, and that we already know what its genus, G, is. We are to discover a list of attributes,

$$A_1, A_2, A_3,\ldots.$$

each of which

(i) is included within the genus (i.e., belongs exclusively to things in that genus), and

(ii) belongs to every member of S.

The definition of S is the conjunction of such A's:

$$A_1 \;\&\; A_2 \;\&\; A_3 \;\&\; \ldots.$$

He gives the following example: we give the definition of "triplet" by stating its genus (number), and listing its attributes: odd, prime (in the sense of not being divisible by 2), and prime (in the less familiar sense of not being the sum of any two numbers).

> [Why is 3 prime in this sense? For 3 = 2 + 1. Answer: For Aristotle, 1 is not a number.]

Aristotle concludes: "this, then, is precisely what a triplet is: a number that is odd, prime, and prime in *this* way."

This conjunction of attributes ("odd, prime, and prime in *this* way"), is what Aristotle elsewhere calls a *differentia*. The entire definition ("a triplet is a number that is odd, prime, and prime in *this* way") clearly constitutes a classic Aristotelian definition *per genus et differentiam*.

The mathematical example makes the method seem non-empirical, but I think that is misleading. Aristotle spends the remainder of the chapter arguing against Plato's "method of division" (an *a priori* method) as a way of arriving at definitions.

Instead of working our way **down** from universals (as in Plato's method) Aristotle proposes to work our way **up** from particulars.

Nous and First Principles

1. **Features of First Principles**

   Recall the characteristics of first principles (*archai*) that Aristotle sets out in *An. Pst*. I.2. First principles must be:

   a. true
   b. primary (primitive)
   c. immediate
   d. better known ("in themselves," although not "to us")
   e. prior ("in themselves," although not "to us")
   f. explanatory

2. As we saw when we examined these characteristics earlier, they require that first principles be **non-demonstrable**; they cannot be proved.

3. **Knowledge of First Principles**

   But (d) requires that these principles must be **knowable**, in some sense. Therefore there must be a kind of knowledge that does not consist in demonstration.

   Aristotle's term for demonstrative knowledge is *epistêmê*. So we must have a "familiarity" or acquaintance with or apprehension of first principles that is not *epistêmê*.

   This raises two questions:

   i. How do first principles become "familiar"? I.e., how do we **acquire** first principles?

   ii. What "state" (*hexis*) is it that grasps or apprehends first principles? (It can't be *epistêmê*, so what is it?)

   Aristotle deals with these two questions in the notoriously difficult final chapter of *An. Pst.*, II.19. He first raises them at 99b18. The first part of II.19 deals with (i)—the problem of acquisition; the last part of the chapter (100b5ff) identifies the mental state involved in it.

4. **Difficulties in *An. Pst.* II.19**

   There are a number of difficulties in II.19. They include:

a. Is his account coherent? It seems to contain seeds of both empiricism (induction) and rationalism (intuition). How do these fit together?

b. Are the *archai* Aristotle is discussing basic propositions or basic concepts?

c. What does he mean by *nous* (the faculty or state that grasps first principles).

d. What happens to the distinction he makes in the beginning of *An. Pst.* between what is more knowable **to us** and what is more knowable **in nature** (or in itself)?

   Why doesn't it turn up in II.19, where it might be put to some use? Other references to this:

   An. Pst. I.2, 71b34-72a5; *An. Pr.* 68b35-7; *Phys*. A.1; *Metaph*. Z.3, 1029b3-12; *Top*. Z.4, 141b3-142a12

5. **Answer to question (4a): the coherence of Aristotle's account**

There is nothing rationalistic about II.19's account of the acquisition of first principles. Our knowledge of first principles is not demonstrative (i.e., it is not **deduced** from other knowledge), but it is not innate either. Nor is it gained by a direct mental grasping of something that is self-evident. Rather, we move from individual cases, beginning with perception, to a grasp of the universal, by means of a process Aristotle calls *epagôgê*. This is usually translated as **induction**, although not every interpreter thinks that what he has in mind is what we understand as inductive inference. Still, the process he describes can be made to fit a standard pattern of inductive inference, although in places the fit is not quite right.

(If there is anything rationalistic involved, it would be in the role of *nous*, which we will discuss later.)

This is a four-stage process, as Aristotle describes it. (Compare his similar description in *Metaph.* A.1.)

1. perception
2. memory
3. experience
4. knowledge

This is the way, Aristotle says, that **universals** come to be in the mind. But what are these universals? ***A*** and ***E*** **propositions**? Or universal **concepts**? This brings us to our next question.

6. **Answer to question (4b): Concepts or Propositions?**

Aristotle seems to be indifferent to the question of whether he is describing the acquisition of basic **concepts** or basic **propositions**. And this is not surprising, for we can look at the matter either way. Here's what his story would look like on the two understandings (following Barnes, pp. 259-60).

a. **Propositional knowledge**:

1. You see that this swan is white. [Perception: seeing that $W(s_1)$]

2. You remember that this swan is white. [Memory: remembering that $W(s_1)$]

   This process is repeated for other swans: seeing that $W(s_2)$, that $W(s_3)$, etc., remembering that $W(s_2)$, that $W(s_3)$, etc., until

3. You grasp that: this swan is white, and that swan is white, and the other swan is white, etc. [Experience: remembering that ($W(s_1)$ & $W(s_2)$ & $W(s_3)$)

   I.e., you grasp that all the swans you have ever seen (i.e., in your experience) have been white. [Experience: grasping that *W**a**S-seen-by-me*]

4. You "understand" (i.e., have *nous* that) all swans are white. [*Nous*: grasping that *W**a**S*]

   This is not demonstrative knowledge, of course, since you have not **proved** that all swans are white.

b. **Concept acquisition**:

1. You see a swan. [Perception: seeing swan s_1]

2. You retain a memory image of the swan. [Memory: remembering swan s_1]

   This process is repeated for other swans:

   seeing swan s_2, seeing swan s_3, … remembering swan s_2, remembering swan s_3, … until

3. You grasp (simultaneously) many such memory images of swans. [Experience: you remember (swan s_1, swan s_2, swan s_3, … etc.)]

4. You acquire the concept of a swan. [*Nous* of (the universal) *Swan*]

Aristotle might well have thought that there are no important differences between these two accounts. For the concept of a swan that you grasp, according to (b), just consists in the **definition** of a swan. In some sense, everything important there is to know about swans is contained in their definition. (If not there explicitly, it is deducible from the definition.) So Aristotle would be unlikely to distinguish sharply between concept acquisition, on the one hand, and propositional knowledge, on the other. To have a concept just **is** to grasp certain basic propositions.

So sequence (a) can be thought of as one part of sequence (b). That is, sequence (b) can be thought of a collection of sequences of the same type as (a). Having the concept of *X* is just knowing the various components of the definition of *X*.

7. Answer to question (4c): What is *nous*?

The state of mind that grasps these universals Aristotle calls *nous*. This is often translated "intuition"; and this leads to a problem. (This is part of the reason why Fine & Irwin translate *nous* as "understanding".)

How can an empirical, inductive process, proceeding from perception of individual cases to knowledge of universals, be carried out by a rationalistic faculty of intuition? This is a long-standing interpretative problem with II.19.

Barnes (*Aristotle's* ***Posterior Analytics***) suggests that there is no incompatibility if we take **induction** and *nous* to be answers to two different questions—viz., the ones Aristotle starts the chapter with.

i. How do first principles become "familiar"? I.e., how do we **acquire** first principles?

   Answer: by *epagôgê*, the (inductive?) process Aristotle describes.

ii. What "state" (*hexis*) is it that grasps or apprehends first principles? (It can't be *epistêmê*, so what is it?)

   Answer: *nous*.

Trouble arises only if one supposes that *nous* is the **faculty** that we use in acquiring knowledge of first principles. According to Barnes, *nous* is, rather, the **state of mind** (an alternative to *epistêmê*) we come to be in when we grasp first principles.

Nous is not the method of acquiring knowledge of first principles; it is the kind of apprehension we get, a kind of understanding that is not demonstrative.

8. **Concepts and Definitions**

Whether we accept this or not, Aristotle's account of concept acquisition, for all its obscurities, fits in well with what he says earlier in *An. Pst.* II about definitions.

Aristotle's idea is that essence and definition are a matter of scientific discovery. And among the most important of the *archai* that will be grasped by *nous* as the result of induction are definitions.

Aristotle has already argued earlier in Book II (chs. 3-7) that definitions cannot be proved. II.19 now helps us to see how we can acquire them: inductively, by a study of particular cases. We arrive at a definition of (e.g.) **tiger** by examining individual tigers. This examination leads us (through memory and experience) to a grasp of the definition of **tiger**; an understanding of what it is to be a tiger.

This knowledge may come late in the process of discovery; but when we come to get out a finished (e.g., biological) science, the **definition** of **tiger** would be a first principle—a basis for our explanations of the various traits and features of tigers.

This account of understanding of first principles (as the result of induction) fits well with the idea of interpreting *APst* as describing the presentation of a completed science, not a scientific methodology.

> In the discovery mode, first principles come at the end: they are what we discover late in the process.
>
> In the presentation mode, we state the definitions (first principles) first; for they form the basis of the rest of what we know when we know that science.

9. **Grasping Universals**

The final statement of how we grasp universals (100^{a}15-^{b}6):

Questions about this passage:

a. What is an "undifferentiated thing" which makes a stand in the soul, and with which the process begins?

b. In what sense is this the "first universal" in the soul?

c. What sense are we to make of the military metaphor of "making a stand"?

d. What is it that "has no parts and is universal"?

e. What are the "first things" (^{b}5) which we come to know by induction?

Some answers:

a. The usual answer is *infimae species*, i.e., lowest level universals, such as *man*, *horse*, etc. (thus Ross, Fine & Irwin, Barnes). After all, Aristotle goes on to say that “this is the first universal in the soul”.

   But there are problems with this line. (1) The process is supposed to begin with a perception of a particular, so one would expect the first thing in the soul to be an awareness of a particular. (2) Aristotle describes a 2-stage process: (i) abstracting a lowest-level universal from particulars, and (ii) abstracting a higher-level universal from lower-level universals. If these two stages are symmetrical, each should begin at a lower level of abstraction than the one it ends up at. (I.e., just as we abstract *animal* from *man* and *horse*, so we should abstract *man* from Callias and Socrates.

   What happens if we take the “undifferentiated things” to be particulars? We take Aristotle to be saying this: when we are first aware of a particular, we do not differentiate it from others of its kind. In so doing, we are grasping its universality, not its particularity—we perceive it **as a thing of a kind** (although we do not have, as yet, a very good grasp of the kind).

   That is why Aristotle says that although we perceive particulars, perception is of the universal. We perceive Callias, but when Callias first appears in the soul, he does so **as a man**, that is, as a thing of a kind.

b. We have, in effect, answered our second question. The very first mental grasp of a particular (one of the “undifferentiated things”) is, *ipso facto*, a first-level grasp of a universal.

c. A military stand, as opposed to a rout, is **orderly**. If all we had was a confused collection of perceptions, we would have no grasp of anything universal. But when a number of perceptions “make a stand”, they are recognized as being of several things of the same kind. They can then yield a grasp of a universal, which Aristotle describes as a new “starting point”, i.e., a “principle”. (The word in Greek, *archê*, means both things.)

d. Presumably, a highest level universal—a category. If so, Aristotle is using this single kind of process to explain how we acquire all universals, from *man* to *animal* to *substance*.

e. The “first things” we come to know by induction are presumably the lowest-level universals—*infimae species*.

10. **Final comments**:

What Aristotle describes is a process that we have a capacity to undergo; it is not a method of discovery. As he says, “the soul’s nature gives it a potentiality to be affected in this way” (100^a14).

- How does someone who **lacks** the concept of *F* manage to perceive something as an *F*? If this can’t be done, how does one acquire the concept of *F*? Aristotle’s answer is that we abstract the concept from our perception of individual *F*’s. But his account of perception of individuals requires that we perceive them *qua universal*, i.e., “under a description.”
- How do we get from what is better known to us to what is better known in itself? When we abstract from what is (perceptually) common to all individual *F*’s, we reach (at best) parts of the nominal definition. But that does not get us to its explanation (i.e., the essence).