

24.200: Ancient Philosophy  
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## Aristotle on Science

### I. Scientific Knowledge

Scientific knowledge is unified and systematized. To have *scientific* knowledge of something is not just to know that it is so, but also to know *why* it is so. (E.g., I don't have scientific knowledge that water becomes steam when heated unless I know *why* it does.) To know why it is so, is to know the more general or basic facts which are the reasons for its being so; science aims to connect particular facts and events with these more basic and general facts. (E.g., we know why water becomes steam when heated when we connect that fact with the more basic facts about the chemical composition of water and the laws that concern heat.) So one may have knowledge of a particular matter of fact without having *scientific* knowledge of it, i.e., without a scientific explanation of it.

Aristotle believed that what is *scientifically* known is what is *demonstrable*, i.e., it must be the conclusion of a demonstration. A demonstration is a syllogism (or string of syllogisms) which is valid, the premises of which are necessarily true, and which is such that the premises are more knowable than and prior to the conclusion. A paradigm syllogism is a (valid) argument consisting of two premises and a conclusion, the premises and conclusion each having one of the following forms:

- A: All A's are B's.
- E: No A's are B's.
- I: Some A's are B's.
- O: Some A's are not B's.

For example:

- All kittens are cats.
- All cats are ANIMALS.
- All kittens are ANIMALS.

In this argument the premises and the conclusion are all of the form (A). The *major* term of a syllogism is the predicate of the conclusion (in the above argument 'ANIMALS'); the *minor* term is the subject of the conclusion ('*kittens*'); the *middle* term is the term that occurs in the premises and not in the conclusion ('cats').

We gain scientific knowledge of lunar eclipses once we know that there are occasions when the orbit of the moon places the earth between the moon and the sun; knowing this we know *why* eclipses happen, but note that knowing why the eclipse happens is also just knowing *what a lunar eclipse is*. In other words, knowing why eclipses happen is importantly related to knowing the real definition of an eclipse. This suggests that definitions play a crucial role in scientific knowledge.

We can connect the role of definition in scientific knowledge with scientific explanation in the following way. Note that there are demonstrations that don't yield scientific knowledge because they don't tell us "why", but only "that" something is so. For example, compare the following two demonstrations (see 93a37-b8):

- A.  
Occasions when an apparently unveiled full moon causes no shadows are lunar eclipses.

This is an occasion when an apparently unveiled full moon causes no shadows.  
Therefore, this is a lunar eclipse.

B.

Occasions when the earth screens the moon are lunar eclipses.

This is an occasion when the earth screens the moon.

Therefore, this is a lunar eclipse.

In both cases we have a demonstration of a fact that something is so, but only in (B) do we have a demonstration of *why* it is so. It is part of the nature of an eclipse that it occurs when the earth screens off the sun's light so that the moon cannot reflect the sunlight. So the cause or nature of an eclipse is given in the premise of the demonstration (B). In (A) the premises do not give the cause or explanation of the eclipse. The moon's failing to cause shadows may be the evidence for the occurrence of an eclipse, but in order to understand *what an eclipse is*, i.e., in order to give a scientific definition of an eclipse, we must understand it to be a screening of the sun's light by the earth. This definition is provided in (B) and not in (A).

The principles of Aristotelian science will only contain necessary and universal truths; it is by applying these general truths to the world that we explain particular individuals, events, and processes. If we can determine that a particular individual, event, or process is of a certain *kind*, scientific principles will enable us to offer demonstrations concerning objects of that kind. Note, however, that Aristotle allows that we *acquire* knowledge by means other than demonstration--e.g., we acquire knowledge in part by means of experience; and he allows that we *apply* knowledge by means other than demonstration. What he is claiming is that science earns its status as a systematic and unified body of knowledge because of its demonstrative structure.

The statement of a definition is a primary truth that is known, but not known by demonstration. It is clear that there must be some basic principles that are not known by demonstration but which serve as the ultimate premises in demonstration. If we gained *all* knowledge through demonstration, then every premise of a demonstration would have to be proven through a further demonstration resting on even more basic principles. (See, e.g., *Posterior Analytics* I: 3) But demonstration must stop somewhere. The primary truths serve as these stopping points. Definitions that serve as the primary truths will be known by some combination of observation with *nous*. *Nous* is an intellectual capacity for obtaining non-demonstrable knowledge; it is plausible to think that our ability to abstract from particular cases is due to *nous*. (See *Posterior Analytics* II: 19, esp. 100b7-13, and *Posterior Analytics* I:3. Note that the translation uses "understanding" as a translation for 'nous'; see fn. 22 p. 520.) So to know *what an eclipse is*, we must make careful observations, and use *nous* to come up with the real definition of an eclipse.

## II. Accidents

According to Aristotle, an event or state of affairs has a proper cause and can be explained only if it is the kind of thing that happens always or (at least) for the most part. More specifically, there is an Aristotelian AITIA, or "cause" of an event or state of affairs only if there is some general law of nature or some general principle which connects (always or for the most part) an AITIA of that kind with events or states of affairs of that kind.

For example, if the copper of which a statue is made (or, alternatively, the fact that the statue is made of copper) is the "cause" of the statue's being green, then there must be a general principle stating that copper (or things made of copper) always or usually turn green under ordinary

conditions. If this is not something that happens always or usually, then we cannot explain why the statue is green by pointing out that it is made of copper. (Suppose that the statue is made of clay which has been painted green. We cannot explain why the statue is green by pointing out that it is made of clay, for (among other things) clay is not always or usually green.)

If something cannot be subsumed under some principle which holds always or usually, then it is an "accident" or a coincidental state of affairs (e.g., it happened by chance), and it has no genuine explanation. Science studies and investigates the regularities in nature, and the body of science contains principles which are either always or usually the case. Since an accident is a kind of thing which does not happen always or usually, there is no science of the accidental (there is no science of what happens by chance), and there can be no scientific explanations of accidental states of affairs.

An example of an accident would be finding buried treasure when digging in the garden. Usually when one digs in the garden one finds dirt, plant roots, rocks, etc., but no buried treasure. Thus, if when digging in the garden you find a rock, that is no accident -- that is the kind of thing that usually happens. However, if you find treasure, that is an accident precisely because this is not the kind of thing that usually happens. Since it is an accident, it simply has no proper cause or explanation. Another example: suppose that I go to the marketplace to purchase eggplant for a meal. I meet one of my debtors and collect some money owed to me. According to Aristotle, my meeting of the debtor has no proper (scientific) cause or explanation because it cannot be subsumed under some principle which holds always or for the most part. One does not usually meet a debtor when going to the market to buy eggplant, thus the meeting is a coincidence.

Notice that in both examples there is something which does have a proper cause. In the first example, my digging in the garden is caused. Perhaps I want to plant a tree, and decide that the garden is the best place for the tree. If so, it is easy to explain why I was digging in the garden. However, my digging in the garden coincides with my finding the treasure, and it is the latter that simply cannot be explained. In the second example, my going to the market can easily be explained: I wanted to buy eggplant, and one typically finds eggplant at the market. Thus I went to the market. (Probably one can give an explanation of why my debtor went to the market too.) However, my going to the market coincides with my going to where my debtor is, and this latter state of affairs itself cannot be explained. Likewise, accidents in nature cannot be explained.