Philosophy of Science // Fall 2016

Handout 11

Explanation: Friedman, Mayr

Purposes of scientific explanation. Friedman begins by observing that the object of scientific explanation is usually regularities, rather than events. Also, a typical scientific explanation proceeds by relating the behaviour of problematic phenomena A to the behaviour of less problematic phenomena B. Friedman says that this is 'reduction'. But what kind of reduction is involved, e.g., in the explanation of steam: "The behaviour of water is reduced to the behaviour of molecules"?

Understanding. Explanation generates understanding. But we cannot in advance say how it is done. Available accounts of explanation yield unintuitive consequences about understanding. We can learn from their mistakes.

Prediction. Just because we expect a certain phenomenon need not entail that we understand why it happens. Observing the barometer's behaviour I may expect a storm to begin, but of course I do not understand why it will happen. Here notice that the D-N model touted as an account of explanation is also naturally viewed as an account of prediction. But is it reasonable to think that whenever we can predict we can also explain, and vice versa?

Question 1. How can the D-N model be adapted as a model of prediction?

Question 2. Try to give an example in which one can explain X but cannot predict it.

Familiarity. So what is the explanation relation? Dray's proposal: to explain is to relate the explanandum to the already familiar explanans. This is a non-starter. We explain the light phenomena (very familiar) by relating them to the very unfamiliar concepts (electromagnetic waves).

Reduction to the already understood. Another proposal: to explain is to relate the explanandum to the already understood explanans. Not good: we are often happy to explain by relating phenomena to the explanans not themselves understood. For example, the orbits of the planets were said to be explained by the gravitational pull of the Sun, but gravitation itself is not (certainly was not at the time) well understood.

Unification. Requirements for a successful explanation: generality, objectivity, and improvement of understanding. Previous proposals fail at least one of these requirements. New proposal: explanation works by unification. In every given epistemic situation there are certain *brute facts*. Each of them seemingly have no connection with each other: we say that they are *independently acceptable* (i.e. acceptable independently of each other). A successful explanation transforms the situation K_1 into another situation K_2 where there are fewer brute facts. Observe that explanation so interpreted is concerned with explaining laws (empirical generalities), rather than individual events. (Why?)

Unification in action. Why should we treat Newtonian mechanics as explanatory at all? It leaves many of its central concepts unexplained. Do we understand what force really *is*? Or momentum? Or do we understand gravitation? However, it allows us to connect previously unconnected phenomena. From the laws of mechanics we can derive the laws describing the behaviour of celestial bodies (Kepler's laws) and the laws describing the falling bodies in the vicinity of our planet (Galileo's laws). So: at the end of the day, science has mysteries, but it works by lowering the number of these mysteries.

Some technical details. We need a method for identifying brute facts in a given epistemic situation. This is done by isolating K-atomic sentences. Roughly put, these sentences cannot be logically decomposed into independently acceptable sentences. So to explain is to reduce the number of K-atomic sentences.

Two biologies. Within the large field of biology we can isolate two sub-disciplines. *Functional biology* deals with the ways different elements of organisms operate. In this sense it answers the question 'How?' Its practice is not different from the practice of other natural sciences. It can be carried out in laboratories and operate by experiments. *Evolutionary biology* involves an essential historical aspect. It asks the question how an organism came to possess its characteristics in the evolutionary process. Thus it asks the question why the organism possesses those characteristics.

Remark 3. Under the heading 'functional biology' we can include physiology, molecular biology, cellular biology.

Four causes. Suppose our question is about the causes of avian migration. Specifically, we enquire about the causes that led a particular warbler Will to migrate south on a day D.

Ecological. Will has to migrate south to a habitat containing sources of his nutrition (insects).

Genetic. Will has a genetic makeup he shares with other warblers allowing him to react to stimuli supplied by the environment. The genetic makeup 'instructs' him to react to a certain environmental condition by migrating south. That condition was obtained on *D*.

Intrinsic physiological. Will reacts to a decrease in the day length. When the day length drops below a certain threshold, he is ready to take off. The day length on *D* was below the threshold.

Extrinsic physiological. The cold spell on *D* led the bird to actually migrate. That was possible in the first place because Will was already in a physiological condition ready to migrate.

Mayr now claims that the first pair of causes can be explored by evolutionary biology, while the second one by functional biology.

Some comments. The way Mayr formulates these causes suffers from a serious lack of clarity. The genetic cause looks empty, unless we specify how the genetic makeup actually instructs Will to migrate. But then it would belong to functional biology. The extrinsic physiological cause should be tied to an intrinsic physiological cause: warblers migrate when the weather is sufficiently cold, *D* was that cold etc. Instead, we are given photoperiodicity. The latter, again, should be matched by the extrinsic physiological cause: *D* was sufficiently short etc.

Later on, however, we are given a much more satisfactory distinction. Proximate causes govern the behaviour of a concrete organism. They direct the organism to respond in a certain way to the environmental input. Ultimate causes should be cited in explaining why the species have evolved a particular behavioural trait. They should similarly tell us what evolutionary advantages that adaptation (including the possession of that genetic makeup that allows manifesting the behavioural trait) conferred on the given species.

Tinbergen's four questions. Another, less famous distinction echoing Mayr's was proposed by the ecologist Nico Tinbergen. In the presence of a biological characteristic we can ask four questions:

Causation What is its immediate cause?
Development How does it develop?
Function What is its evolutionary advantage?
Evolution How did it evolve?

Here there is a separate role allocated to developmental biology. Secondly, function here is separated from evolution.

Question 4. Is it possible to distribute these four question between functional biology and evolutionary biology as understood by Mayr?

Unpredictability in biology. What Mayr says about unpredictability of biological phenomena strikes me as strangely inadequate. Of course, complexity is a source of unpredictability of biological events. But we have to ask, what distinguishes biological and physical phenomena in this regard? Are physical phenomena simple? If they are, then exactly in what sense?

The example of evolutionary unpredictability is strange too. It is like saying that no one could predict the destruction of Twin Towers in New York and on that basis to conclude that physical or engineering phenomena are similarly unpredictable.

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