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Philosophy of Science 2
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History of Scientific Thought 2

This week we will look at developments in scientific thought that took place post-Aristotle. This will include, by popular demand, a sketch of the work of Francis Bacon but will be more focussed on the notion of paradigm shifts as exemplified by the change from the Ptolemaic geocentric model to the Copernican heliocentric model. In this respect, we will be looking at two specific philosophers of science – Thomas Kuhn (1922-1996) and Paul Feyerabend (1924-1994)

We ended last week (after a lengthy but interesting diversion concerning the status of psychology among other things!) by looking at the scientific method as advanced by Aristotle. Broadly speaking, Aristotle construed the scientific method as developing principles from inductive reasoning of two kinds that would then provide premises for deductive arguments in the form of syllogisms. The conclusions of these deductive arguments then yield further propositions that explain why something is the case and can be used as the basis for further investigations of related phenomena.

Again, it is should be emphasised that this is one of the ways in which human beings have evolved to think; many consider it to be a better (or more authoritative) form of thinking than that which is internal to religious thought, for example. However, the judgement of it as “better” or “more authoritative” rather depends upon one’s aims – what kind of understanding is trying to be attained, for instance. Moreover, those who take the view that this is a better mode of thinking than that internal to religious or moral thought are, in a sense at least, making the judgement that only authentic understanding can be gained through it. The idea that the scientific method can solve and explain everything that we do not understand is known as scientism; an example of this might be the assertion that science can explain or tell us what our moral values are (or should be).

Consider the following:

It is a common belief among scientists and laymen that because morality is of human origin we must have created it to further our own purposes, as part of our evolutionary adaptations. When our environment changes, this thought continues, we adapt our morality to suit the new conditions. If such adaptations are well-judged, they will ensure the continuing survival of a culture in the evolutionary competition that seeks to select and improve.

Natural though it might seem to think this way about morality, such a conception of it is, I believe, mistaken. To demonstrate this, let us take the case of a businessman who realises his business will founder unless he does something legal but morally questionable. This is not an uncommon occurrence, I’m sure.

Morality is supposed to guide us round such difficulties. But this is odd because, were it not for morality, there would be no difficulties. As the philosopher Peter Winch put it: ‘This is a strange sort of guide, which first puts obstacles in our path and then shows us the way round them’. Surely, it would be far more straightforward if we ditched morality altogether so we could get on with whatever we were doing unhindered?

Consequently, when faced with a moral difficulty, it becomes obvious that we cannot ask what purpose morality serves from an evolutionary standpoint. What would be advantageous for us in terms of the survival of the fittest frequently requires that we ignore the demands of morality as opposed to embracing them.

Thus, when people say that morality has been invented by human beings in the interests of developing social cooperation, they forget that it is morality that judges which forms of social cooperation are acceptable and which are not. There is, for example, social cooperation amongst thieves which is generally thought to be unacceptable whereas social cooperation for charitable activities is encouraged. Accordingly, it is morality which judges our various survival strategies (such as those employed by our hypothetical businessman), as opposed to such strategies determining what is right and wrong.

After the time of Ptolemy, there was precious little in the way of scientific advance until about 1400 hundred when there was an astronomical revival spearheaded by Arabs in Uzbekistan. It was, however, temporary insofar as the death of its greatest exponent – Ulugh Beigh – in 1420 saw the revival fizzle out. Beigh had no telescopes at his disposal but he drew up star charts that were far more detailed and accurate than anything that had gone before. We then had to wait another 100 years or so until the work of Nicholas Copernicus for further progress to be made.

The period between Ptolemy and the great astronomical revolution initiated by Copernicus was largely dominated by religious forms of life – among the big philosophical names of this interim period were St. Augustine of Hippo, St Anselm of Aosta and St. Thomas Aqunias. They were fine philosophers but concentrated very much on examining and developing religious ideas.

After his conversion to Christianity (in his early 30s), Augustine came to believe that rational thought of any kind (pertaining to truth) required faith – as such, philosophy was in a substantial sense, inferior to religion since it did not require faith. He also thought that one needs to believe in order to understand; in this, he was right – although perhaps the full epistemological implications eluded him. Anselm was famous for developing the Ontological Argument for the existence of God (largely in response to the recent translations of Greek texts by Plato and Aristotle, which generated a trend for demanding rational justifications); we will revisit the ontological argument at some point this year. Suffice to say, for the moment, that Anselm believed that perfection is a predicate only applicable to God. Aquinas lived about 100 years after Anselm and by then the demand for philosophers to rationalise their justifications had become well-established. However, substantial scientific work was still some way off, so the rationality of such justifications was still largely confined to religious domains. Aquinas was chiefly responsible for the revival of the Cosmological (First Cause) Argument that had been advanced (albeit in a different form) by Aristotle; he made a series of developments and variants of the argument that partly constituted his 'Five Ways' – what he (and subsequently many others) considered to be proofs of the existence of God.

Francis Bacon (1561-1626)

Francis Bacon was an interesting character – what one might think of as an aspirant maverick. He was neither a scientist nor an academic but, nevertheless, published two well known works – *The Advancement of Learning* and *Novum Organum*; the latter was part of what Bacon believed was going to be his magnum opus *Instauratio Magna*.

At the age of 13 Bacon went to the University of Cambridge before studying law at Gray's Inn; he was admitted to the bar in 1586 at the age of 25. Always on a quest for recognition, he made repeated efforts to obtain an appointment in government under Elizabeth I but was not successful until the accession of James I. Subsequently however, he was charged and imprisoned for bribery and corruption and, although the King terminated his prison sentence after a few days, he was permanently excluded from all forms of public life. He is alleged to have died from catching a cold brought on by trying to establish the preserving effects of inserting snow into the rear end of a chicken.

There is some dispute over just how original Bacon's work was and how much of a contribution he made to the philosophy of science. He certainly developed an antipathy towards the philosophy of Aristotle, often making substantial and, not infrequently, unfair criticisms of it – ironic, given the amount of Aristotelian influence contained within his own work.

Bacon noted that a foundation of the scientific method should be the development of neutrality in observation and method – something that, these days, is commonly taught from early school science lessons onwards. Bacon went on claim that the study of nature (in general) had commonly been beset by what he called four idols.

1. *The idols of the tribe.* Here understanding is influenced by human nature e.g. we may suppose there is more regularity in nature than there actually is. Perhaps Einstein was guilty of this in his belief of ultimate unity in the universe.
2. *Idols of the cave.* Attitudes that arise in humans as a result of upbringing, and the education of man as individuals. Creationists may be victims of this idol.
3. *Idols of the Market Place.* Are where distortions take place as a result of the meanings of words being reduced to the lowest common denominator of vulgar usage – thus impeding scientific concept formation. Some of this we covered in our debate about whether language was inadequate.
4. *Idols of the theatre.* Are received opinions and methods of the various philosophies. Dogmatic government policies can be cited as an example of this idol.

Bacon believed that Aristotle's model of science as Phenomenon –> Induction → First Principles → Deduction was an Idol of the Theatre. This is strange because he also tacitly accepted (without acknowledging Aristotle) the main tenet of Aristotle's position – namely the inductive-deductive theory of scientific procedure. Certainly, Bacon emphasised the importance of induction (of both kinds) more than Aristotle but this was more a matter of degree, as opposed to asserting anything new. So what, exactly, are Bacon's objections to Aristotle?

Firstly, Bacon accused Aristotle of being unsystematic in his collection of data from which he formed general (inductive) principles. Secondly, that Aristotle was too ready to generalise from too few examples – thus, subsequent deductive arguments would suffer (or, rather, yield conclusions that could not be relied upon). Indeed, Bacon argued that Aristotle had reduced science to little more than deductive logic. He was right to emphasise the importance of method in collecting data and observations, and right, too, to stress that deductive arguments are only of value if sustained by decent inductive support. He was wrong however, to claim that Aristotle's methods were unsystematic and reducing of all science to deductive logic. Aristotle had insisted that inductive premises be induced from the systematic collection of substantial observational evidence before any deductive arguments could be made.

Bacon's four Idols are, therefore, useful philosophical devices but he was, perhaps, a little too quick to attribute to himself ideas that should have contained acknowledgement of the work of others.

Objections to this version of the scientific method

Having said all that, there are substantial objections to be made against both Bacon and Aristotle in relation to the kind of neutral observation that both argued is required for induced premises (general principles that act as the starting point for deductive arguments). In short, they centre on the idea of observational perspective and disposition to observe one thing over another. Firstly, scientists choose which aspects of a situation upon which to concentrate – to try to observe literally every aspect of a situation would not only be impractically cumbersome but, in a number of cases, illustrative of insanity. Secondly, by choosing which aspects of situation to observe, there are already theory-laden presuppositions at work.

The Problem of Induction

Induction and deduction are two different methods argument / scientific investigation. Induction involves generalization based on a certain number of observations. Deduction moves logically through from premises to conclusions e.g.

All dogs are animals.
All Labradors are dogs.
Therefore
All Labradors are animals.

Deductive arguments are truth preserving i.e. if the premises are true, the conclusion must necessarily be true. Obviously, if the premises are false, then the conclusions will be false.

However the conclusions of an inductive argument with true premises have the potential to be false. Bertrand Russell illustrates this with an example of a chicken that wakes up each morning believing it will be fed, as that has been the case every other morning. However one morning it wakes up and is killed by the farmer – here the predictive power of induction is shown to be flawed. Yet, induction is the method we use that allows us to draw the conclusion that the future will, for the most part, resemble the past. Without induction we would have no reason to believe that the future would resemble the past in any way – thus our lives would be chaotic. Yet is there a case for believing that we are foolish in placing our faith in induction? Certainly, there are other problems that face the induction method. The forecasts we make on the grounds of induction are not necessarily the only ones we could make using the available evidence (remember the form of induction known as Inference to Best Possible Explanation).

Defending Induction?

For the most part, induction is of great predictive value – it is a useful method of forecasting the behaviour of the natural world. (A possible objection to this is that the defence itself relies on induction, thus how do we know that continuing to believe in the method of induction will remain rewarding?).

Human beings are genetically programmed with a group of categories into which they slot experience. It could be argued that we use inductive reasoning as a result of evolution in the sense that by a process of natural selection we have arrived at the partiality inclination to make inductive generalisations as they (on the whole) lead to reliable predictions. In other words we adopt the strategy that is most effective in advancing our species. (But, of course, this is not neutral as Aristotle and Bacon had demanded observations to be)

Using the idea of probability can also be used as a defence of the Problem of Induction, however this is open to objection in the sense that probability itself can change.

I won't say more about this now as I want to move on to Logical Positivism and Karl Popper's falsificationism.

Logical Positivism

The Verification Principle: Where the conditions for sentences / statements to be meaningful are equated with the conditions of its being confirmable or falsifiable. In other words: The meaning of a sentence is given by its means of verification or falsification.

One of the main aims of the logical positivists was to try and make philosophy more scientific as they believed it to be too subjective and psychological. However, there is one massive objection to Logical Positivism – namely that the verification principle is scuppered by its own criteria. Moreover, the majority of philosophical statements are not analytic or synthetic and therefore logical positivism effectively eliminated all of philosophy apart from logic.

Karl Popper (1902-1994): Falsificationism

From Newton to the time of the logical positivists, the main task of science had been the search for natural laws i.e. general statements about the world that that were known to be always true e.g. '*every physical object in the universe attracts every other object in the universe with a force directly proportional to their masses and inversely proportional to the square of the distance between them'* (Newton's Inverse Square Law).

This 'law' (and others like it) is not empirically verifiable; generally they come about as the result of various hypotheses based on large amounts of observation, these are then tested and most proved false. However where an experiment confirms a hypothesis, it is by and large accepted that a new scientific law has been discovered. These statements (laws) are never analytic – if they were they would give us no information about the world; their truth does not result by deductive logic from the definitions of their terms and neither is their rejection self-contradictory. However the unlimited generality of scientific laws makes them impossible to verify no matter how many observations are carried out, thus (according to Popper) scientific laws are meaningless statements as they are neither analytic nor synthetic – a point he used to further dismantle Logical Positivism.

Thomas Kuhn (1922-1996)

- Is there a pattern to the way scientific ideas change over time?
- When one theory is abandoned and replaced with a new one, is the new theory objectively better than the previous one?
- Does the concept of objectivity make any sense at all?

Kuhn was primarily a historian and believed that insufficient attention to the history of science had led the Logical Positivists to form an inaccurate idea of the scientific picture.

The concept of a paradigm was central to Kuhn's account of science. A paradigm consists of two main parts: 1. A set of fundamental theoretical assumptions that the whole scientific community agrees on at a given time. 2. A set of exemplars (particular problems) that have been solved by means of these assumptions.

A paradigm is not only something scientists agree on, it is also something on which these agreeing scientists base how future scientific research in their field should be conducted. Think of Ptolemy here. Now think of Copernicus.

What does science involve? Kuhn believed it to be a matter of puzzle solving. However successful the paradigm, it will always encounter problems i.e. phenomena that it finds difficult to accommodate. For example, mismatches between the predictions of a theory and the experimental facts. The job of a scientist is to attempt to eliminate these problems while altering the paradigm as little as possible.

Kuhn emphasised that scientists are not trying to test the paradigm; rather they accept the paradigm and conduct their research within the conditions it sets. If a normal scientist acquires a result that does not fit, he / she will normally put the fault down to methodological error or bad experimental technique. The paradigm is nonnegotiable.

However, over time, anomalies are discovered - phenomena that cannot be reconciled with theoretical assumptions of the paradigm. A small number of anomalies tend to be ignored, but as they accumulate, confidence in the paradigm weakens then breaks down. At this point Kuhn's "revolutionary science" comes into play. This means basically that any fundamental scientific ideas are up for grabs - various ideas for new paradigms are proposed. Think again of Copernicus and Galileo.

Eventually, a new paradigm is established in the scientific community - an event that signals the end of a scientific revolution. This is termed a "paradigm shift" i.e. there is a shift from the old paradigm to a new one. Numerous examples from the history of science fit Kuhn's model reasonably well e.g. the transition from Ptolemaic to Copernican astronomy (from an Earth centred solar system to a Sun centred one).

We assume that when scientists reject an old paradigm in favour of a new one, they do so on the basis of objective evidence. Kuhn however, believes that a new paradigm involves a certain amount of faith on the part of the scientist. He believed scientists to have good reasons for abandoning old paradigms for new ones but, nevertheless, insisted that reason alone could never inspire a paradigm shift. Moreover, he questioned whether there were any fixed facts about the world and, as such, concluded that the concept of objective truth was incoherent.

Kuhn's alternative was that the facts about the world are paradigm relative i.e. the facts change when paradigms change. If this is right, then truth itself becomes paradigm relative.