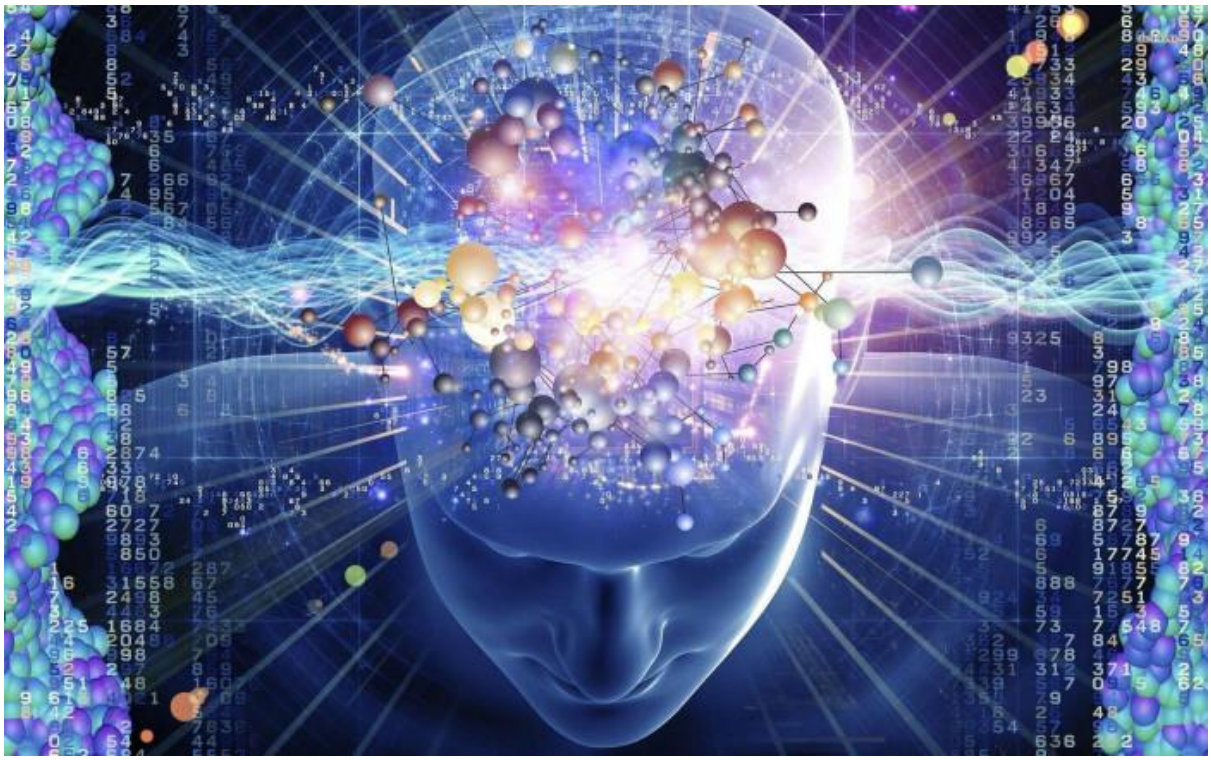
Manchester Lit&Phil

Philosophy Forum



What is Science?

Focus paper for the Manchester Lit & Phil Philosophy Forum

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Regardless of the topic, our Forum meetings consistently raise questions about knowledge. For example: what is knowledge? how do we get knowledge? and what are the limits of knowledge? Given that science is in the business of producing knowledge, it is a worthy topic for our consideration.

"Science is a way of thinking much more than it is a body of knowledge"
Carl Sagan

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1 What is science?

What is Science and how do we get scientific knowledge? The Science Council defines science as

> "… the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence."[1]

However, a short review of some philosophy of science suggests that the acquisition of scientific knowledge is not as simple as it sounds.

2 Logical Positivism: science is about verifying knowledge statements

2.1 Logical Positivism emerged from a group of philosophers working in Vienna during the 1920s and 30s. They argued that knowledge statements are only meaningful if they can be derived from mathematical or logical premises, or if it is possible to publicly verify them via human senses (i.e. by experimentation or observation). Any other statement was regarded as strictly meaningless. From this perspective, the dividing line between scientific and non-scientific knowledge is that scientific knowledge is verifiable, whereas non-scientific knowledge is not. A problem with this approach is that it isn't always possible to verify if something is true. For example, it isn't possible to verify the Logical Positivists' own claim that 'knowledge statements which cannot be verified are meaningless.' Therefore, the theory of Logical Positivism appears to be self-contradicting…

3 Karl Popper: science is about falsifying knowledge statements

3.1 There was another problem with the Logical Positivists' claim that only scientific statements based on verification were valid. No matter how many times you verified a scientific knowledge statement, could you be sure it would apply in the future? In logic and mathematics, you can *deduce* valid statements about particulars from general statements, with absolute certainty. For instance, from the general statement 'all humans are born as babies' you can deduce with certainty that any individual human was once a baby. However, this logical certainty of *deduction* from a general statement doesn't work the other way round. As David Hume pointed out in the 18th century, no amount of particular instances can guarantee that logical *induction* to a generalised scientific statement

Used here are stricter logical definitions which differ from their looser everyday usage.

Deduction [n]
Inference from general or universal premises to a conclusion about particulars.

Induction [n]
Inference from particular instances to a generalized conclusion.

[1] https://sciencecouncil.org/about-science/our-definition-of-science/

was valid. For example, in Europe it was thought that all swans were white until Dutch explorer Willem de Vlamingh ventured to Australia in 1697 and saw some black swans. So, no matter how many times you observe instances supporting a general scientific statement, there could always be a 'black swan event' that will provide contradictory evidence. This is known as The Problem of Induction and it fundamentally threatens the very notion of being able to positively verify scientific knowledge statements.

3.2 Karl Popper addressed the problem of induction by turning Logical Positivism on its head and arguing that scientific knowledge is not acquired by verifying knowledge statements, but by trying to falsify them. From this perspective, the dividing line between scientific and non-scientific knowledge is that scientific knowledge consists of falsifiable hypotheses that we have been unable to falsify despite our best efforts, whereas hypotheses that have been falsified or cannot logically be falsified are non-scientific or pseudo-scientific.

3.3 A problem with Popper's approach is that it implies that a single observation which appears to falsify a theory should lead to that theory being abandoned. However, this is rarely routine practice in science, and scientists have often been proven right to have not abandoned their theories after finding contradictory evidence. For example, Isaac Newton's gravitational theory predicted the paths that planets should follow when orbiting the sun. These predictions were mostly verified by observation, but the observed orbit of Uranus contradicted what Newton's theory predicted. However, instead of immediately abandoning Newton's theory, scientists stuck with it and hypothesised that an unknown planet must be exerting additional gravitational force on Uranus. This hypothesis was eventually proven true when the planet Neptune was discovered, and Newton's theory continued to fruitfully dominate science for 200 years.[2] Hence, in practice, multiple instances of contrary evidence are needed before a shift in scientific opinion will take place. This idea was developed on a grand scale by Thomas Kuhn…

4 Thomas Kuhn: science is about paradigm shifts

4.1 Kuhn argued that science can be understood via the concept of scientific paradigms, which are distinct scientific outlooks consisting of shared assumptions, beliefs, and values which unite scientific communities and allow their science to proceed.[3] From this perspective, the job of a scientist is not to falsify their paradigm, but to develop and extend it by integrating new findings. In this sense, scientific progress is, in effect, achieved accidently, when scientists develop their paradigms to the point where contradictory evidence cannot be integrated and the paradigm must therefore be replaced by a new one. An example of this was the shift from the Ptolemaic model of the universe

[2] Example taken from p.13 of Samir Okasha's 'Philosophy of Science: A Very Short Introduction.'
[3] Definition taken from p.75 Samir Okasha's 'Philosophy of Science: A Very Short Introduction.'

(where the earth is at the centre), to the Copernican model of the universe (where the sun is at the centre).

5 Imre Lakatos

5.1 Addressing the problems with Popper's approach and trying to reconcile it with some of Kuhn's ideas, Lakatos argued that the basic units of science are 'research programmes', such as quantum physics, which consist of core hypotheses and secondary hypotheses. From this perspective, if a core hypothesis is contradicted by new evidence, scientists should firstly try to rescue the core hypothesis by inventing and testing a secondary hypothesis to explain the contradictory evidence. Research programmes should only be abandoned when they no longer make accurate predictions and/or are unable to explain contradictory evidence via secondary hypotheses.

6 Regardless of how we get it, are there limits to scientific knowledge?

6.1 To answer this question, we need to consider at least two further questions. Firstly, how we can know if there are limits to scientific knowledge? Secondly, if we think there are limits, how can we know where those limits are?

6.2 Both of these questions pose serious problems because, after all, how can we answer either of them with certainty? Furthermore, even if we feel certain about our answer to either question, how can we be certain that new evidence won't come to light in the future that will show us to be mistaken?

6.6 Because scientific knowledge is a form of human knowledge, questions about the limits of scientific knowledge are, ultimately, questions about the limits of humans. If we define science simply as a systematic approach to explaining things, then the question is whether or not humans can explain everything, via any form of knowledge, scientific or otherwise?

6.7 The claim that 'humans can explain everything' seems somewhat arrogant, given how much we don't know and how limited our capacities for knowing seem to be. However, the claim that 'there are things that humans can never explain' seems equally unjustifiable, given that we can now explain things that our ancestors would have thought unexplainable, and given the likelihood that future generations will be able to explain things that we currently cannot explain. In other words, what is unexplainable today might be explainable tomorrow via new data, better theories, or better technology – but it appears that we cannot be certain either way.

6.8 Having said that, it could be the case that regardless of what scientific knowledge might be able to explain, scientific knowledge itself will never achieve or provide complete understanding. For example, science might be able to explain why we experience the taste or colour of a strawberry in a

certain way, but will it ever be able to provide an understanding of what it is actually like to experience the taste or colour of a strawberry? Probably not, if understanding is only possible via experience, and if experience is only possible from the standpoint of a conscious individual who can, ultimately, only experience their own experiences. In other words, even if we define our experiences as merely the sum total of the causes/parts that give rise to them, it is only possible for an outsider (i.e., a scientist and/or scientific observation equipment) to observe the causes/parts of our experiences (e.g., brain activity, facial expression, blood pressure etc.) and not the actual experiences themselves.[4]

Perhaps this means that there will always be a need for the humanities…!

7 Suggested discussion questions:

Q1 What does science mean to you and how strictly can we define it?
Q2 What is scientific knowledge and how do we get it?
Q3 How can we differentiate scientific and non-scientific knowledge?
Q4 Are there limits to scientific knowledge? If so, how do we know, and can we know where those limits are?
Q5 What other forms of knowledge are there besides scientific knowledge? Can any of these be considered more truthful than scientific knowledge?
Q6 Is there any knowledge that we can be certain about?

[4] For arguments that there are indeed limits to scientific knowledge, see Marcelo Gleiser, 2014, '*The Island of Knowledge*' or Marcus Du Sautoy, 2016, '*What we Cannot Know*'.

Your notes