

Demarcation problem

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The **demarcation problem** in the philosophy of science is about how to distinguish between science and nonscience,^[1] including between science, pseudoscience, and other products of human activity, like art and literature, and beliefs.^{[2][3]} The debate continues after over a century of dialogue among philosophers of science and scientists in various fields, and despite broad agreement on the basics of scientific method.^{[4][5]}

Contents

- [Ancient Greek science](#)
- [Logical positivism](#)
- [Falsifiability](#)
- [Postpositivism](#)
- [Feyerabend and Lakatos](#)
- [Thagard](#)
- [Some historians' perspectives](#)
- [Laudan](#)
- [References](#)

Ancient Greek science

An early attempt at demarcation can be seen in the efforts of Greek natural philosophers and medical practitioners to distinguish their methods and their accounts of nature from the mythological or mystical accounts of their predecessors and contemporaries.^[6]

Aristotle described at length what was involved in having scientific knowledge of something. To be scientific, he said, one must deal with causes, one must use logical demonstration, and one must identify the universals which 'inhere' in the particulars of sense. But above all, to have science one must have *apodictic certainty*. It is the last feature which, for Aristotle, most clearly distinguished the scientific way of knowing.^[2]

—Larry Laudan, *Physics, Philosophy, and Psychoanalysis*, "The Demise of the Demarcation Problem"

G. E. R. Lloyd notes that there was a sense in which the groups engaged in various forms of inquiry into nature set out to "legitimate their own positions,"^[7] laying "claim to a new kind of wisdom ... that purported to yield superior enlightenment, even superior practical effectiveness."^[8] Medical writers in the Hippocratic tradition maintained that their discussions were based on necessary demonstrations, a theme developed by Aristotle in his Posterior Analytics.^[9] One element of this polemic for science was an insistence on a clear and unequivocal presentation of arguments, rejecting the imagery, analogy, and myth of the old wisdom.^[10] Some of their claimed naturalistic explanations of phenomena have been found to be quite fanciful, with little reliance on actual observations.^[11]

Logical positivism

Logical positivism held that only statements about matters of fact or logical relations between concepts are meaningful. All other statements lack sense and are labelled 'metaphysics' (see the verifiability theory of meaning also known as verificationism). This distinction between science, which in the view of the Vienna Circle possessed empirically verifiable statements, and what they pejoratively called 'metaphysics', which lacked such statements, can be seen as representing another aspect of the demarcation problem.^[12] Logical positivism is often discussed in the context of the demarcation between science and non-science or pseudoscience. However, "The verificationist proposals had the aim of solving a distinctly different demarcation problem, namely that between science and metaphysics."^[13]

Falsifiability

Falsifiability is the demarcation criterion proposed by Karl Popper as opposed to verificationism: "statements or systems of statements, in order to be ranked as scientific, must be capable of conflicting with possible, or conceivable observations".^[14] Popper saw demarcation as a central problem in the philosophy of science. Unlike the Vienna Circle, Popper stated that his proposal was not a criterion of "meaningfulness".

Popper's demarcation criterion has been criticized both for excluding legitimate science... and for giving some pseudosciences the status of being scientific... According to Larry Laudan (1983, 121), it "has the untoward consequence of countenancing as 'scientific' every crank claim which makes ascertainably false assertions". Astrology, rightly taken by Popper as an unusually clear example of a pseudoscience, has in fact been tested and thoroughly refuted... Similarly, the major threats to the scientific status of psychoanalysis, another of his major targets, do not come from claims that it is untestable but from claims that it has been tested and failed the tests.^[14]

—Sven Ove Hansson, *The Stanford Encyclopedia of Philosophy*, "Science and Pseudo-Science"

In Popper's later work, he stated that falsifiability is both a necessary and a sufficient criterion for demarcation. He described falsifiability as a property of "the logical structure of sentences and classes of sentences," so that a statement's scientific or non-scientific status does not change over time. This has been summarized as a statement being falsifiable "if and only if it logically contradicts some (empirical) sentence that describes a logically possible event that it would be logically possible to observe."^[14]

Postpositivism

Thomas Kuhn, an American historian and philosopher of science, is often connected with what has been called postpositivism or postempiricism. In his 1962 book *The Structure of Scientific Revolutions*, Kuhn divided the process of doing science into two different endeavors, which he called normal science and extraordinary science (which he sometimes also called "revolutionary science"). "In Kuhn's view, 'it is normal science, in which Sir Karl's sort of testing does not occur, rather than extraordinary science which most nearly distinguishes science from other enterprises'..."^[14] That is, the utility of a scientific

paradigm for puzzle-solving, which suggests solutions to new problems while continuing to satisfy all of the problems solved by the paradigm that it replaces.

Kuhn's view of demarcation is most clearly expressed in his comparison of astronomy with astrology. Since antiquity, astronomy has been a puzzle-solving activity and therefore a science. If an astronomer's prediction failed, then this was a puzzle that he could hope to solve for instance with more measurements or with adjustments of the theory. In contrast, the astrologer had no such puzzles since in that discipline "particular failures did not give rise to research puzzles, for no man, however skilled, could make use of them in a constructive attempt to revise the astrological tradition"... Therefore, according to Kuhn, astrology has never been a science.^[14]

—Sven Ove Hansson, *The Stanford Encyclopedia of Philosophy*, "Science and Pseudo-Science"

Popper criticized Kuhn's demarcation criterion, saying that astrologers are engaged in puzzle solving, and that therefore Kuhn's criterion recognized astrology as a science. He stated that Kuhn's criterion leads to a "major disaster...[the] replacement of a rational criterion of science by a sociological one".^[14]

Feyerabend and Lakatos

Kuhn's work largely called into question Popper's demarcation, and emphasized the human, subjective quality of scientific change. Paul Feyerabend was concerned that the very question of demarcation was insidious: science itself had no need of a demarcation criterion, but instead some philosophers were seeking to justify a special position of authority from which science could dominate public discourse.^[15] Feyerabend argued that science does not in fact occupy a special place in terms of either its logic or method, and no claim to special authority made by scientists can be upheld. He argued that, within the history of scientific practice, no rule or method can be found that has not been violated or circumvented at some point in order to advance scientific knowledge. Both Lakatos and Feyerabend suggest that science is not an autonomous form of reasoning, but is inseparable from the larger body of human thought and inquiry.

Thagard

Paul R. Thagard has proposed another set of principles to try to overcome these difficulties, and believes it is important for society to find a way of doing so.

According to Thagard's method, a theory is not scientific if it satisfies two conditions:

1. The theory has been less progressive than alternative theories over a long period of time, and faces many unsolved problems; and...
2. The community of practitioners makes little attempt to develop the theory towards solutions of the problems, shows no concern for attempts to evaluate the theory in relation to others, and is selective in considering confirmations and disconfirmations.^[16]

Thagard specifies that sometimes theories will spend some time as merely "unpromising" before they truly deserve the title of pseudoscience. He cites astrology as an example: it was stagnant compared to advances in physics during the 17th century, and only later became "pseudoscience" in the advent of alternative explanations provided by psychology during the 19th century.

Thagard also states that his criteria should not be interpreted so narrowly as to allow willful ignorance of alternative explanations, or so broadly as to discount our modern science compared to science of the future. His definition is a practical one, which generally seeks to distinguish pseudoscience as areas of inquiry which are stagnant and without active scientific investigation.

Some historians' perspectives

Many historians of science are concerned with the development of science from its primitive origins; consequently they define science in sufficiently broad terms to include early forms of natural knowledge. In the article on science in the eleventh edition of the *Encyclopædia Britannica*, the scientist and historian William Cecil Dampier Whetham defined science as "ordered knowledge of natural phenomena and of the relations between them."^[17] In his study of Greek science, Marshall Clagett defined science as "first, the orderly and systematic comprehension, description and/or explanation of natural phenomena and, secondly, the [mathematical and logical] tools necessary for the undertaking."^[18] A similar definition appeared more recently in David Pingree's study of early science: "Science is a systematic explanation of perceived or imaginary phenomena, or else is based on such an explanation. Mathematics finds a place in science only as one of the symbolical languages in which scientific explanations may be expressed."^[19] These definitions tend to focus more on the subject matter of science than on its method and from these perspectives, the philosophical concern to establish a line of demarcation between science and non-science becomes "problematic, if not futile."^[20]

Laudan

Larry Laudan concluded, after examining various historical attempts to establish a demarcation criterion, that "philosophy has failed to deliver the goods" in its attempts to distinguish science from non-science—to distinguish science from pseudoscience. None of the past attempts would be accepted by a majority of philosophers nor, in his view, should they be accepted by them or by anyone else. He stated that many well-founded beliefs are not scientific and, conversely, many scientific conjectures are not well-founded. He also stated that demarcation criteria were historically used as "*machines de guerre*" in polemical disputes between "scientists" and "pseudo-scientists." Advancing a number of examples from everyday practice of football and carpentry and non-scientific scholarship such as literary criticism and philosophy, he saw the question of whether a belief is well-founded or not to be more practically and philosophically significant than whether it is scientific or not. In his judgment, the demarcation between science and non-science was a pseudo-problem that would best be replaced by focusing on the distinction between reliable and unreliable knowledge, without bothering to ask whether that knowledge is scientific or not. He would consign phrases like "pseudo-science" or "unscientific" to the rhetoric of politicians or sociologists.^[2]

Others have disagreed with Laudan. Sebastian Lutz, for example, argues that demarcation does not have to be a single necessary and sufficient condition as Laudan implied.^[2] Rather, Laudan's reasoning at the most establishes that there has to be one necessary criterion and one possibly different sufficient criterion.^[21] Other critics have argued for multiple demarcation criteria suggesting that there should be one set of criteria for the natural sciences; another set of criteria for the social sciences, and claims involving the supernatural could have a set of pseudoscientific criteria. Massimo Pigliucci wrote that science generally conforms to Ludwig Wittgenstein's concept of family resemblances.^[22]

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6. Lloyd, G. E. R. (1983), *Science, Folklore and Ideology: Studies in the Life Sciences in Ancient Greece*, Cambridge: Cambridge University Press, pp. 79–80, ISBN 0-521-27307-2, *Faced with ... competition from a variety of more or less exploitative rival healers, the doctors responsible for many or most of the Hippocratic treatises unite, at least, in their desire to turn the practice of healing into a τέχνη.... [N]ot only do they reject interference in most cases from priests and prophets, they also criticise many current practices and assumptions.*
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