

Karl Popper's demarcation problem

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Karl Popper, as a critical rationalist, was an opponent of all forms of skepticism, conventionalism and relativism in science. In 1935 he wrote *Logik der Forschung. Zur Erkenntnistheorie der modernen Naturwissenschaft*, later translating the book into English and publishing it under the title *The Logic of Scientific Discovery* (Karl Raimund Popper 2002b) considered to be a pioneering work in its field. Many of the arguments in this book are directed against the members of the "Vienna Circle", such as Moritz Schlick, Otto Neurath, Rudolph Carnap, Hans Reichenbach, Carl Hempel and Herbert Feigl. Popper agrees with them on the general aspects of scientific methodology and their mistrust in traditional philosophical methodology, but its solutions have been significantly different. Popper has contributed significantly to the debates on general scientific methodology, the demarcation of pseudoscience, the nature of probability, and the methodology of social sciences.

Popper was deeply impressed by the differences between Freud's and Adler's supposed "scientific" theories and the revolution triggered by Einstein's theory of relativity in physics during the first two decades of the 20th century. While Einstein's theory was extremely "risky" in the sense that it was possible to deduce consequences from it which, if it were proved to be false, would have falsified the whole theory, nothing could, in principle, falsify the psychoanalytic theories, which are not predictive. (Thornton 2017)

Popper was criticized about his prescriptive approach to science and the focus on the logic of falsifiability. His theory was opposed to Thomas Kuhn's socio-historical approach developed in *"The Structure of Scientific Revolutions"*, (T. S. Kuhn 1996) which, in support, reintroduced the idea that the change of science is essentially dialectical and depends on the establishment of a consensus within the communities of researchers.

There have been attempts to demarcate science of non-science since the ancient period: "To be scientific," Aristotle said, "one must deal with causes, one must use logical demonstration, and one must identify the universals which 'inhere' in the particulars of sense." (Laudan 1983)

The demarcation of science by pseudoscience has both theoretical reasons (the problem of delimitation is an illuminating perspective that contributes to the philosophy of science in the same way that error analysis contributes to the study of informal logic and rational reasoning) and practical reasons (the demarcation is important for decision-making both in private and public life). (Mahner 2007)

Logical positivism, through the theory of verifiability of significance (verificationism), considered that only affirmations of factual matters or logical relationships between concepts are significant. (Grayling 2001) But "the verificationist proposals had the aim of solving a distinctly different demarcation problem, namely that between science and metaphysics." (Hansson 2017)

According to Popper, the central issue of the philosophy of science is the demarcation, the distinction between science and what he calls "non-science" (including logic, metaphysics, psychoanalysis, etc.).

"Any demarcation in my sense must be rough. (This is one of the great differences from any formal meaning criterion of any artificial 'language of science'.) For the transition between metaphysics and science is not a sharp one: what was a metaphysical idea yesterday can become a testable scientific theory tomorrow; and this happens frequently." (Miller 1985)

"There will be well-testable theories, hardly testable theories, and non-testable theories. Those which are non-testable are of no interest to empirical scientists. They may be described as metaphysical. Here I must again stress a point which has often been misunderstood. Perhaps I can avoid these misunderstandings if I put my point now in this way. Take a square to represent the class of all statements of a language in which we intend to formulate a science; draw a broad horizontal line, dividing it into an upper and lower half; write 'science' and 'testable' into the upper half, and 'metaphysics' and 'non-testable' into the lower: then, I hope, you will realize that I do not propose to draw the line of demarcation in such a way that it coincides with the limits of a language, leaving science inside, and banning metaphysics by excluding it from the class of meaningful statements." (Karl Raimund Popper 2002a)

A major argument of Popper is Hume's critique of induction, (Hume 1738) arguing that induction should never be used in science. But he disagrees with the skepticism associated with Hume, nor with the support of Bacon and Newton's pure "observation" as a starting point in the formation of theories, as there are no pure observations that do not imply certain theories. Popper argues that there is no unique methodology for science. It is necessary to solve the problem of demarcation of metaphysics from science. But we should recognize that many metaphysical systems have led to important scientific results. He reminds Democrit's system; and that of Schopenhauer that is very similar to that of Freud. And some, for example, those of Plato or Malebranche or Schopenhauer are wonderful constructions of thought. But at the same time, we should oppose those metaphysical systems that tend to charm and wonder. But obviously, we should do the same with non-metaphysical or anti-metaphysical systems if it displays this dangerous trend. And Popper think we cannot do it in one move. Rather, we must make the effort to analyze the systems in detail; we must show that we understand what the author wants to say, but what he says does not deserve the effort to understand. (Miller 1985)

Instead, Popper proposes falsifiability as a method of scientific investigation. For him, a theory is scientific only if it is falsifiable by a conscious event. Popper's theory of demarcation is based on his perception of the logical asymmetry he has between verification and falsification: it is logically impossible to definitively verify a universal proposition by reference to experience (as Hume says), but a single counter-example refutes definitively the corresponding universal law. In a word, an exception, far from "proving" an exception to the rule, definitively rejects it: (Thornton 2017)

Popper says that they are people of courageous ideas, though very critical of their own ideas, they try to find out if their ideas are correct, trying to find out first whether they are wrong.

They operate with courageous conjectures and severe attempts to reject their own conjectures. The criterion of demarcation between science and non-science that he proposes is a simple logical analysis of this image. If it is good or bad, this will be shown by its fertility. Courageous ideas are new and bold hypotheses or conjectures. And severe rejection attempts are critical discussions and severe empirical tests. But when it is a bold conjecture in the sense proposed here, and when not? It is bold if and only if it assumes a great risk of being false - if things were different, and if they seem at that moment to be different. (Miller 1985)

A true scientific theory is restrictive, and can therefore be tested and falsified, but never logically verified. Thus, if a theory has resisted the test, it does not mean it has been verified, it has only a greater degree of corroboration, and can be replaced at any time by a better theory.

Popper uses falsifiability as a demarcation criterion to evaluate theories. The Popper criterion does not exclude from the field of science statements that cannot be falsified, but only theories that contain no falsifiable statement, yet it is not clear what constitutes a "whole theory" and what makes a statement to be "significant".

Verificationism¹ was an essential feature of the logical positivism of the so-called Vienna Circle. Popper noticed that the philosophers of the Vienna Circle mixed up two different issues, the significance and demarcation, and proposed to verify a single solution for both. Popper said that there are significant non-scientific theories, and therefore a significance criterion does not coincide with a delimitation criterion, proposing replacing verifiability with falsifiability as a delimitation criterion. On the other hand, he strictly opposed the view that statements that are not falsifiable are meaningless or wrong. (Karl Raimund Popper 2002b)

¹ Verificationism claims that a statement must, in principle, be empirically checked to be both meaningful and scientific.

Popper argues that the only logical technique that is integral part of the scientific method is that of deductive testing, the conclusions being deduced from a hypothesis and then compared with each other and other relevant statements to determine whether they falsify or corroborate the hypothesis. Such conclusions are not directly compared to the facts, simply because there are no "pure" facts available; all observations-statements are loaded by theory and are just as much a function of purely subjective factors (interests, expectations, desires, etc.) as they are a function of what is truly objective. (Thornton 2017)

Popper specifies four steps for the deductive procedure²:

"I proposed (though years elapsed before I published this proposal) that the refutability or falsifiability of a theoretical system should be taken as the criterion of its demarcation. According to this view, which I still uphold, a system is to be considered as scientific only if it makes assertions which may clash with observations; and a system is, in fact, tested by attempts to produce such clashes, that is to say by attempts to refute it. Thus testability is the same as refutability, and can therefore likewise be taken as a criterion of demarcation. There are, moreover (as I found later), degrees of testability: some theories expose themselves to possible refutations more boldly than others." (Karl Raimund Popper 2002a)

Popper believes that Hume's philosophy demonstrates that there is an implicit contradiction in traditional empiricism, which claims that all knowledge comes from experience, and that universal sentences (including scientific laws) are verifiable by reference to experience. Contradiction derives from the attempt to show that, despite the openness of the experience, scientific laws can be interpreted as empirical generalizations, which in a way finally confirm a "positive" experience. Popper eliminates the contradiction by rejecting the first of these principles and eliminating the imposition of empirical verification into falsifiability in the second principle. He states that scientific theories are not inductively deduced from experience, nor are scientific

² The steps for the deductive procedure, according to Popper: (1) A test of internal consistency to see possible contradictions; (2) Axiomatization of theory to distinguish between empirical and logical elements; (3) Comparing the new theory with the existing one; (4) Testing the theory by empirically applying the conclusions derived from it to verify whether the theory is corroborated (but not verified). (Karl Raimund Popper 2002b)

experiments conducted to verify or establish their truth; all knowledge is provisional, conjectural, hypothetical - we can never prove theories definitively, we can only confirm (temporarily) or refute them. That is why we have to make a choice between theories that explain the set of investigated phenomena, eliminating only those theories that are falsified, and rationally choose between the remaining, unfalsified theories, the one that possesses the highest level of explanatory power and predictive power. Popper emphasizes the importance of the critical spirit of science - critical thinking is the very essence of rationality. (Thornton 2017)

There have been various demarcation proposals: this should refer to a research program, (Lakatos 1974) an epistemic domain or a cognitive discipline, representing common goals of knowledge and practice (Bunge 1982) (Mahner 2007) a theory (K. Popper 1963), a practice, (Lugg 1992) (Morris 1987) a problem or a scientific inquiry (Siitonen 1984) and a specific investigation. (T. Kuhn 1970) (Mayo 1996) The difficulty is to select the demarcation method. Derksen (Derksen 1993) places emphasis on demoting the pseudoscience man (the person who promotes pseudoscience), in the idea that pseudoscience has scientific claims and such claims are associated with a person, not a theory.

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