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Against the Applicability of Popperian Falsificationism

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The demarcation problem, first raised in the early 20th century, concerns the issue of how one could distinguish between sciences and pseudosciences. Austrian-British philosopher of science Karl Popper was famous for his proposed solution to the demarcation problem, the standard of falsifiability. In this essay, I will object to the standard of falsifiability by challenging and rejecting its capability as a response to the demarcation problem. I will achieve this by demonstrating several problems, some universal and some more particular, that arise with the application of the standard of falsifiability to theories in the real world. A wide range of examples will be used to illustrate and reinforce my argument.

Before I discuss the details of Popper's theory, let me define some essential terms to assist readers in understanding this essay:

1) From now on, I will use "falsification" to refer to the method of using the standard of falsifiability to distinguish between sciences and pseudosciences; I will use "Popperian falsificationism" or simply "falsificationism" to refer to the theory that falsification is a solution to the demarcation problem.
2) I sometimes use the word "hypothesis" to refer to a theory being tested with falsification, since that theory provides a prediction that might be corroborated or rejected by experimental evidence.

Popper's theory of falsification has a straightforward argument: that the ability to be falsified is the criterion that separates the sciences from the pseudosciences (Popper 36). Popper contends that a theory can only be considered scientific if predictions based on that theory can potentially be proven wrong by some empirical evidence. Popper believes that the progressive scientific model should involve the following: proposing hypotheses, conducting rigorous testing, and discarding hypotheses if they fail to withstand empirical scrutiny. I will now argue against the applicability of Popperian falsificationism.

The Problem of Existential Statements

I will first discuss a common objection to Popperian falsificationism, the Problem of Existential Statements, and why it is barely successful. Popper explains in his paper that "a theory which is not refutable by any conceivable event is non-scientific." This line suggests that Popper's version of falsification is experimental and observable. Then, we immediately notice how Popper's theory leaves the scientific status of many existential statements unclear (Cohen and Laudan 121). For instance, consider the statement, "There are positrons." What conceivable event, if we follow Popper's theory, would allow us to falsify this statement and deem it scientific? The only hypothetical possibility would be to search the entire universe for positrons and, upon failing to find any, conclude that the statement is false. However, such an experimental approach is practically unachievable — no observation method will allow us to search the entire universe. Then, by falsificationism, we must conclude that the statement "there are positrons" is unscientific, regardless of the truth value in the statement (whether we have already found positrons) and the fact that the existence of positrons is fundamental to highly scientific studies like condensed matter physics and nuclear medicine. We can easily substitute "positrons" with any other scientific entity, and the logic still holds. This suggests a significant underinclusion of falsificationism.

However, though it sounds clear and direct, the above objection does not succeed in refuting Popper's theory. Popper can modify his theory slightly and claim that he focuses on the logical falsifiability of subjects instead of practical/observable falsifiability. If logical falsification is allowed, then any statement that can fit into the following logical structure is falsifiable:

To test whether statement A is scientific, set situation B, which, if true, would lead to "not A." If situation B is logically possible, A is falsifiable regardless of whether situation B is practically observable.

We can solve the problem with the positron statement — and other existential statements — using the above logical structure method. Without the burden of practicality, it is logically possible that no positrons exist in this world (situation B). Thus, statement A is falsifiable and, therefore, scientific. After our slight modification, the Existential Statement Objection has been successfully avoided. I will now move to more effective objections to Popperian falsificationism.

THE PROBLEM OF INCLUSIVITY

As a proposed solution to the demarcation problem, Popperian falsificationism is both underinclusive and overinclusive, which I will demonstrate in this section. Using two effective examples, I will first present the objecting argument that falsificationism is underinclusive. In other words, it excludes certain legitimate scientific studies from falsifiability and scientific status. Let us first consider the theory of evolution, which has been greatly controversial among philosophers. Under falsificationism, theories of evolution would be deemed pseudoscientific. This is not due to the complexity and impracticality of experimentation that follows from the long timescale of evolution, since the falsification theory now only considers the logical falsifiability of theory. Instead, the problem (the reason for its unfalsifiability) lies in what I call the interpretive flexibility of the theories of evolution. Consider the following case:

Evolution scientists have proposed an explanation, using the theory of natural selection, for why giraffes have long necks: long necks provide an advantage to accessing higher foliage as food, so giraffes with long necks were more successful in obtaining food and thus had higher probabilities of survival and reproduction.

It may seem that the above is falsifiable: If researchers were to discover historical evidence of a population of short-necked giraffes living in an area with abundant high foliage, it seems that the above explanation can be falsified. However, the flexible nature of the theories of evolution allows us to disregard this falsification logically. Proponents of the explanation could argue that the theories of evolution can still explain the phenomenon in many ways:

1) Perhaps the resources available in the specific geographic area imposed developmental restraints on the giraffe population.

2) Perhaps in that geographic area, male giraffes with shorter necks have an advantage in attracting female giraffes (sexual selection)

3) Perhaps the geographic area experienced a drop in temperature for many consecutive years, and giraffes with shorter necks had an advantage in survival because they could better regulate blood pressure and blood circulation.

Here, evolution bears a striking resemblance in terms of its interpretive flexibility with theories of psychoanalysis like Freudian psychology: there exist infinite possibilities for offering a logical explanation. The interpretive flexibility of the theories of evolution makes the explanation about the neck length of giraffes unfalsifiable. The same logic can be applied to all other claims about evolution. Therefore, even though evolution is a foundational block of modern biology, Popper's falsificationism categorizes it as a pseudoscience.

Next, let us consider the subject of mathematics. It may initially seem that mathematics demonstrates one of the highest possible levels of falsifiability, since it is primarily based on the proof and utilization of hypotheses. However, notice the axiomatic nature of mathematics — that is, almost all mathematical claims and theories can be reduced to fundamental axioms. Precisely this axiomatic nature makes mathematics unfalsifiable (Feinstein 213). A simple example would be as follows:

Imagine encountering the axiomatic statement "1 + 1 = 2".

Then we realize that there exists no method of falsifying "1 + 1 = 2"; number theory, which the statement is part of, is a collection of mathematical axioms that require no proof and cannot be falsified.

All theories and theorems in pure mathematics can be eventually reduced to a combined interaction between different axioms of mathematics that are as simple and unfalsifiable as "1 + 1 = 2." For instance, Euclidean geometry can be reduced to simple axioms about numbers, shapes, distances, angles, and more. Therefore, Popper's falsificationism deems all of the pure mathematics unfalsifiable and hence unscientific. This is another example of underinclusion — few will agree that mathematics should not be considered science.

In response to these single-case objects, Popper could simply accept the pseudoscientific statuses of evolution theory and mathematics. However bizarre that decision might initially sound to us. Then, he avoids the accusation that his theory is underinclusive. Note that Popper never equates the scientific status of a subject to the value of that subject: he does not undermine the value of evolution theory and mathematics by not labeling them as science.

l will argue now, with the help of an example, that falsificationism is overinclusive at the same time in that it problematically labels many pseudoscientific studies as science. Popper would label a study pseudoscientific in one of three ways:

1) If the study is untestable. Such is the case with Freudian psychoanalysis, the advocates of which can explain any observed human behavior with some theory of human development/experience within psychoanalysis.

2) If people involved in the study refuse to allow any falsification to falsify the study. Popper suggests that such is the case with Karl Marx's theory of history, historical materialism, the advocates of which escape falsification by always re-interpreting the original theory.

3) If people involved in the study disregard the possibility of falsification. Such is the case with astrologists, who neglect any falsifying evidence.

Therefore, according to falsificationism, a theory is not a pseudoscience — and therefore a science — as long as it does not demonstrate any of the three qualities above. It follows that as long as a theory is prepared to indicate specific observations that would cause a change in their minds, it can be labeled as a science (Cohen and Laudan 122). Too many studies fulfill this criterion: people like flat-earthers, Bigfoot researchers, ghost hunters, and Bermuda Triangulors are all ready to accept falsifying evidence. For instance, the statement "there are no Bigfoots in this world" would serve as a sufficient logical falsification for Bigfoot researchers, and Bigfoot researchers themselves widely accept the possibility of this falsification. We are then forced to grant the equal status of being "science" to Bigfoot researchers and positron physicists. This suggests a clear over-inclusivity of falsificationism.

There is one way to avoid the above objection: perhaps we can regard scientific status as a degree. That is to say, even though they are both sciences, perhaps we can say that positron-related physics is somehow more scientific than Bigfoot research. It seems that the problem is resolved if we just label studies like Bigfoot research "bad science." Since the status between positron physicists and Bigfoot researchers is now distinguished, there now exists no clear indication of over-inclusivity. However, another problem arises with this distinction: how can we compare the scientific-ness of two studies? Let us again take Bigfoot research and positron-related physics as an example. Certainly, we can't compare their scientific-ness by comparing their testability, since both studies have the same testability level and even similar testing methodology. We cannot argue that "there are no Bigfoots" is a less effective logical falsification than "there are no positrons." It follows that we cannot argue that "there are Bigfoots" is any less falsifiable than "there are positrons." Secondly, we also cannot compare their scientific-ness by comparing the attitudes of those who study each field, since Bigfoot researchers are just as likely to accept "there are no Bigfoots" as a falsification as positron physicists are to accept "there are no positrons" as a falsification. Lastly, we cannot compare their scientificness by comparing how "risky" the possibility of falsification is, which is the method Popper suggests. Clearly, the consequence that "there are no Bigfoots" would bring to Bigfoot research is very similar to the consequence that "there are no positrons" would bring to positron-related physics. If true, both statements would completely annul their respective studies. Popper's falsificationism provides no functional criterion of comparison for scientific status to exist as a degree.

Again, Popper can simply claim that he accepts Flatearthers, Bigfoot researchers, ghost hunters, and Bermuda Triangle enthusiasts as scientists, and the above chain objection can be avoided to a certain degree. However, we must ask ourselves this: how valuable is a demarcation theory that labels Bigfoot researchers as scientists but mathematicians as pseudoscientists? If Popper continues to simply accept these conclusions, he eventually makes falsificationism minimally practical and strips it of value.

THE PROBLEM OF TESTABILITY AND THE NONFUNCTIONAL NATURE OF FALSIFICATIONISM

In this section of my paper, I argue that no theory may be deemed scientific if we accept Popperian falsificationism. I will reach this conclusion by objecting to the individual testability of virtually any scientific or pseudoscientific theory.

For example, let us examine the falsifiability of Newton's law of universal gravitation, a theory that enjoys universal recognition as science, given by the equation $F = G \cdot (m1m2/r2)$. If we want to test this theory using any method, we realize that using the theory itself is not enough – we cannot observe either side of the equation on its own. To observe force (F), we require some other theory that provides a relationship between the force exerted on an object and its behavior/motion (since we are discussing gravitation, we cannot simply use a device like the force gauge to measure the force). This theory may be Newton's second law of motion, $F = ma$. Still, to use this formula, we need to find a method to measure mass (m) in addition to another theory that connects acceleration (a) to something observable – in this case, perhaps the theory that acceleration is the second derivative of position with respect to time. Then, we need another method that allows us to measure position over time. This process goes on and on.

Inspecting the right side of Newton's law of universal gravitation equation would lead us into a similar, if not more complex, path of constantly adding background assumptions, which I call auxiliary hypotheses. At this point, it has become clear that Newton's law of universal gravitation is not testable on its own but only with the help of the auxiliary hypotheses. Note that the law of universal gravitation is already a theory of remarkable clarity, concerning only five variables in total. This implies that we would require even more auxiliary hypotheses to put the more complex scientific theories to test. Hence, most scientific theories are strictly never testable on their own, only after we add many auxiliary hypotheses and procedures. Assessing these theories with Popperian falsificationism, we would then deem all of these individually untestable theories, Newton's law of universal gravitation included, as pseudoscience. It is absurd that any theory of the slightest complexity must no longer be labeled as science, so falsificationism must not be accepted.

Following that blunt statement, let us attempt to practice some charity to Popper by claiming that it is acceptable to test a theory together with auxiliary hypotheses — that we no longer bother ourselves with falsification *simpliciter* but accept some form of falsification *complicatim*. Would this modification allow the theories above to be falsifiable? No, because the existence of auxiliary hypotheses does not only mean that the theory is not testable on its own. There are further problematic implications.

Suppose we have tested a theory, say the law of universal gravitation, with the help of auxiliary hypotheses, and the results differ from what the theory predicted. What can this tell us? Only that at least one of the hypotheses made, whether the auxiliary ones or the law of universal gravitation itself, is false. Logically, there is no method of pinpointing which hypotheses are falsified in the process. Since the experimental results cannot indicate the falsity of the law of universal gravitation – in other words, there exists no possibility that any outcome would falsify the law of universal gravitation – this theory is unfalsifiable. Then, any scientific theory requiring auxiliary hypotheses during experimental testing would still be unfalsifiable even if we accept falsification *complicatim*. Thus, Popperian falsificationism remains highly problematic.

A similar line of objection can be found in the Duhem-Quine thesis developed by P. Duhem and W. Quine, which I highly recommend for interested readers to explore (Quine 21).

The necessary existence of auxiliary hypotheses while testing most scientific theories leads to another practical objection to falsificationism, which I will briefly outline here. When scientists encounter experimental falsifications (results that do not align with predictions from theory) while testing a theory, they rarely give up that theory. Instead, they almost always assume that the problem lies in

one of the auxiliary hypotheses. Logically, though they may initially seem different, what scientists do when they assume the falsity of some auxiliary hypotheses is highly similar to what pseudoscientists do when they establish new hypotheses to protect their theories from contradictory evidence. Then, we are left with no clear distinction between scientists and pseudoscientists. Perhaps one could argue that the difference between scientists and pseudoscientists, in this scenario, is one about their attitudes – that the pseudoscientists are coming up with explanations solely to protect their theory, whereas scientists are more interested in the truth. However, there is no clear criterion to distinguish these two attitudes effectively. Popper does not provide any guidance, either. Therefore, we must again accept that Popperian falsificationism is nonfunctional in practice.

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