Falsifiability [1]

Karl Popper's Basic Scientific Principle

Falsifiability, according to the philosopher Karl Popper, defines the inherent testability of any scientific hypothesis.

Science and philosophy [3] have always worked together to try to uncover truths [4] about the universe we live in. Indeed, ancient philosophy can be understood as the originator of many of the separate fields of study we have today, including psychology, medicine, law, astronomy, art and even theology.

Scientists design experiments [5] and try to obtain results verifying or disproving a hypothesis, but philosophers are interested in understanding what factors determine the validity [6] of scientific endeavors in the first place.

Whilst most scientists work within established paradigms, philosophers question the paradigms themselves and try to explore our underlying assumptions and definitions behind the logic of how we seek knowledge. Thus there is a feedback relationship between science and philosophy - and sometimes plenty of tension!

One of the tenets behind the scientific method is that any scientific hypothesis [7] and resultant experimental design must be inherently falsifiable. Although falsifiability is not universally accepted, it is still the foundation of the majority of scientific experiments. Most scientists accept and work with this tenet, but it has its roots in philosophy and the deeper questions of truth and our access to it.

What is Falsifiability?

Falsifiability is the assertion that for any hypothesis to have credence, it must be inherently disprovable before it can become accepted as a scientific hypothesis or theory.

For example, someone might claim "the earth is younger than many scientists state, and in fact was created to *appear* as though it was older through deceptive fossils etc." This is a claim that is unfalsifiable because it is a theory that can never be shown to be false. If you were to present such a person with fossils, geological data or arguments about the nature of compounds in the ozone, they could refute the argument by saying that your evidence was fabricated to appeared that way, and isn't valid.

Importantly, falsifiability doesn't mean that there are currently arguments against a theory, only that it is possible to imagine some kind of argument which would invalidate it. Falsifiability says nothing about an argument's inherent validity or correctness. It is only the minimum trait required of a claim that allows it to be engaged with in a scientific manner – a dividing line between what is considered science and what isn't. Another important point is that falsifiability is not any claim that has yet to be proven true. After all, a conjecture that hasn't been proven yet is just a hypothesis.

The idea is that no theory is completely correct [4], but if it can be shown both to be falsifiable *and* supported with evidence that shows it's true, it can be accepted as truth.

For example, Newton's Theory of Gravity was accepted as truth for centuries, because objects do not randomly float away from the earth. It appeared to fit the data obtained by experimentation [8] and research [9], but was always subject to testing.

However, Einstein's theory makes falsifiable predictions that are different from predictions made by Newton's theory, for example concerning the precession of the orbit of Mercury, and gravitational lensing of light. In non-extreme situations Einstein's and Newton's theories make the same predictions, so they are both correct. But Einstein's theory holds true in a superset of the conditions in which Newton's theory holds, so according to the principle of Occam's Razor [10], Einstein's theory is preferred. On the other hand, Newtonian calculations are simpler, so Newton's theory is useful for almost any engineering project, including some space projects. But for GPS we need Einstein's theory. Scientists would not have arrived at either of these theories, or a compromise between both of them, without the use of testable, falsifiable experiments.

Popper saw falsifiability as a black and white definition; that if a theory is falsifiable, it is scientific [11], and if not, then it is unscientific. Whilst some "pure" sciences do adhere to this strict criterion, many fall somewhere between the two extremes, with pseudo-sciences [12] falling at the extreme end of being unfalsifiable.

Pseudoscience

According to Popper, many branches of applied science, especially social science, are not truly scientific because they have no potential for falsification.

Anthropology and sociology, for example, often use case studies [13] to observe people in their natural environment without actually testing [14] any specific hypotheses or theories.

While such studies and ideas are not falsifiable, most would agree that they are scientific because they significantly advance human knowledge.

Popper had and still has his fair share of critics, and the question of how to demarcate legitimate scientific enquiry can get very convoluted. Some statements are logically falsifiable but not practically falsifiable – consider the famous example of “it will rain at this location in a million years' time.” You could absolutely *conceive* of a way to test this claim, but carrying it out is a different story.

Thus, falsifiability is not a simple black and white matter. The Raven Paradox [15] shows the inherent danger of relying on falsifiability, because very few scientific experiments can measure all of the data, and necessarily rely upon generalization [16]. Technologies change along with our aims and comprehension of the phenomena we study, and so the falsifiability criterion for good science is subject to shifting.

Conclusion

For many sciences, the idea of falsifiability is a useful tool for generating theories that are testable and realistic. Testability is a crucial starting point around which to design solid experiments that have a chance of telling us something useful about the phenomena in question. If a falsifiable theory is tested and the results are significant [17], then it can become accepted as a scientific truth.

The advantage of Popper's idea is that such truths can be falsified when more knowledge and resources are available. Even long accepted theories such as Gravity, Relativity and Evolution are increasingly challenged and adapted.

The major disadvantage of falsifiability is that it is very strict in its definitions and does not take into account the contributions of sciences that are observational [18] and descriptive [19].

Source URL: https://staging.explorable.com/en/falsifiability

Links
[1] https://staging.explorable.com/en/falsifiability
[2] https://staging.explorable.com/en
[3] https://explorable.com/philosophy-of-science
[4] https://explorable.com/truth-and-theory
[5] https://explorable.com/design-of-experiment
[6] https://explorable.com/types-of-validity
[7] https://explorable.com/research-hypothesis
[8] https://explorable.com/conducting-an-experiment
[9] https://explorable.com/what-is-research
[10] http://explorable.com/occams-razor
[11] https://explorable.com/what-is-the-scientific-method
[12] https://explorable.com/pseudoscience
[13] https://explorable.com/case-study-research-design
[14] https://explorable.com/hypothesis-testing
[15] https://explorable.com/raven-paradox
[16] https://explorable.com/what-is-generalization
[17] https://explorable.com/statistically-significant-results
[18] https://explorable.com/observational-study
[19] https://explorable.com/descriptive-research-design