

## **Falsifiability**

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Edge's question this year [What have you changed your mind about? Why?] wittily refers to a way of demarcating science from philosophy and religion. "When thinking changes your mind, that's philosophy ... When facts change your mind, that's science." Behind the witticism lies the important claim that science—or more precisely, scientific theories—can be clearly distinguished from all other theories, that scientific theories bear a special mark, and what this mark is is falsifiability. Said Popper: *The criterion of the scientific status of a theory is its falsifiability.*

For most scientists, this is all they need to know about the philosophy of science. It was bracing to come upon such a clear and precise criterion for identifying scientific theories. And it was gratifying to see how Popper used it to discredit the claims that psychoanalysis and Marxism are scientific theories. It had long seemed to me that the falsifiability test was basically right and enormously useful.

But then I started to read Popper's work carefully, to teach him in my philosophy of science classes, and to look to scientific practice to see whether his theory survives the test of falsifiability (at least as a description of how successful science gets done). And I've changed my mind.

For one thing, Popper's characterization of how science is practiced—as a cycle of conjecture and refutation—bears little relation to what goes on in the labs and journals. He describes science as if it was skeet-shooting, as if the only goal of science is to prove that one theory after another is false. But just open a copy of *Science*. To pick a random example: "In a probabilistic learning task, A1-allele carriers with reduced dopamine D2 receptor densities learned to avoid actions with negative consequences less efficiently." Not, "We tried to falsify the hypothesis that A1 carriers are less efficient learners, and failed." Scientists rarely write the way that Popper says they should, and a good Popperian should recognize that the Master may have over-simplified the logic of theory testing.

Also, scientists don't, and shouldn't, jettison a theory as soon as a disconfirming datum comes in. As Francis Crick once said, "Any theory that can account for all of the facts is wrong, because some of the facts are always wrong." Scientists rightly question a datum that appears to falsify an elegant and well-supported theory, and they rightly add assumptions and qualifications and complications to a theory as they learn more about the world. As Imre Lakatos, a less-cited (but more subtle) philosopher of science points out, all scientific theories are unfalsifiable. The ones we take seriously are those that lead to "progressive" research programs, where a small change accommodates a large swath of past and future data. And the ones we abandon are those that lead to "degenerate" ones, where the theory gets patched and re-patched at the same rate as new facts come in.

Another problem with the falsifiability criterion is that I have seen it become a blunt instrument, unthinkingly applied. Popper tried to use it to discredit not only Marxism and Freudianism as scientific theories but also Darwin's theory of natural selection—a position that only a creationist could hold today. I have seen scientists claim that major theories in contemporary cosmology and physics are not "science" because they can't think of a simple test that would falsify them. You'd think that when they are faced with a conflict between what scientists really do and their memorized Popperian sound-bite about how science ought to be done, they might question the sound bite, and go back and learn more than a single sentence from the philosophy of science. But such is the godlike authority of Popper that his is the one theory that can never be falsified!

Finally, I've come to think that identifying scientificity with falsifiability lets certain non-scientific theories off the hook, by saying that we should try to find good reasons to believe whether a theory is true or false only when that theory is called "science." It allows believers to protect their pet theories by saying that they can't be, and shouldn't be, subject to falsification, just because they're clearly not scientific theories. Take the theory that there's an omnipotent, omniscient, benevolent God. It may not be a scientific hypothesis, but it seems to me to be eminently falsifiable; in fact, it seems to have been amply falsified. But because falsifiability is seen as demarcating the scientific, and since theism is so clearly not scientific, believers in religious ideologies get a free pass. The same is true for many political ideologies. The parity between scientific and nonscientific ideas is concealed by thinking that there's a simple test that distinguishes science from nonscience, and that that test is falsifiability.