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Drawing the line between science and pseudo-science

Janet D. Stemwedel

Associate Professor of Philosophy at San José State University

Recently, we've been discussing strategies for distinguishing sound science from attractively packaged snake-oil. It's worth noting that a fair number of scientists (and of non-scientists who are reasonably science-literate) are of the view that this is not a hard call to make -- that astrology, alternative therapies, ESP, and the other usual suspects fall on the wrong side of some bright line that divides what is scientific from what is not -- the clear line of demarcation that (scientists seem to assume) Karl Popper pointed out years ago, and that keeps the borders of science secure.

While I think a fair amount of non-science is so far from the presumptive border that we are well within our rights to just point at it and laugh, as a philosopher of science I need to go on the record as saying that right at the boundary, things are not so sharp. But before we get into how real science (and real non-science) might depart from Sir Karl's image of things, I think it's important to look more closely at the distinction he's trying to draw.

A central part of Karl Popper's project is figuring out how to draw the line between *science* and *pseudo-science*. He could have pitched this as figuring out how to draw the line between science and non-science (which seems like less a term of abuse than "pseudo-science"). Why set the project up this way? Partly, I think, he wanted to compare science to non-science-that-looks-a-lot-like-science (in other words, pseudo-science) so that he could work out precisely what is missing from the latter. He *doesn't* think we should dismiss pseudo-science as utterly useless, uninteresting, or false. It's just not science.

Of course, Popper wouldn't be going to the trouble of trying to spell out what separates science from non-science if he didn't think there was something special on the science side of the line. He seems committed to the idea that scientific methodology is well-suited -- perhaps uniquely so -- for building reliable knowledge and for avoiding false beliefs. Indeed, under the assumption that science has this kind of power, one of the problems with pseudo-science is that it gets an unfair credibility boost by so cleverly mimicking the surface appearance of science.

The big difference Popper identifies between science and pseudo-science is a difference in attitude. While a pseudo-science is set up to look for evidence that supports its claims, Popper says, a science is set up to *challenge* its claims and look for evidence that might prove it false. In other words, ***pseudo-science seeks confirmations and science seeks falsifications.***

There is a corresponding difference that Popper sees in the form of the claims made by sciences and pseudo-sciences: ***Scientific claims are falsifiable*** -- that is, they are claims where you could set out what observable outcomes would be impossible if the claim were true -- ***while pseudo-scientific claims fit with any imaginable set of observable outcomes.*** What this means is that you could do a test that shows a scientific claim to be false, but no conceivable test could show a pseudo-scientific claim to be false. ***Sciences are testable, pseudo-sciences are not.***

So, Popper has this picture of the scientific attitude that involves taking risks: making bold claims, then gathering all the evidence you can think of that might knock them down. If they stand up to your attempts to falsify them, the claims are still in play. But, you keep that hard-headed attitude and keep you eyes open for further evidence that could falsify the claims. If you decide *not* to watch for such evidence -- deciding, in effect, that because the claim hasn't been falsified in however many attempts you've made to falsify it, it must be true -- you've crossed the line to pseudo-science.

This sets up the central asymmetry in Popper's picture of what we can know. We can find evidence to establish with certainty that a claim is false. However, we can never (owing to the problem of induction) find evidence to establish with certainty that a claim is true. So the scientist realizes that her best hypotheses and theories are always tentative -- some piece of future evidence could conceivably show

them false -- while the pseudo-scientist is sure as sure as can be that her theories have been proven true. (Of course, they haven't been -- problem of induction again.)

So, why does this difference between science and pseudo-science matter? As Popper notes, the difference is not a matter of scientific theories always being true and pseudo-scientific theories always being false. The important difference seems to be in ***which approach gives better logical justification for knowledge claims.*** A pseudo-science may make you *feel* like you've got a good picture of how the world works, but you could well be wrong about it. If a scientific picture of the world is wrong, that hard-headed scientific attitude means the chances are good that we'll find out we're wrong -- one of those tests of our hypotheses will turn up the data that falsifies them -- and switch to a different picture.

A few details are important to watch here. The first is the distinction between a claim that is ***falsifiable*** and a claim that has been ***falsified.*** Popper says that scientific claims are falsifiable and pseudo-scientific claims are not. A claim that has been falsified (demonstrated to be false) is obviously a falsifiable claim (because, by golly, it's been falsified). Once a claim has been falsified, Popper says the right thing to do is let it go and move on to a different falsifiable claim. However, it's not that the claim shouldn't have been a part of science in the first place. So, the claim that the planets travel in circular orbits wasn't an inherently unscientific claim. Indeed, because it*could* be falsified by observations, it is just the kind of claim scientists should work with. But, once the observations show that this claim is false, scientists retire it and replace it with a different falsifiable claim.

This detail is important! Popper isn't saying that science *never* makes false claims! What he's saying is that the scientific attitude is aimed at locating and removing the false claims -- something that doesn't happen in pseudo-sciences.

Another note on "falsifiability" -- the fact that many attempts to falsify a claim have failed does not mean that the claim is unfalsifiable. Nor, for that matter, would the fact that the claim is true make it unfalsifiable. A claim is falsifiable if there are certain observations we could make that would tell us the claim is false -- certain observable ways the world *could not be* if the claim were true. So, the claim that

Mars moves in an elliptical orbit around the sun could be falsified by observations of Mars moving in an orbit that deviated at all from an elliptical shape.

Another important detail is just what scientists mean by "theory". A theory is simply a scientific account (or description, or story) about a system or a piece of the world. Typically, a theory will contain a number of hypotheses about what kind of entities are part of the system and how those entities behave. (The hypothesized behaviors are sometimes described as the "laws" governing the system.) The important thing to note is that ***theories can be rather speculative or extremely well tested -- either way, they're still theories.***

Some people talk as though there's a certain threshold a theory crosses to become a fact, or truth, or something more-certain-than-a-theory. This is a misleading way of talking. Unless Popper is completely wrong that the scientist's acceptance of a theory is always tentative (and this is one piece of Popper's account that most scientists whole-heartedly endorse), then even the theory with the best evidential support is still a theory. Indeed, even if a theory happened to be completely true, it would still be a theory! (Why? You could never be absolutely certain that some future observation might not falsify the theory. In other words, on the basis of the evidence, you can't be 100% sure that the theory is true.)

So, for example, dismissing Darwin's theory as "just a theory" as if that were a strike against it is misunderstanding what science is up to. *Of course* there is some uncertainty; there is with all scientific theories. *Of course* there are certain claims the theory makes that might turn out to be false; but the fact that there is evidence we could conceivably get to demonstrate these claims are false is a scientific virtue, not a sign that the theory is unscientific.

By contrast, "Creation Science" and "Intelligent Design Theory" don't make falsifiable claims (at least, this is what many people think; Larry Laudan* disputes this but points out *different* reasons these theories don't count as scientific). There's no conceivable evidence we could locate that could demonstrate the claims of these theories are false. Thus, these theories just aren't scientific. Certainly, their proponents point to all sorts of evidence that fits well with these theories, but they never make any serious efforts to

look for evidence that could prove the theories false. Their acceptance of these theories isn't a matter of having proof that the theories are true, or even a matter of these theories having successfully withstood many serious attempts to falsify them. Rather, it's a matter of faith.

None of this means Darwin's theory is necessarily true and "Creation Science" is necessarily false. But it does mean (in the Popperian view that most scientists endorse) that Darwin's theory is scientific and "Creation Science" is not.

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