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PSEUDOSCIENCE

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Good science, bad science, pseudoscience

Pseudoscience is not science, though it masquerades as science. (We'll unpack this accusation of masquerading below.) But not all non-science is pseudoscience. Playing football, writing a novel, and dancing a jig are all activities that are neither scientific nor pseudoscientific. (One can, of course, scientifically study each of these activities – and presumably it's equally possible to pseudoscientifically study them.) But such activities, as standardly engaged in, are neither scientific nor pseudoscientific.

So, we have a three-part distinction: science, non-science that is pseudoscience, and non-science that is not pseudoscience. Within the "science" category, it is helpful to distinguish between good science and bad science. Suppose a worker in a chemistry lab accidentally contaminates a sample, makes an incorrect pipette reading, and reports a false result as a consequence. Assuming that this worker is otherwise behaving as one normally would while working in a chemistry lab, then this worker is doing bad science, but not pseudoscience. Bad science is still science.

Regarding what counts as doing bad science, it's the behavior that violates the norms of scientific practice that's the key, not the achieving of the false result. Suppose that some physicists add two numbers incorrectly, and end up getting a true result as a consequence – the theory they are working with is a false theory, and their math error coincidentally is what was needed for the theory to generate a true result. Still, the behavior of adding numbers incorrectly is bad science, and that's what the physicists are doing.

But the key point is that violating the norms of scientific practice isn't by itself enough to count as pseudoscience – violating the norms is not a sufficient condition. This raises the question: what are the conditions that are jointly sufficient and necessary for something to count as pseudoscience?

Some examples of pseudoscience

Analyses of the concept of pseudoscience are all controversial, as we'll see below. It's somewhat less controversial to give examples of particular instances of pseudoscience. Martin Gardner is probably the most famous pseudoscience-debunker, and even he

admits that it's hard to demarcate between pseudoscience and science: "Pseudoscience is a fuzzy word that refers to a vague portion of a continuum on which there are no sharp boundaries" (Gardner 2001: 1). Gardner divides this continuum into four categories. On one end are "beliefs which all scientists find preposterous," such as the claim that the earth is a hollow sphere and we are living inside it, or the claim that the earth was created 10,000 years ago. Next, there are "slightly less weird claims," such as homeopathy and Scientology. Gardner's next category are "controversial claims" (Gardner 2001: 2), such as the belief that God played a role in guiding evolution, and claims about the ability to extract unlimited energy from the vacuum of space. Gardner's last category is "open conjectures by scientists," such as speculations about other universes, and panspermia – the view that life originated elsewhere and then came to earth.

The National Science Board of the United States National Science Foundation (NSF) issued a 2006 report on American public attitudes towards science, in which it said that many Americans have pseudoscientific beliefs (National Science Board 2006). The beliefs listed in the report include: astrology, lucky numbers, the existence of unidentified flying objects (UFOs), extrasensory perception (ESP), magnetic therapy, clairvoyance, ghosts, mentally communicating with the dead, and channeling (allowing a spirit being to temporarily assume control of a human body during a trance).

Lists of particular pseudoscientific claims are often controversial, or at least open to interpretation. For example, consider the NSF claim that belief in the existence of unidentified flying objects is a pseudoscientific belief. Taken literally, that belief isn't pseudoscientific; it's clearly true. There are some mysterious objects that competent people like commercial and military pilots have seen in the sky that remain unidentified.

The NSF report also declares that clairvoyance is pseudoscientific, and points out that many Americans believe in it. But here is the definition of clairvoyance, as given in the report: "the power of the mind to know the past and predict the future." I believe that I do have such power: I know that the Sun rose yesterday, and I predict that the Sun will rise tomorrow.

Thus, one has to be careful in declaring a particular claim to be pseudoscientific – it may be that one is just interpreting the claim differently than other people, or not adequately taking into account ways in which believing the claim could be a reasonable scientific thing to do.

Another reason to be careful in declaring a claim to be pseudoscientific is that, historically, some people have done so, when later developments have shown that the claim in question actually has a solid scientific basis. For example, the claim that rocks sometimes fall from the sky was once declared a pseudoscientific claim (Hines 2003: 35). But we now know that meteorites are real.

Here's another (slightly more controversial) example. The claim that acupuncture is medically effective has in the past been declared a pseudoscientific claim (by e.g. Sampson et al. (1991)), but we now have some plausible scientific evidence for acupuncture's effectiveness (Allchin 1996; Jones 2002). (Note that there does not yet

exist an agreed-upon theory that explains the effectiveness of acupuncture, but that doesn't mean that it's not an effective medical intervention.)

What sort of thing is pseudoscience?

Even though there is a widely agreed-upon list of theories and practices that count as pseudoscience, it's not obvious how to come up with an analysis that demarcates those from cases of science. The above examples of pseudoscience are helpful, but they provide only an incomplete characterization of pseudoscience. Perhaps they are enough if one is simply trying to provide them as paradigm cases, where future cases of possible pseudoscience can be compared to them. But what many would like is an analysis of the form: X is pseudoscience if and only if –, where the blank is filled in with conditions that are jointly necessary and sufficient for something to count as pseudoscience.

Before talking about how to fill in that blank, let's ask a preliminary question: what category of reality does X fall into? I'll consider five possibilities: X is a statement, X is a theory, X is a pairing of a theory and evidence, X is the behavior of a person, and X is the behavior of a group of people.

Imre Lakatos (1974: 5) treats pseudoscience as applying to statements; he writes that "a statement may be pseudoscientific even if it is eminently 'plausible' and everybody believes in it." Thus, by his lights, a single statement like "There is a monster living in Loch Ness" could be a pseudoscientific statement.

One could argue instead that the concept of pseudoscience applies to theories, where a theory is roughly understood as a related set of claims about the world, or as a model of a part of reality. Paul Thagard (1978), for example, characterizes the concept of pseudoscience in terms of theories (we'll critically examine his definition below).

On the view that statements or theories are what count as pseudoscientific, it's not a matter of logic that they so count. It's logically possible for us to live in a world where, for example, spirit beings exist and can control a human body, and astrology is accurate in predicting people's personality characteristics. So, in assessing channeling and astrology as pseudoscientific, one must do so in a context where one is taking into account empirical beliefs about the world.

Because of this, some would argue that evidence plays a key role in declaring something pseudoscientific, and that really it's the pairing of the theory (or statement) and evidence that counts as pseudoscientific. It's easiest to consider this view with an example. In ancient times, people believed that the Earth was flat, and they had good reason for doing so, given the evidence they had: the interior angles of triangles they drew summed to 180 degrees, when people traveled in one direction they didn't come back to their starting point, and so on. Given the evidence they had, it was a reasonable scientific hypothesis that the Earth was flat. But given the evidence we have, such a view is pseudoscientific.

On this view of pseudoscience, what counts as pseudoscience is time dependent. It may also be culture dependent – a contemporary isolated tribe could have the same evidence that the ancients had, and so for that tribe it is a reasonable

scientific hypothesis that the Earth is flat. But if a member of our culture and our epistemic community were to endorse the hypothesis, that person would be behaving pseudoscientifically.

This leads to my next point. Some (such as Derksen 1993) would argue that looking at the evidence/theory relation still misses something crucial about what counts as pseudoscience – they would say that it's really the behavior of a person that should be evaluated as pseudoscientific or not. For example, one can approach astrology in a pseudoscientific way, by blithely endorsing its pronouncements on personality traits, or one can approach it in a scientific way, by conducting a rigorous experiment to test astrology's pronouncements. Indeed, it is because such rigorous experiments have been done that we are confident that astrology is a false theory. The person who is conducting rigorous experiments to test the predictions of astrology is not being pseudoscientific (even if that person is aware of all the evidence we have that astrology is a false theory). But the person who endorses astrology, and ignores all the countervailing evidence, is being pseudoscientific.

If the person's behavior is what counts, then one could pseudoscientifically argue for a legitimate scientific theory. For example, suppose that Fred says that fairies have assured him that general relativity is true; Fred is, arguably, behaving pseudoscientifically.

Finally, it may not be the behavior of a person that counts as pseudoscientific, but the behavior of a group of people. Specifically, sometimes a "practice" is declared pseudoscientific. The idea here is that individuals have their idiosyncrasies; what we should focus on is whether the group of people are generally behaving in a scientifically legitimate way.

To sum up: we've looked at a number of options for what could count as pseudoscience: a statement, a theory, pairing of a theory and evidence, the behavior of a person, and the behavior of a group of people. Note that a combination of these views could be true. For example, it could be that, when evaluating a theory as pseudoscientific, we should look at the relationship between the available evidence and the theory, while when evaluating a person as a pseudoscientist, we should look at the behavior of the person.

Pseudoscience – an analysis

Let's now look at an example of an analysis of the concept of pseudoscience, filling in the blank in: "X is pseudoscience if and only if –." A promising analysis is due to Paul Thagard. He writes:

> A theory is said to be pseudoscientific if and only if (1) it has been less progressive than alternative theories over a long period of time, and faces many unsolved problems, but (2) the community of practitioners makes little attempt to develop the theory towards solutions of the problems, shows no concern for attempts to evaluate the theory in relation to others, and is selective in considering confirmations and disconfirmations.
>
> (Thagard 1978: 227–28)

One arguable virtue of this account is that it yields the result that whether a theory is scientific or not depends in part on when the theory is being evaluated. Another arguable virtue is that it brings in the behavior of practitioners, and doesn't just focus on the content of the theory.

But there are arguably objectionable consequences of Thagard's definition too. Here are two. First, a theory can be pseudoscientific only if there are alternative theories to which it can be compared. Thagard admits this consequence; for example, he writes:

> The current fad of biorhythms, implausibly based like astrology on date of birth, can not be branded as pseudoscientific because we lack alternative theories giving more detailed accounts of cyclical variations in human beings …
>
> (Thagard 1978: 229)

Pace Thagard, I maintain that biorhythm theory can be declared pseudoscientific, simply because of the evidence that refutes it, and the behavior of the practitioners in the face of that evidence.

Thagard's bringing in of the community of practitioners in the definition of pseudoscience has merit, but it leads to the second troubling consequence of his definition. Consider some theory that has been less progressive than alternative theories over a long period, and faces many unsolved problems, but 90 percent of the community of practitioners of that theory are making strenuous attempts to develop the theory toward the solutions of the problems. Suppose that the other 10 percent of the community of practitioners are slackers: they aren't developing the theory, show no concern for attempts to comparatively evaluate the theory, and are selective in considering confirmations and disconfirmations. Suppose that the productive members of the community all go to a conference, and an evil scientist kills them all, so only the slackers are left. Does it follow that the evil scientist caused the theory in question to become pseudoscientific? This is what follows from Thagard's definition, but it strikes me as an implausible consequence.

Pseudoscience – characteristic features

We've seen an example of how to define "pseudoscience" via conceptual analysis; let's now consider a different way of getting a grip on that concept. Instead of giving necessary and sufficient conditions for the concept to hold, some philosophers think it's better to just give a list of features that, while neither necessary nor sufficient, are commonly characteristic "warning signs" of pseudoscience. Here is the type of list that is given (based on Bunge 1984; Lilienfeld 2005; and Hansson 2008):

- A tendency to invoke ad hoc hypotheses, as a means of immunizing claims from falsification.
- A neglecting of observations or experiments that conflict with a theory.
- A tendency to place the burden of proof on skeptics, not proponents, of claims.

- Reliance on experiments that cannot be repeated by others with the same outcome.
- Reliance on some authorities as having a special ability to determine what is true or false.
- Excessive reliance on anecdotal and testimonial evidence.
- Evasion of the scrutiny afforded by peer review.
- Failure to build on existing scientific knowledge.
- Use of impressive-sounding jargon whose primary purpose is to lend claims a facade of scientific respectability.

The more a practice exhibits such features, the more likely it is to be pseudoscientific.

Another related characterization of pseudoscience is provided by Clark Glymour and Douglas Stalker (1982). They do not attempt to provide jointly necessary and sufficient conditions, but instead provide an amusing characterization of the fundamental principles of pseudoscience construction, and use this to construct two original pseudosciences. (The principles include: find some coincidences and base your theory around them; say that the coincidences happened because of a cosmic plan; and don't get bogged down with facts.)

Finally, I'll mention Frank Cioffi's important essay "Freud and the Idea of a Pseudoscience." Cioffi's main point is that "A pseudoscience is not constituted merely by formally defective theses but by methodologically defective procedures" (Cioffi 1970: 115). He argues, specifically, that Freudian psychoanalysis utilizes these methodologically defective procedures, and is hence a pseudoscience. Cioffi never tries to spell out his characterization of the methodologically defective procedures in terms of necessary and sufficient conditions, but the main procedures he focuses on are those that enable psychoanalysis to avoid refutation. For example, Cioffi argues that Freud provides an explanation of a child's sadistic behavior as a product of the actions of his punitive father, but also, elsewhere, provides an explanation of a child's sadistic behavior as a product of the fact that the child had a lenient and indulgent father (Cioffi 1970: 128). Setting up a theory or practice to avoid refutation is presumably neither necessary nor sufficient for something to be a pseudoscience, but it is at least sometimes a characteristic of pseudoscience.

Problems with analysis

Which is more helpful, providing an analysis of the concept of pseudoscience, or providing a list of common characteristics? Listing the common characteristics is nonideal, for the obvious reason that one can't logically deduce whether something is a pseudoscience from the fact that it meets some of the characteristics. An analysis, on the other hand, does in principle enable one to simply divide up the world into pseudoscience and non-pseudoscience. Nevertheless, there are three problems I want to raise with the project of giving a conceptual analysis of pseudoscience.

The first problem is simply that it's hard to give a successful analysis of the concept of pseudoscience – I've never come across one that I wasn't able to generate a counterexample to. Larry Laudan makes a related point about the project of analyzing science,

in his famous 1983 paper "The Demise of the Demarcation Problem". Laudan argues that all criteria that have been given in the past to attempt to demarcate between science and non-science have turned out to be unsuccessful.

My second concern is a general one, about the whole project of analysis. Specifically, I have some sympathies with the argument behind the paradox of analysis. The purported paradox is as follows: if one knows what the meaning of a concept is, one doesn't need to do the analysis; if one doesn't know what the meaning of a concept is, one won't be able to do the analysis. So doing conceptual analysis is either unhelpful or impossible.

Here is the third and final worry I have about the project of giving a conceptual analysis of pseudoscience. The worry is that, in focusing on what the correct analysis is of a concept, one gets side-tracked from the important issues one should be discussing. Suppose that Alice claims that she has achieved cold fusion in her laboratory, and Bob looks at her evidence and accuses her of doing pseudoscience. The discussion could continue in such a way that Alice argues that the evidence does support her claim, or the discussion could continue in such a way that Alice argues that the concept of pseudoscience is such that what she is doing doesn't count as pseudoscience. The important discussion to be having in this context is the former one – does the evidence support the claim? Whether what she is doing counts as pseudoscience is less relevant. (While I gave a fictional example to illustrate this point, a real-life example occurs in the contemporary debates about whether intelligent design theory is pseudo-scientific – see the "Further reading" section below.)

"Pseudoscience" as emotive work

What does one achieve by declaring some theory or practice "pseudoscience"? Laudan, in his aforementioned paper, argues that such a declaration merely expresses an emotive condemnation of that theory or practice. Laudan writes:

> If we would stand up and be counted on the side of reason, we ought to drop terms like "pseudo-science" and "unscientific" from our vocabulary; they are just hollow phrases which do only emotive work for us.
>
> (Laudan 1983: 349)

Laudan says that, instead, we should focus on the evidence for and against the claims made.

Relatedly, historian of science Michael Gordin (2012) argues that scientists designate a doctrine as "pseudoscience" only when the scientists perceive themselves to be threatened – perhaps by the new ideas themselves, but potentially also by what those ideas represent about the authority of science. Those who ignore the opinion of Laudan and Gordin, and continue using the term "pseudoscience" to reflect negatively about a theory or practice, may also unintentionally be reflecting negatively on themselves.

Laudan's overall point, in his paper where he says that we should drop terms like "pseudo-science" from our vocabulary, is that the project of demarcating between

science and non-science is a project that we should give up on. While I have some sympathies with this position, I worry that it goes too far. Some claims can be made about the difference between science and non-science, and these claims are helpful. For example, it is helpful to note that we shouldn't necessarily expect more certainty from science than from non-science. We can be more certain about what will happen in a football game than we can about what will happen in a particle detector, for example. Ironically, Laudan, in the course of eschewing the demarcation between science and non-science, gets this wrong. He says that

> any philosophically interesting demarcation device must distinguish scientific and non-scientific matters in a way which exhibits a surer epistemic warrant or evidential ground for science than for non-science.
>
> (Laudan 1983: 343)

If one followed this desideratum, though, one would get an implausible demarcation, because in fact we often have surer epistemic warrant for non-scientific claims than for scientific claims.

Just as it can be helpful to examine the differences between science and non-science, so it can be helpful to examine the differences between science and pseudoscience. We can gain a better understanding of how science works by trying to figure out why, for example, general relativity is a science while ESP is a pseudoscience. But the project of giving a general analysis of the concept of pseudoscience, in such a way that one can apply that analysis to any future theory or instance of human practice to determine whether or not it counts as pseudoscience, outstrips our abilities to conceptualize how all possible future instances of science and pseudoscience might go.

The scientific method, Feyerabend, and astrology

So far, I haven't talked about the scientific method, which is sometimes appealed to as a way of demarcating between science and pseudoscience. The reason I haven't is that I agree with, for example, Paul Feyerabend (1975), who argues that there is no such thing as "the scientific method." Different methods have been successfully used by scientists in different fields and at different times. Any attempt to lay out the methodology of science would simply impose inappropriate and unhelpful constraints on future scientific work. Feyerabend presents a number of historical examples to argue that new and successful science work violated the then-extant canons of scientific methodology. Once the new science was recognized as successful, the canons of scientific methodology simply changed to accommodate the new work.

What would Feyerabend say about a particular example of a purported pseudoscience, like astrology? He has a fascinating piece criticizing a statement by 186 "leading scientists" that objects to astrology (Bok et al., 1975). Feyerabend (1978) maintains that their arguments against astrology are misguided, and don't recognize the sophisticated foundation that astrology is built on. He also argues that, while the leading scientists successfully show that certain predictions of astrology are incorrect,

"every moderately interesting theory is always in conflict with numerous experimental results" (Feyerabend 1978: 26).

When I forget about the dangers of doing emotive work with the concept of pseudoscience, astrology strikes me as a paradigm example of a pseudoscience. It is a scientific-looking theory about the connection between the physical world and our mental lives, and it is, as the leading scientists point out, widely endorsed and uncritically distributed by mainstream media sources. And yet it is a false theory, and its endorsers ignore all the empirical evidence against it. But Feyerabend warns us to be careful here – modern astrology may be problematic, but Feyerabend points out that it "inherited interesting and profound ideas." The leading scientists who criticize it unfairly criticize the basic assumptions of astrology, and "in the process turn their own subjects into caricatures," because in fact we do have scientific evidence of a correlation between the motions of the planets and life on earth (via a correlation between the motions of the planets and solar flares, and the influence of solar activity on e.g. tree growth) (Feyerabend 1978: 24). The lesson I draw from this is that, while pseudoscience does exist in the world, and it deserves our condemnation, one has to ensure that one is not misrepresenting good science in order to fulfill one's goal of condemning the pseudoscience.

See also Evidence; Explanation; Scientific method; Social studies of science; The virtues of a good theory.

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Further reading

A number of good popular books have been written about pseudoscience, such as Martin Gardner's *Science: Good, Bad, and Bogus* (Amherst, NY: Prometheus Books, 1981); James Randi's *Flim-Flam! Psychics, ESP, Unicorns, and Other Delusions* (Amherst, NY: Prometheus Books, 1982); Carl Sagan's *The Demon-Haunted World: Science as a Candle in the Dark* (New York: Random House, 1996); and Michael Shermer's *Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time* (New York: Henry Holt & Co., 2002). My book, *Seeking God in Science: An Atheist Defends Intelligent Design* (Peterborough, Ontario: Broadview Press, 2009) argues that intelligent design theory is not a pseudoscience, contrary to what many critics argue. Massimo Pigliucci, in *Nonsense on Stilts: How to Tell Science from Bunk* (Chicago: University of Chicago Press, 2010), defends the standard view that intelligent design theory is a pseudoscience (and discusses many other topics). Arthur Still and Windy Dryden, in their paper "The Social Psychology of 'Pseudoscience': A Brief History," *Journal for the Theory of Social Behavior* 34: 265–90, discuss some of the social and cultural issues associated with declaring something pseudoscience.