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REVIEWS

Scientific Expertise is Needed to Identify Pseudoscience

Etymologically, pseudoscience means false science. The term is often explained as referring to claims or teachings that are presented as scientific but are in fact not scientific. Any understanding of the notion of pseudoscience must therefore build on both an understanding of what science is and a clarification of what forms of errors or misrepresentations make a statement pseudoscientific instead of scientific.

The nature of science

A science, such as biology, chemistry etc., can be defined as *the totality of knowledge and knowledge-creating activities that provide us with the currently most reliable information within its subject-area* (Hansson, 2013). We turn to biologists when looking for reliable information about living organisms, to chemists when we want to know about molecules and their reactions, etc.

It is a crucial feature of this definition that it refers to the "currently most reliable information," not to some supposedly unchangeable set of doctrines. It is almost universally recognized that even well-founded empirical knowledge is fallible. Therefore, science cannot issue any guarantees that its current assertions will never have to be modified or given up. To the contrary, it is essential to realize that scientific assertions are always provisional. The ability of science, as a collective enterprise, to correct itself is one of its most important strengths. It is part of what makes scientific progress possible.

However, science as we usually define it does not cover all kinds of human knowledge. This is because of two limitations of the domain of science. First, there are many areas of knowledge that are not studied academically in any systematic way. For instance, the best available knowledge about conjuring has been collected and systematized by conjurers rather than by academics. The same applies to a large range of other activities that are based on knowledge that is collected, improved, upheld, and transmitted by members of a trade

or profession, rather than by academics. Football, chess, and violin playing are examples of practical arts that have large collections of systematic and sophisticated but non-academic knowledge. Obviously, a claim in one of these areas can be just as severely wrong as a claim about chemistry. However, whereas a severe misconstruction of chemistry can be called pseudoscientific, an equally severe misconception of conjuring or violin playing would not be called a pseudoscience. This is because of the subject-area. Since conjuring and violin playing are not parts of science, false claims about them are not pseudoscience.

The second delimitation is that the English word 'science' does not cover all the academic disciplines. It covers all academic studies of the physical and natural world, but only some of the academic disciplines that investigate human societies and human culture. In this respect, it differs from the corresponding words in several other languages, most notably the German *Wissenschaft*, which covers all the academic disciplines. For instance, art history is typically not counted as a science, but it is certainly a *Wissenschaft*.[1] Strictly speaking, this would mean that a seriously misleading claim about art history can be classified as *Pseudowissenschaft* but not as 'pseudoscience.' In practice, however, the English term 'pseudoscience' is often used in cases like this. (Those who do not use it typically use other similar terms instead, such as 'pseudohistory' or 'pseudoscholarship.')

Considerations like these guide one part of the definition of pseudoscience. We can call it the *territorial* part of the definition. Basically, something that we call pseudoscience must deal with subject matter that is within the domains of science or at least within the broader domains of *Wissenschaft*.

There is one somewhat tricky case for the territorial delimitation that needs to be mentioned. Many misconceptions consist in a claim that something exists which does not in fact exist but would, if it existed, fall within the domains of science. One example of this is the Loch Ness monster. There are no reasons whatsoever to believe that such a creature exists, but if it did, then study and knowledge

[1] Elsewhere, I have proposed that philosophy of science should employ the term 'science' in a broad sense that also covers academic disciplines not commonly so designated, in accordance with the usage of corresponding words in many other languages such as German. This proposal has three major motivations: (1) The common delimitation of 'science' is the result of historical accident and has no sensible justification. (2) The academic disciplines are increasingly interdependent, also across the supposed divide between 'sciences' and humanities. (3) The notion of a fact-finding practice that produces the most reliable information in its subject area delineates an important category of human activities. It is this category, rather than the disciplines traditionally called 'sciences,' that is of particular philosophical interest and justifies specialized philosophical studies in addition to general theory of knowledge (Hansson, 2013; 2018).

about it would fall within the domains of science. Therefore, claims that this monster exists can be classified as pseudoscience. Similarly, if telepathy and clairvoyance existed, or if alchemical transmutation of base metals to gold and silver were possible, then parapsychology and alchemy would have been sciences. Therefore, claims that these alleged phenomena exist can and should be classified as pseudoscientific. (It is of course possible to study an alleged phenomenon such as telepathy while fully recognizing the lack of evidence for its existence. This would not be pseudoscience, although it would be rather dull science. Elsewhere, I have proposed the term 'vacu-science' for a science with an empty set of study objects (Hansson, 2020, p. 46).)[2]

What does 'pseudo' mean?

Let us now turn to the other component of the notion of pseudoscience, namely 'pseudo-.' According to the *Oxford English Dictionary*, the prefix 'pseudo' corresponds in meaning to words such as 'false,' 'pretended,' 'counterfeit,' 'spurious,' and 'sham.' There is a distinction between different uses of the prefix that we need to attend to. In some cases, it refers to someone or something that intendedly poses as something else. For instance, a pseudopriest is a person who claims to be a priest despite not having been ordained as such. In other cases, the prefix 'pseudo' just denotes that something is false, without indicating any intention. For example, a pseudomemory is an apparent memory of something that has not occurred. It can arise through mechanisms such as inaccurate perceptions or inferences that do not involve any intention. We need to clarify which of these two meanings the prefix 'pseudo-' has in the term 'pseudoscience.' In other words: Does pseudoscience, by definition, involve an intention to deceive? Consider the following two examples:

> Astrofraudator claims that he can predict future events in a person's life from the apparent positions of celestial objects at her time of birth. He claims that this is science.

[2] Moreno Paulon (2023) describes the classification of phrenology and alchemy as pseudosciences as a matter of territorial delimitation. He claims that these classifications are "intended to dismiss entire research programmes or disciplines, in compliance with the territorial purpose" (Paulon, 2023, p. 20). The teachings of phrenology consist of a large number of claims about connections between the shape of the skull and mental characteristics. These claims are now known to be erroneous, but if they were correct, then they would have belonged to the domain of science. The same is true of the central claims of alchemy. These teachings were not excluded from science due to territorial considerations about which topics belong to the domain of science, but due to convincing evidence of their falsity.

> Astromendax makes the same type of predictions. He says that his predictions are reliable, but he does not call them science.

If we define pseudoscience in a way that requires intentional posing as science (in analogy with 'pseudopriest'), then Astrofraudator is promoting pseudoscience, but Astromendax is not. If we instead define pseudoscience more broadly so that it does not require any such intentionality, then the two astrologers are both promoting pseudoscience. I prefer the latter approach. It does not seem to make much difference if promotors of a spurious claim use the term 'science' when they promote it. The crucial criterion should instead be that they present their teachings as having the role and function that we assign to science, namely that of being the currently most reliable information on its subject-matter.

There are many ways to be wrong in science: mistakes in the set-ups of experiments and other observations, miscalculations, incorrect interpretation of data, ignorance of other data that should have been taken into account, etc. Obviously, the vast majority of such errors should not be called 'pseudoscience.' We reserve that term for false claims that are particularly serious, and this in two respects.

First and most obviously, pseudoscience refers to errors that are so large that the resulting statements about the nature of the world cannot at all be relied upon. A researcher whose estimate of when a particular dinosaur species lived is wrong by a couple of million years will not be classified as a pseudoscientist (at least not if the mistake was honest). A creationist who claims that the dinosaurs lived at the same time as the first humans will most certainly be classified as a pseudoscientist.

However, there is more to this than the size of errors. The claims that we usually classify as pseudoscientific tend to be much more long-lived than other errors in science. Homeopathy is one of the best examples of this. It was invented in the 1790s by the German physician Samuel Hahnemann. Homeopathy's major claim is that if a solution of some drug is diluted again and again, then its effects will become stronger and stronger. (It is also required to be shaken in particular ways during the dilution process.) Obviously, this goes against common sense. Few of us would take just a tiny crumb of an analgesic tablet instead of a whole tablet if we were told that a single whole pill does not reduce pain sufficiently. Already around the year 1800, critics made fun of Hahnemann's ideas, pointing out that if he was right, then drinking a small amount of wine diluted in a lot of water would make a person more drunk than just drinking an ordinary glass

of wine (Kendl, 2017). However, the intellectual death blow to homeopathy came in the nineteenth century with confirmations of the molecular theory and increasingly precise knowledge of the size of molecules. Calculations showed that after the recommended homeopathic dilutions, not a single molecule of the alleged active ingredient would be left in the homeopathic "drug". This has been known for long, but homeopathy is still thriving, unethically treating patients with pure water and often keeping them away from proven effective treatments (Ernst, 2016; Smith, 2012).

At the time when Hahnemann constructed his homeopathic doctrine, many other medical treatments that we now know to be dangerous and inefficient were widely used by physicians. Today, the vast majority of these treatments are no longer in use. Why is homeopathy so resistant to devastating refutations? The only plausible explanation I can find is that homeopathy comes with a doctrine that immunizes its adherents against refutations by making them reject medical science and its methods to assess the effects of medical treatments.

We can call this an immunization against scientific criticism. We see it in other pseudoscientific communities as well. Creationists have developed a remarkable ability to isolate themselves from the immense body of evidence of evolution that has been collected and systematized by paleontologists and biologists. Similarly, climate science deniers have found ways to reject the massive evidence of anthropogenic climate change. In general, pseudosciences are characterized by a stubborn unwillingness to reconsider one's position in the light of contradicting evidence. This attitude is of course the very contrary of a central feature of scientificity that I mentioned above, namely willingness and ability to revise one's opinions when new information arrives. This evidence-defying attitude makes pseudoscience more intractable than most other forms of flawed science. Honest mistakes can usually be corrected by just pointing them out to the person who made them. This is how faulty observations, miscalculations, and dubious interpretations are usually corrected. The effects of frauds can usually be eliminated by revealing them. In all these cases, the self-correcting mechanisms of science will remove the flawed science (but not always as swiftly as might be wished). What makes pseudoscience more dangerous than other forms of flawed science is its Teflon-like ability to fend off even devastating scientific criticism. This property of pseudosciences usually comes with some form of theory or teachings that seemingly defuse criticism. It is, as I see it, the major reason why pseudoscience has to be dealt with specifically, and why it requires countermeasures that are different from those needed to remedy other types of flaws in science.

Defining pseudoscience

In previous work I have proposed the following definition of pseudoscience, which encompasses the insights mentioned above:

A statement is pseudoscientific if and only if it satisfies the following three criteria:

1. It pertains to an issue within the domains of science in the broad sense (the criterion of scientific domain).
2. It suffers from such a severe lack of reliability that it cannot at all be trusted (the criterion of unreliability).
3. It is part of a doctrine whose major proponents try to create the impression that it represents the most reliable knowledge on its subject matter (the criterion of deviant doctrine). (Hansson, 2013)

The first of these three criteria concerns the territorial delimitation, and the other two the qualitative delimitation. Thus, the last two criteria serve specifically to distinguish between the types of faulty science that give rise to pseudoscience and those that do not fall into that category.

The qualitative delimitation includes a determination of what claims are severely unreliable (the second criterion). Obviously, this assessment has to be performed by qualified expertise in the relevant scientific discipline(s). If we want to know if a claim about vaccines is pseudoscientific or not, then we have to consult medical scientists with expertise in that area. Similarly, evaluations of archaeological claims have to be performed by expert archaeologists, evaluations of biological claims by biological scientists, etc.

In practical endeavours to identify pseudosciences and clarify what their defects are, the focus is almost entirely on the qualitative delimitation. This can be seen from the argumentation put forward by authors who argue that some particular doctrine or claim is pseudoscientific. (Examples of this can be found in many articles in the *Skeptical Inquirer*.) Such argumentation consists almost exclusively in showing that the doctrine in question is severely unreliable, or in other words, that it consists of incorrect empirical claims and/or disproven theoretical statements. There is a good reason for this focus: The unreliability (and usually proven wrongness) of pseudoscientific claims is what makes their dissemination dangerous. In contrast, the territorial issue is usually not very important. It

does not matter much for critics of homeopathy if it is called 'pseudoscience' or 'quackery,' as long as the uselessness of homeopathic drugs is recognized. Critics of false claims in archaeology do not worry much about whether the refuted claims are classified as pseudoscience or, instead, included in a separate category for pseudoarchaeology. What matters is, of course, that erroneous archaeological claims are not presented as true. For physicians and others who fight Andrew Wakefield's lies about the MMR vaccine, it is no big issue if his anti-vaccinationism is labelled 'pseudoscience,' 'quackery,' or 'fraud.' In fact, it qualifies for all three designations. The crucial issue is not what these claims are called but that they are false and that their dissemination puts children's lives at risk (McBrien *et al.*, 2003; Asaria & MacMahon, 2006).

Larry Laudan's allegations

In 1983, the American philosopher Larry Laudan published a book chapter in which he claimed that "the problem of demarcation between science and non-science is a pseudo-problem (at least as far as philosophy is concerned)" (Laudan, 1983, p. 124). The major reason he gave for this standpoint is that there do not seem to be any 'epistemic invariants' in science. To be invariant means not to change over time. Thus, his claim that there can be no way to distinguish between science and pseudoscience is based on the assumption that such a demarcation must be timeless. This would mean that what is science at one time must also be science at some other time, and similarly for pseudoscience. He does not state this assumption in a clear fashion, but it follows from his use of the term 'invariant' and from the following sentence: "There seems good reason, given from the historical record, to suppose that most scientific theories are false; under the circumstances, how plausible can be the claim that science is the repository of all and only reliable or well-confirmed theories?" (Laudan, 1983, p. 123). (He does not cite anyone who has made such a claim.)

As already mentioned, science changes all the time, and its capacity to self-correct is one of its major strengths. Therefore, it is strange, to say the least, to require that the demarcation between science and pseudoscience should be invariant. Someone who claimed in the late eighteenth century that Newton's laws of motion apply to all moving bodies at all speeds would certainly not be guilty of promoting pseudoscience. In contrast, someone who makes the same claim today, in awareness of relativity theory, would in all probability be guilty

of pseudoscience. An invariant criterion of demarcation cannot make sense of this obvious difference.

Laudan did not clarify what it means for an invariant criterion to be 'epistemic.' However, we can see what he means from the examples he gave when preparing for his use of the term 'epistemic invariant.' These examples all refer to properties of a scientific theory that are easily understood by philosophers of science, such as whether the theory makes predictions, whether it depends on ad hoc hypotheses, and what use it makes of inductive reasoning (Laudan, 1983, p. 124). Nowhere in his text does he consider the possibility that quality assessments of scientific claims may require qualified scientific expertise. However, it does not take much study of the critical literature on pseudoscience to see that demarcations often require quite specialized scientific competence. To mention just one example, some climate science deniers claim that the presently ongoing increase in the earth's temperature depends on variations in solar radiation. There is nothing on the philosophy-of-science level in these claims (such as their reference to hypotheses, inductions, or predictions) that can help adjudicate whether they are scientifically reasonable or not. In order to determine the credibility of this claim, highly technical analysis of empirical data is needed. Such analysis shows, indeed, that variations in solar radiation cannot explain the ongoing climate change (Sloan & Wolfendale, 2013).

In summary, Laudan's argumentation is based on two implausible assumptions, namely (1) that the demarcation between science and pseudoscience has to be invariant, i.e., not change over time, and (2) that it should be based on 'epistemic' criteria that can be applied by philosophers of science who lack expert knowledge about the scientific issues in question. Without these two implausible presuppositions, his argument against the distinction between science and pseudoscience falls apart. In practice, the demarcation between science and pseudoscience proceeds unaffected by Laudan's claims that it cannot be done. Climate scientists do not need any 'epistemic invariants' to distinguish between climate pseudoscience and legitimate climate science, and neither do medical scientists need any such invariants to distinguish between pseudoscience and genuine medical knowledge in their area.

Laudan's mistakes repeated

In his article in this journal, Moreno Paulon (2023) uncritically accepts Laudan's claim that a distinction between science and pseudoscience has to be based on 'epistemic invariants.' Furthermore, he claims that Laudan has proved that "there is no possibility to succeed" in demarcating pseudoscience from science "due to the absence of any possible epistemic invariants" (Paulon, 2023, p. 24). To exemplify this, Paulon refers to alchemy: "However, if we consider alchemy in the light of its evolution over time, namely as a direct precursor to modern chemistry, why should we define it as a pseudoscience and not, say, a protoscience?" (Paulon, 2023, p. 8) The obvious answer is that alchemy was a protoscience at a time when the impossibility of transmuting metals was unknown, but today, adherence to its core beliefs will have to be categorized as pseudoscientific.

In spite of rejecting all demarcations between science and pseudoscience, Paulon concedes that the doctrines commonly called pseudosciences can and should be refuted. However, he claims that other terms than 'pseudoscience' should be applied to the refuted doctrines.[3] He even sees these doctrines as a growing problem, since more and more people will try to exploit the prestige of science "without doing all the necessary work, by claiming scientific authority in order to support the weirdest claims, policies, and practices" (Paulon, 2023, p. 24). After quoting a passage from a text by Massimo Pigliucci and Maarten Boudry (2013, p. 3) that mentions creationism, homeopathy, spiritism, and conspiracy theories about AIDS as particularly problematic, he says:

> I believe we all share such concerns, precisely because we want to trust science and scientists. But we can also consider that those activities, doctrines, and movements are equally dangerous under the name of "unjustified beliefs," "wrong ideas," and "disproven theories." Their qualification as pseudoscience makes no real difference in regard to their potential for harm. The core of the claim is still an accusation of promoting a wrong idea about the world. We have to be careful with the spread of flat-earthers not because that is pseudoscience, but because it represents the spread of a form of ignorance with the right to vote. (Paulon, 2023, p. 26)

However, as we noted above, almost all the published criticism of doctrines now called pseudosciences aims at showing that these doctrines are demonstrably false, and therefore unjustified beliefs. The additional conclusion that these doctrines

[3] Laudan makes the same move, but spends less ink on it (Laudan 1983, pp. 124–125).

are pseudosciences is in many cases not even treated explicitly since it is trivial. As an example, we can again use the claim that the ongoing climate change depends on variations in the solar radiation. The important and difficult task in determining that this is a pseudoscientific claim is a specialized scientific task, namely the technical analysis that proves the falsity of the claim. The territorial issue is trivial in this case, since there can be no doubt that the influence of solar variations on our climate belongs within the domains of science. The difficult, scientific, task is exactly the same if the purpose is to determine whether the claim in question belongs to one of the categories that Paulon refers to, namely "unjustified beliefs," "wrong ideas," or "disproven theories." If it were impossible because of lack of 'epistemic invariants' to determine that this claim about solar radiation is pseudoscience, how can it then be possible to determine that it is an unjustified belief? Are there any 'epistemic invariants' common to all beliefs that are not unjustified?

Paulon claims that the distinction between science and pseudoscience is "not an impartial, unbiased one," but "a discriminating, value-charged judgement" (Paulon, 2023, p. 23). He does not explain how assigning some other label, such as "unjustified beliefs," to the same doctrines would remove this alleged partiality, bias, discrimination and value-ladenness.

In his article, Paulon repeatedly claims that the distinction between science and pseudoscience is political (Paulon, 2023, pp. 20, 22, 24 & 25). At least in most cases, this is wrong. For instance, the reason why homeopathy is commonly called a pseudoscience is not that it is politically undesired but that it does not work and often stands in the way of effective treatments. The claim that demarcation is political is not only wrong but also dangerous. It provides a justification for the promotion of proven wrong claims as alternatives that should have the same social and intellectual standing as mainstream science. The pseudoscientists can say: "If this is political, then we should be given equal time in schools and in media." In fact, this is exactly how creationists and climate science deniers have argued in order to obtain equal time in schools and media. If criticism of flat earthers is also considered to be "political," should they be given half the time in geography classes?

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