

Science versus Pseudoscience

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The prefix “pseudo” means “false.” Accordingly, pseudoscience is false science. Yet equating pseudoscience with false science is not entirely accurate, because most false scientific claims are not pseudoscientific. Instead, we can best view pseudosciences as *fake* sciences that display (often intentionally, but sometimes unintentionally) the superficial appearance of science but largely lack its substance (Hines, 2002). Nevertheless, distinguishing “fake” science from both genuine science and other forms of false science is more easily said than done (Pigliucci & Boudry, 2013). The question of how to differentiate pseudoscience from other disciplines bears significant implications for clinical psychology and allied mental health fields, because numerous authors contend that these fields’ scientific foundations are being increasingly eroded by pseudoscientific practices (e.g., Lilienfeld, Lynn, & Lohr, 2003; McFall, 1991, 2001). Moreover, mental health consumers, practitioners, and researchers would benefit from guidance in separating scientific from pseudoscientific claims, largely because the latter assertions can fool even well-trained individuals (Herbert, 2002).

The Demarcation Problem

The “demarcation problem” refers to the challenge of distinguishing science from non-science, including pseudoscience (Pigliucci & Boudry, 2013). To this day, there is no universally agreed upon solution to this problem. Perhaps the best-known attempt to resolve the demarcation problem was offered by the

Austrian (and later British) philosopher of science Sir Karl Popper; we begin with his conceptualization.

Popper

According to Popper (1959), scientific claims are *falsifiable*: They are in principle capable of being proven false (according to Popper, scientific claims can never be proven true; they can only be falsified). In contrast, Popper maintained, pseudosciences are impossible to falsify, either because their proponents (a) advance claims that are so vague that they are untestable or (b) continually invoke *ad hoc hypotheses*—escape hatches or loopholes—that effectively immunize their claims from refutation. Eventually, the overuse of *ad hoc* hypotheses can place claims outside of the purview of scientific testing. For example, Popper argued that much of Freudian theory is pseudoscientific, because no conceivable evidence could disprove it. For example, Popper considered Freud’s concept of the Oedipus complex (the idea that young children are romantically attracted to the opposite-sex parent) as unfalsifiable and therefore pseudoscientific. If a psychoanalytic researcher were to find that most adults recall a time when they were romantically attracted to their opposite-sex parents, she could interpret this finding as confirming Freud’s hypothesis of the Oedipus complex. In contrast, if this researcher were to find that most adults do not recall such a time, she could interpret this finding as implying that adults find memories of romantic attraction toward their parents to be so threatening that they repress them. This “heads I win, tails you lose” reasoning, according to Popper, renders Freudian theory difficult or impossible to falsify and therefore pseudoscientific.

Nevertheless, few scientists believe that Popper’s falsifiability criterion, important as it is, succeeds as a necessary or sufficient criterion

for distinguishing science from pseudoscience. For one thing, certain pseudoscientific claims do appear to be capable of refutation. For example, although astrology is a prototypical pseudoscience, many of its claims, such as the proposition that astrological signs are correlated with personality traits, are falsifiable, and have been essentially falsified (Carlson, 1985). Moreover, several critics have argued that *contra* Popper, many scientific claims are difficult or impossible to falsify. Specifically, because legitimate scientists can almost always invoke ad hoc hypotheses to rescue their claims from refutation, these claims may never be strictly disproven, a view known as the Duhem–Quine thesis after the two philosophers who propounded it.

Lakatos

An alternative perspective on the demarcation problem derives from Hungarian philosopher of science Imre Lakatos. According to Lakatos (1975), scientific theories, or as he called them “research programs,” possess two major components: (a) a “hard core” of fundamental presuppositions that is integral to the theory and (b) a “protective belt” of auxiliary (secondary) hypotheses that are not central to the theory but that help to protect the theory from refutation. For example, the existence of the unconscious comprises part of the hard core of psychoanalytic (Freudian) theory. It is difficult to imagine calling oneself psychoanalytic in theoretical orientation without endorsing the core assumption of unconscious processing. In contrast, the existence of the defense mechanism of reaction formation (the supposed tendency to deal with an anxiety-provoking emotion, such as hatred, by transforming it into its opposite, such as love) almost certainly resides in the protective belt of psychoanalytic theory. One could legitimately call oneself psychoanalytic, although perhaps not an orthodox Freudian, even if one rejected Freud’s concept of reaction formation.

According to Lakatos, when data repeatedly conflict with a theory’s hard core, proponents of this theory typically perform a “strategic

retreat” to the protective belt, thereby invoking ad hoc hypotheses that could explain away the negative findings. In doing so, these advocates tinker with the theory’s auxiliary hypotheses in an effort to salvage their theory from falsification. In certain cases, strategic retreats are justifiable in science, especially when they enhance the theory’s content, predictive power, or both. Yet, when strategic retreats to the protective belt are merely “pasted on” to the theory in desperate attempts to rescue it from falsification, such retreats become problematic.

According to Lakatos (1975), in *progressive* research programs, theory tends to precede data. The hard core of the theory generates novel predictions that are generally corroborated by findings. In contrast, in *degenerating* research programs, data tend to precede theory. Negative findings—those that challenge the theory’s hard core—repeatedly emerge, and the theory’s advocates continually invoke auxiliary hypotheses within the protective belt in an effort to keep the sinking theory afloat. The theory is not moving forward; it is merely trying to keep up with the accumulating influx of negative findings. Yet, as Lakatos noted, because some degenerating research programs do eventually right themselves by amending their protective belts (cognitive dissonance theory is arguably a potential example in psychology; see Greenwald & Ronis, 1978), it is not necessarily illegitimate to cling to a degenerating research program, just so long as one honestly admits to oneself and others that it is degenerating. What *is* illegitimate is to pretend that a degenerating research program is in good scientific shape.

Lakatos’ framework provides a useful way of conceptualizing the difference between science and pseudoscience. Specifically, from a Lakatosian perspective, we can define pseudosciences as *degenerating research programs that its proponents claim are progressive*. In the case of pseudoscientific theories or methods, claims are not supported by evidence, yet adherents of these theories or methods insist that they are. As a consequence, these adherents are deceiving themselves, deceiving others, or

both. As helpful as Lakatos' conceptualization is, it does not offer a strict set of criteria for demarcating progressive from degenerating research programs. For example, when a theory's predictions are met with mixed results, how do we decide whether it is progressive or degenerating? Nevertheless, this may not be a fundamental flaw within a Lakatosian framework, because strict criteria for distinguishing science and pseudoscience may not exist.

Pseudoscience: A Family Resemblance View

Indeed, some eminent philosophers of science (e.g., Laudan, 1983) have declared the demarcation problem dead, because there appears to be no single criterion—or set of criteria considered jointly—that can invariably be used to distinguish science from pseudoscience. Some of these scholars have gone further, recommending that the very concept of pseudoscience be abandoned.

Still, there is an alternative. According to a family resemblance view of pseudoscience (Pigliucci & Boudry, 2013), there is no “bright line” distinguishing science from pseudoscience. Yet just as first-degree relatives within a biological family typically share a loosely correlated set of facial features, allowing us to distinguish them from members of other families, pseudosciences tend to exhibit a loosely correlated set of characteristics. According to this view, pseudoscience is an “open concept” (Pap, 1953). Open concepts are characterized by (a) fuzzy boundaries, (b) an indefinitely extendable indicator list, and (c) an unclear inner nature. If pseudoscience is an open concept, the distinction between science and pseudoscience is one of degree rather than kind.

The fact that one cannot draw a clear line in the sand distinguishing science from pseudoscience does not imply that most scientific claims cannot be distinguished from most pseudoscientific claims in clinical psychology or related disciplines. As the psychophysicist S. S. Stephens observed, although there is no clear

dividing line between day and night (hence the equally fuzzy concepts of dusk and dawn), we can still distinguish morning from night for most pragmatic purposes (Leahey & Leahey, 1983). Similarly, we can differentiate clear-cut sciences from clear-cut pseudosciences, even though the distinction inevitably becomes murky in certain cases.

According to the family resemblance perspective, pseudosciences are characterized by a set of useful, albeit fallible, indicators (Bunge, 1984). We can think of these indicators as “warning signs” of pseudoscience. Although no single criterion is dispositive of a theory's status as a pseudoscience, the more criteria are present, the more skeptical of this discipline we should typically become. Here we present 10 warning signs of pseudoscience that are useful for distinguishing pseudoscientific from scientific claims in clinical psychology, psychiatry, social work, and allied fields (Lilienfeld et al., 2003).

Overuse of Ad Hoc Hypotheses Designed to Immunize Claims from Falsification

When taken to an extreme, ad hoc hypotheses can provide virtually impermeable barriers against falsification. In other words, when one overuses ad hoc hypotheses, one is attempting to explain away findings that are inconsistent with a claim. For example, proponents of a new psychotherapy might insist that negative findings are due to inadequate training of the individuals delivering the treatment. Although this ad hoc hypothesis might be true, it cannot stand on its own; it itself requires systematic testing. Otherwise, it becomes what Dawes (1994) termed an “argument from a vacuum:” an assertion advanced in the absence of any supportive evidence.

Absence of Self-Correction

Like the assertions within pseudoscientific disciplines, the assertions within most scientific disciplines are incorrect in certain respects. Nevertheless, in the long run, most scientific research programs tend to learn from and correct errors, whereas most

pseudoscientific research programs do not. Consequently, intellectual stagnation is a hallmark of most pseudoscientific research programs. For example, astrology has changed remarkably little over the past 2,500 years despite enormous advances in planetary and stellar science (Hines, 2002).

Evasion of Peer Review

Many proponents of pseudoscience avoid subjecting their work to the crucial safeguard of peer review, which is an essential means for identifying errors in authors' reasoning, methodology, and analyses. They may do so on the grounds that the peer-review process is biased against findings that contradict well-established paradigms or that their assertions cannot be evaluated adequately using standard scientific methods. For example, advocates of graphology (handwriting analysis intended to infer personality traits) have rarely subjected their claims to peer review. By avoiding or circumventing the peer-review process, proponents of pseudoscience forfeit an invaluable opportunity to obtain corrective feedback from informed colleagues.

Emphasis on Confirmation rather than Refutation

Nobel Prize-winning physicist Richard Feynman (1985) maintained that the essence of science is a bending over backwards to prove oneself wrong. Popper's student Bartley (1962) similarly argued that science entails the maximization of constructive criticism. Ideally, scientists subject their cherished claims to the risk of refutation (Meehl, 1978; see also Ruscio, 2002). In contrast, pseudoscientists tend to seek only confirming evidence for their claims. For example, if the developers of a treatment for a psychological disorder request feedback from clients to help them "prove" that the treatment is effective, they will avoid important information that could show that the treatment is ineffective, or even harmful. Because a determined advocate can find at least some supportive evidence for virtually any claim, a confirmatory hypothesis-testing

strategy is not an efficient means of rooting out error in one's web of beliefs. In fairness, however, confirmation bias—the tendency to seek out evidence consistent with one's hypotheses, and to deny, dismiss, or distort evidence that is not—is not unique to pseudosciences and is a serious problem in some sciences, including medicine, as well (Ioannidis, 2008).

Reversal of the Burden of Proof

The burden of proof in science typically falls squarely on individuals who put forth a claim, not on critics of this claim. Proponents of pseudoscience often insist that skeptics demonstrate beyond a reasonable doubt that a claim (e.g., an assertion regarding the efficacy of a novel psychotherapy) is false. This error is similar to the logician's *ad ignorantium* fallacy (the argument from ignorance), the mistake of assuming that a claim is likely to be correct because there is no convincing evidence against it.

Absence of Connectivity

In contrast to scientific research programs, pseudoscientific research programs tend to lack "connectivity" with other scientific disciplines (Stanovich, 2012). In other words, pseudosciences often purport to create novel paradigms out of whole cloth rather than to build on extant, well-supported ideas. For example, many proponents of extrasensory perception (ESP) argue that it is a genuine—although heretofore undetected—physical process of perception, even though reported cases of ESP violate almost every major law of physical signals (e.g., ESP purportedly operates just as strongly from thousands of miles away as it does from a few feet away). Although scientists should remain open to the possibility that an entirely novel paradigm has successfully overturned all preexisting paradigms, they must insist on high standards of evidence before drawing this conclusion (Wagenmakers, Wetzels, Boorsbom, & van der Maas, 2011).

Overreliance on Anecdotal Evidence

Anecdotal evidence or "anecdota" can be quite useful in the early stages of scientific

investigation. Nevertheless, such evidence is almost always more helpful in the context of discovery (hypothesis generation) than in the context of justification (hypothesis testing; see Reichenbach, 1938). Proponents of pseudoscientific claims frequently invoke reports from selected cases (e.g., “This treatment clearly worked for Person X, because Person X improved following the treatment”) as a means of furnishing dispositive evidence for these claims. For example, proponents of unvalidated treatments (e.g., facilitated communication, secretin, gluten-free diets, chelation therapy) for autistic spectrum disorder have often pointed to uncontrolled case reports of improvement as supportive evidence. As Gilovich (1991) observed, case reports almost never provide sufficient evidence for a claim, although they often provide necessary evidence for a claim. For example, if a new form of psychotherapy is efficacious, one should certainly expect at least some positive case reports of improvement. Nevertheless, such case reports do not provide adequate evidence that the improvement was attributable to the psychotherapy, because this improvement could have been generated by a host of extraneous influences (e.g., placebo effects, regression to the mean, spontaneous remission, maturation; Lilienfeld, Ritschel, Lynn, Cautin, & Latzman, 2013).

Use of Obscurantist Language

Many proponents of pseudoscience resort to impressive-sounding or technical jargon in an effort to provide their disciplines with the superficial trappings of science. Such language may seem persuasive to individuals unfamiliar with the scientific underpinnings of the claims in question, and may therefore lend these claims an unwarranted imprimatur of scientific legitimacy. The ascendancy of neuroscientific explanations of behavior (Satel & Lilienfeld, 2013) over the past two decades has rendered questionable explanations that invoke neurological concepts especially popular. For example, consider the following explanation

for the efficacy of eye movement desensitization (EMDR), a controversial treatment for posttraumatic stress disorder and related conditions:

We propose that the repetitive redirecting of attention in EMDR induces a neurobiological state similar to that in REM sleep, which is optimally configured to support the cortical integration of traumatic memories into general semantic networks. We suggest that this integration can then lead to a reduction in the strength of hippocampally mediated episodic memories of the traumatic event as well as the memories’ associated, amygdala-dependent negative affect. (Stickgold, 2002, p. 61)

Absence of Boundary Conditions

Most well-supported scientific theories possess boundary conditions: well-articulated limits under which hypothesized phenomena should and should not occur. In contrast, many pseudoscientific phenomena are purported to operate across an exceedingly wide range of conditions and individuals. As Hines (2002) noted, one common characteristic of fringe psychotherapies is that they are ostensibly efficacious for almost all disorders regardless of their causes. For example, some proponents of thought field therapy, a widely used “energy therapy,” have proposed that this treatment is beneficial for virtually all mental disorders. The developer of this treatment has even posited that it is effective not only for adults, but for “horses, dogs, cats, infants, and very young children” (Callahan, 2001, p. 1255). Although it is certainly possible that a therapy derived from a well-supported scientific theory could effectively treat a wide variety of disorders (e.g., cognitive behavioral therapy; Butler, Chapman, Forman, & Beck, 2006), therapies of this nature are rare.

The Mantra of Holism

Proponents of pseudoscientific claims, especially in mental health, often resort to the “mantra of holism” (Ruscio, 2002) to explain away negative findings. When invoking this mantra, they typically maintain that scientific claims can be evaluated only within the context

of broader claims and cannot be judged in isolation. For example, some proponents of the Rorschach inkblot test have responded to criticisms of this technique by asserting that clinicians virtually never interpret results from a Rorschach in isolation. Instead, in actual practice clinicians consider numerous pieces of information, only one of which may be a Rorschach protocol. There are two major difficulties with this line of reasoning. First, it implies that clinicians can mentally integrate a great deal of complex psychometric information from diverse sources, a claim that is dubious given the research literature on clinical judgment. Second, by invoking the mantra of holism, proponents can avoid subjecting their claims to the risk of falsification. In other words, if findings corroborate the validity of a given Rorschach index, proponents can point to these findings as supportive evidence, but if these findings are negative, their proponents can explain them away by maintaining that “clinicians never interpret this index in isolation anyway” (see Merlo & Barnett, 2001, for an example).

According to the “open concept” view described above, these 10 warning signs do not exhaust the list of possible indicators of pseudoscience. To the contrary, they are only a partial list of potential features of pseudoscience (for a list of useful websites containing information on additional warning signs, see Lilienfeld, Lohr, & Morier, 2001). Indeed, other writers have proposed additional or alternative useful indicators of pseudoscientific disciplines, such as exaggerated claims (e.g., “This weight-loss program is a miracle cure!”), frequent appeals to authority (e.g., “This new psychotherapy must work because Professor X claims it works”), reliance on the bandwagon fallacy (e.g., “This figure drawing test must be valid because thousands of clinicians use it”), frequent *ad hominem* attacks against critics (e.g., “I’ll bet that most of the critics of recovered memory therapy are child abusers themselves”), and arguments from antiquity (e.g., “Astrology has been around for millennia, so there

must be something to it”). Nevertheless, researchers have not examined whether these or other putative indicators of pseudoscience we have delineated are intercorrelated, as would be anticipated of a family resemblance model.

The distinction between science and pseudoscience has been one of the most contemplated and debated issues in philosophy of science, and it bears potentially important implications for distinguishing well-supported from poorly supported claims in clinical psychology and allied disciplines (Lilienfeld et al., 2003). The question of how to differentiate science from pseudoscience is not fully resolved, and the difference is probably one of degree rather than kind. Nevertheless, psychologists and other mental health professionals need not wait for philosophers of science to solve the demarcation problem to make use of the pseudoscience indicators delineated here to ascertain the validity of novel and untested claims.

SEE ALSO: Clinical Science Model; Duhem–Quine Thesis; Hypothetico–Deductive Model; Meehl, Paul E. (1920–2003); Popper, Karl (1902–94); Science–Practice Gap; Scientific Metaphysics and Ontology

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Further Reading

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