On the Fringe

Where Science Meets Pseudoscience

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PREFACE

Pseudoscience is not a real thing. The term is a negative category, always ascribed to somebody else's beliefs, not to characterize a doctrine one holds dear oneself. People who espouse fringe ideas never think of themselves as "pseudoscientists"; they think they are following the correct scientific doctrine, even if it is not mainstream. In that sense, there is no such thing as pseudoscience, just disagreements about what the right science is. This is a familiar phenomenon. No believer ever thinks she is a "heretic," for example, or an artist that he produces "bad art." Those are attacks lobbed by opponents.

Yet pseudoscience is also real. The term of abuse is deployed quite frequently, sometimes even about ideas that are at the core of the scientific mainstream, and those labels have consequences. If the reputation of "pseudoscience" solidifies around a particular doctrine, then it is very hard for it to shed the bad reputation. The outcome is plenty of scorn and no legitimacy (or funding) to investigate one's theories. In this, "pseudoscience" is a lot like "heresy": if the label sticks, persecution follows.

Sorting out these kinds of debates has traditionally been the domain of philosophy. For religion, we use theology to discriminate between correct and incorrect belief (though that does not mean people agree on the right way to reason theologically). For art, there is aesthetics, and disagreement is rampant there as well. For

scientific knowledge, the relevant philosophical domain is *epistemology*, the philosophy of knowledge. Epistemology hits similar roadblocks when it comes to separating science and pseudoscience. This book explores those problems and offers some alternative, nonphilosophical ways to think about the issues. The main approach will be historical: looking at debates from over the past several centuries about what constitutes pseudoscience in order to learn what arguments about the boundaries of acceptable knowledge can tell us about the scientific enterprise as a whole.

This book concerns debates within the natural sciences, and not arguments over the humanities and social sciences. Only rarely will medicine come up, and in those instances the focus is on the intersection of medical knowledge with the practices of scientific research. It is hard to exclude phenomena like alternative medicine entirely, but the distinction is nonetheless conceptually significant. The problem of "quackery" in medicine is analogous to "pseudoscience," but sometimes even "false" treatments can make the patient feel better. Efficacy provides a nonepistemological standard in medicine in a way that does not quite happen in science. Tackling pseudoscience separately focuses us on the problem of what counts as *truth*. Some medical claims tackle that head-on, but many others do not.

Understanding how pseudoscience works is an important matter. The problem of reliable knowledge is quite general, ranging from medical treatments to "fake news" to rumors floating among your circle of friends. Thinking about doctrines that have been called "pseudoscience"—creationism, psychical research, UFOlogy, Nazi eugenics, or cold fusion—highlights the dilemmas sharply. What you find in these pages can prove broadly applicable, even if you don't care about Bigfoot.

Chapter 1

The Demarcation Problem

Any discussion of pseudoscience must start with the so-called demarcation problem. Indeed, without a proposed solution to the demarcation problem—valid or invalid, explicit or implicit—the term *pseudoscience* has no real meaning. If there were a universally recognized and workable demarcation criterion (as one calls a solution to the demarcation problem), then the task of this book would be simple: those doctrines that passed the test would be "science," and those that failed would be "pseudoscience." Alas, the demarcation problem has to date eluded resolution. There are good reasons to think that it will remain a puzzle, which means that debates about what counts as "pseudoscience" will always be with us.

In fact, we have wrestled with the problem of demarcation for as long as domains of knowledge about the natural world have claimed authoritative status. One of the oldest medical writings in the Western tradition, the fifth-century BCE Hippocratic text "On the Sacred Disease," is essentially a demarcation document about how to understand and treat what we now call epilepsy. In the text, the author—conventionally called "Hippocrates," though these documents were likely composed by a variety of authors over a sizable span of time—lambastes "the sort of people we now call witch-doctors, faith-healers, quacks and charlatans."[1] Instead, Hippocrates provides his own theory of the cause of epilepsy, and explains why no faith healer deserves the title of physician. Every claim to scientific authority necessarily implies the exiling of rivals from it.

The basic formulation of the demarcation problem is: how should we distinguish science from pseudoscience? Yet there are really several demarcation problems. There is the core question of epistemology: how do you sift correct knowledge from incorrect claims? Beyond that you also might want to differentiate science from all those domains (art history, theology, gardening) that are "nonscience," or from those things that look an awful lot like science but for some reason do not quite make it. This last set, the imposters, are frequently designated "pseudosciences." Any demarcation criterion worthy of the name ought to be able to distinguish science from them.

The term *demarcation problem* was coined by the philosopher Karl Popper, and his demarcation criterion remains the most commonly invoked among scientists, philosophers, and those undergraduates who have views on this subject. We will start, then, with the philosopher and his criterion of "falsifiability," before elaborating why the criterion fails.

Karl Popper and Falsifiability

Karl Popper was born just after the turn of the twentieth century in Vienna, then the capital of the sprawling Austro-Hungarian Empire. By the time he received his doctorate in psychology (not, interestingly, in philosophy) in 1928, he was living in the same city but a very different country: the much smaller republic of Austria. Vienna was home to a vibrant and contentious socialist movement, so he was exposed early on to Marxism but was quickly disillusioned. This was also the birthplace of psychoanalysis, and Popper in the early 1920s volunteered in the clinics of Alfred Adler, who had split with his former mentor, the creator of psychoanalysis, Sigmund Freud. Precocious interest in both theoretical frameworks, and his subsequent rejection of them, were crucial in the later formulation of Popper's philosophy of science.

Philosophy of science was a big deal in Popper's Vienna, and the decade when he was a student saw the flourishing of a group of philosophers called the "Vienna Circle." This group elaborated the dominant philosophy of science of the first half of the twentieth century: *logical empiricism*. Not only did the Vienna Circle and its like-minded peers in Berlin dominate European philosophy of science, but after the rise of National Socialism many of the leading lights (who were either Jewish, or socialist, or both) emigrated to the United States, where they reestablished their school of thought. Popper, though not a member of the Vienna Circle, was likewise thrust into globetrotting, for similar reasons. Although baptized as a Lutheran and a member of a middle-class family, all of his grandparents were Jewish, clouding his future as the annexation of Austria to Hitler's Germany loomed in 1938. Popper emigrated to New Zealand a year before that event, and in 1946 moved to London.

Logical empiricism can be usefully understood by examining its component terms. Its advocates are *empiricists* because they believe that sense data constitute our only reliable sources of information about the natural world. Building on centuries of philosophical thought—most notably that of David Hume, the eighteenth-century Scottish philosopher who was especially important for Popper, and Ernst Mach, an Austrian physicist who emphasized the centrality of sense data for the natural sciences—logical empiricists rejected as "metaphysical" any claims about the structure of nature that could not be traced back to sensory observations. Moving beyond Hume and Mach, however, the logical empiricists also stressed the significance of *logical* relations in coherently assembling the shards of reality brought to us through our senses. These logical relations were not necessarily grounded in empirical data themselves, but they were essential to ascertaining nonmetaphysical truths about nature. At first, Popper was quite taken with logical empiricism, but he would diverge with the mainstream of the movement and develop his own framework for understanding scientific thought in *The Logic of Scientific Discovery*

(1934, in revised English translation in 1959) and *Conjectures and Refutations* (1963).

Popper claimed to have formulated his initial ideas about demarcation in 1919, when he was seventeen years old. He had "*wished to distinguish between science and pseudo-science*; knowing very well that science often errs, and that pseudo-science may happen to stumble on the truth."[2] That's all very well and good, but how to do it? The results from the British expedition to study the solar eclipse of May 29, 1919, provided the key insight. Astronomers Arthur Eddington and Frank Dyson organized two groups to measure the deflection of starlight around the sun in order to test a prediction from general relativity, the gravitational theory recently formulated by Albert Einstein. One of Einstein's crucial tests for the theory was that light's path would be bent by strong gravitational fields, such as those surrounding massive bodies like the sun, and during an eclipse one would be able to measure the precise degree of curvature for light hailing from stars located behind the solar disk. According to Eddington and Dyson, the measured curvature more closely adhered to Einstein's theory than to that predicted by Newtonian gravity. The news made an immediate international sensation, catapulting Einstein to his global celebrity.

Popper was struck by Einstein's prediction for idiosyncratic reasons. "Now the impressive thing about this case," he wrote decades later, "is the risk involved in a prediction of this kind." Had the measurements found Einstein in error, the physicist would have been forced to abandon his theory. Popper built his demarcation criterion around the bravado of wagering against refutation: "One can sum up all this by saying that *the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability*."[3]

This demarcation criterion is by far the most widely recognized of Popper's philosophical contributions, although it was somewhat of a digression. He first presented it at a lecture sponsored by the British Council at Peterhouse at the University of Cambridge in 1953, and it was later published in *Conjectures and Refutations*. This post–World

War II articulation of his demarcation criterion has often obscured the importance of its Austrian origins, though Popper in the lecture stressed its historical roots in post–World War I Vienna.

All demarcation criteria are designed to *exclude* something; although Popper stated that his goal was to explain Einstein's achievement, what he really wanted to do was to show why psychoanalysis and Marxism were not scientific. Those latter theories had been widely understood as "scientific" in his Viennese milieu because of a logical empiricist theory called *verificationism*. According to this view, a theory is scientific if it is verified by empirical data. For Popper, this was grossly insufficient. There was plenty of data that apparently confirmed psychoanalysis, he noted: Freudians could claim that a man with such-and-such characteristics and upbringing would become a homosexual; but they would also claim that someone with the same characteristics who was not homosexual *also* confirmed the theory. In fact, every piece of data about personalities might be another brick in the confirmatory edifice for Freud, just as every event in politics or economics seemingly further confirmed Marxist theories such as the centrality of class conflict in history or the surplus value of labor. To Popper, the logical empiricists were looking at things the wrong way around. The issue was not whether a theory was confirmed—anything might be interpreted as confirming if you formulated the theory flexibly enough. Rather, the point was whether it was possible to *falsify* the theory. Was there any imaginable observation such that, should it be found, Freudians or Marxists would concede that their theories were false? If the answer was no, these were not sciences. (This is why it is not exactly weighty evidence against Freud and Marx that they fail Popper's criterion; it was literally *designed* to exclude them.) If you claimed to be scientific but could not, as Einstein had, posit conditions under which your theory would be falsified, then you were a pseudoscientist.

The appeal of falsificationism is obvious. It provides a bright line between theories that are scientific and those that can be considered

pseudoscientific, and it rewards the boldness that we often like to see exemplified in science. How well does it work?

Falsifying Falsificationism

The short answer is: not very. Philosophers of science recognized this almost immediately, for two main reasons. First, it is difficult to determine whether you have actually falsified a theory. This is largely a restatement of one of Popper's objections to verificationism. How do you determine that an observation actually constitutes a confirmation of a theory? Well, you interpret it within its framework, and sometimes those interpretations produce the lamentable distortions that Popper decried. But the same holds true for falsifying a theory. Suppose you did an experiment in your laboratory to test theory *X*, which predicts that under certain conditions your fact-o-meter should register a value of 32.8, and you got a result of 5.63. You have apparently falsified *X*. What do you do? Should you run to the journals and proclaim the death of *X*?

Not so fast. How do you know that your experimental result was accurate? Maybe the reason you did not get the value of 32.8 is that your fact-o-meter malfunctioned, or perhaps you did not perform the experiment under precisely the right conditions. In short, it is rare to have a thumbs-up/thumbs-down result like in the 1919 eclipse expedition. (As a matter of fact, the results of that expedition were more equivocal than Eddington made them seem. It was several years before absolutely incontrovertible results in support of general relativity were obtained, largely by observatories in California.) If any disconfirming result would invalidate the theory that predicted it, then every tenet of modern science would have already been falsified by middle-school science students failing to replicate utterly uncontroversial standard experiments. This is clearly nonsense. While it sounds like a good idea to insist on falsifying observations, it is far from straightforward to determine when precisely this has

been done—and that defeats the purpose of having a bright-line standard.

The second problem has to do with the actual demarcations that Popper's criterion gives us. The very minimum we should expect from a demarcation criterion is that it slices the sciences in the right places. We want our criterion to recognize as scientific those theories which are very generally accepted as hallmarks of contemporary science, like quantum physics, natural selection, and plate tectonics. At the same time, we want our criterion to rule out doctrines like astrology and dowsing that are almost universally labeled pseudosciences. Popper's falsifiability standard is not especially helpful in this regard. For starters, it is difficult to present the "historical" natural sciences, such as evolutionary biology, geology, or cosmology—those fields where we cannot "run the tape again" in the laboratory—exclusively in terms of falsifiable claims. Those sciences provide persuasive explanations of nature through the totality of a narrative chain of causal inference rather than a series of empirical yes-no votes. Popper inadvertently excludes important domains of contemporary science.

The situation with inclusion is even worse. The difficulty is sharply expressed by philosopher of science Larry Laudan in an influential article from 1983:

> [Popper's criterion] has the untoward consequence of countenancing as "scientific" every crank claim that makes ascertainably false assertions. Thus flat Earthers, biblical creationists, proponents of laetrile or orgone boxes, Uri Geller devotees, Bermuda Triangulators, circle squarers, Lysenkoists, charioteers of the gods, *perpetuum mobile* builders, Big Foot searchers, Loch Nessians, faith healers, polywater dabblers, Rosicrucians, the-world-is-about-to-enders, primal screamers, water diviners, magicians, and astrologers all turn out to be scientific on Popper's criterion—just so long as they are prepared to indicate some observation, however improbable, which (if it came to pass) would cause them to change their minds.[4]

(Do not worry if many of those doctrines are unfamiliar to you; we will meet most of them in the following pages.) Laudan's critique went further: any bright-line semantic criterion—that is, a formulation that relied on a linguistic test like Popper's—would necessarily fail. He went on to describe the demarcation problem as a "pseudoproblem," a statement that infuriated many philosophers who insisted that it remained a vital question in the philosophy of science. Yet the fact that Laudan was a tad overzealous in his phrasing does not invalidate his point: Popper's criterion does not fringe out many of the doctrines that common usage would demand of it. On the contrary: creationists and UFOlogists often quote Popper to assert that their own positions are scientific and those of their opponents are pseudoscientific.

A more technical examination of Popper reveals that his formulation requires acceding to philosophical positions that are likely uncongenial to his many vocal partisans who readily quote the falsifiability criterion. In his original demarcation article as well as his monumental *Logic of Scientific Discovery*, Popper was explicit that his framework demands that we give up the possibility of ever attaining the truth about nature (or anything else). According to Popper, no scientific theory can, strictly speaking, ever be *true*. The best scientists can achieve is *not yet false*. The existence of atoms, relativity theory, natural selection, the cellular structure of life, gravity, what have you—these are *all* provisional theories awaiting falsification. Popper's is a consistent picture, but it is one that cuts against the intuitions of almost all practicing scientists, philosophers, and the general public.

As comforting as it would be for Popper's clean demarcation criterion to resolve the question of separating science and pseudoscience, both logical analysis and a sociological glance at how scientists and laypeople actually demarcate demonstrate that it does not work. This raises another question: given that the inadequacies of Popper's standard are so evident, why is it so popular?

Popper on Trial

The ubiquity of the falsifiability standard is the inadvertent consequence of a legal battle in the United States about "creation science"—a scientized rendering of the Judeo-Christian creation story as depicted in Genesis. A brief examination of this story, which concerns the legality of teaching this doctrine in public schools, introduces some broader themes about the challenges of demarcation and the importance of reflecting on the problem rather than relying on simple (and simplistic) answers.

Controversies over teaching evolution in American public schools simmered during most of the twentieth century, occasionally bursting into open conflagration. The first and most notorious of these is the "Scopes Monkey Trial" of July 1925. Due to the intense boosterism of the town of Dayton, Tennessee, and the immensely successful fictionalization of the story in the stage play (1955, by Jerome Lawrence and Robert E. Lee) and movie (1960, directed by Stanley Kramer and starring Spencer Tracy) *Inherit the Wind*, the story is broadly known. In spring 1925, Tennessee passed the Butler Act, which criminalized the teaching in public schools of human evolutionary descent from primate ancestors. The American Civil Liberties Union enrolled teacher John Thomas Scopes to knowingly violate the law to test the constitutionality of the ban on Darwinism in court, arguing that by forbidding Darwin's theory because it violated a particular religion's creation story, the Butler Act transgressed the First Amendment of the United States Constitution that prevented the government from establishing a state religion. That Scopes would be convicted was built into the strategy, which centered on appealing the case to the United States Supreme Court. The plan partially worked: Scopes was found in violation of the law and was fined $100.

Scopes appealed to the Tennessee Supreme Court, which set aside the fine on a legal technicality but upheld the constitutionality

of the law on the grounds that while it forbade the teaching of evolution, it did not *require* the teaching of any other doctrine of human origins, and thus did not benefit any specific religion. And that is where matters rested. By 1927 thirteen American states had debated similar measures, but only Mississippi and Arkansas enacted them. The Scopes Trial had shown that it was legal to bar the teaching of evolution, but the media hoopla surrounding it had depicted such measures as ridiculous. Although most states did not ban instruction in evolution, they also did not encourage the theory's introduction into the classroom, and there was much regional variation.

Two incidents sparked a reevaluation of the legitimacy of excluding Darwinism from public schools. The first was the Soviet Union's launch of the first artificial satellite, *Sputnik*, on October 4, 1957. The Soviets' success triggered an extensive discussion about whether the United States had fallen behind in science education, and reform proposals were mooted for many different areas, building on the model of the Physical Sciences Study Committee, which had already been impaneled in 1956. The centenary of the publication of Darwin's *On the Origin of Species* (1859), two years after *Sputnik*, prompted biologists to decry that "one hundred years without Darwinism are enough!" The Biological Sciences Curriculum Study recommended an overhaul of secondary-school education in the life sciences, with Darwinism (and human evolution) given a central place. The cease-fire between the evolutionists and Christian fundamentalists had been broken.

In the 1960s, religious groups countered with a series of laws insisting on "equal time": if Darwinism (or "evolution science") was required subject matter, then it should be balanced with an equivalent theory, "creation science." Those who wanted to challenge the introduction of creationism into school curricula understood that they needed to make their case by arguing about demarcation. If creationism was not science, then it must be religion, and thus could not be taught in public schools, since this would constitute illegitimate

state support of religion. (Private schools, then and now, could and do teach what they like.)

Cases from both Arkansas and Louisiana made it to the appellate courts in the early 1980s. The first of these, *McLean v. Arkansas Board of Education,* was a *cause célèbre,* with a host of expert witnesses sparring over whether Darwinism was science, whether creation science also met the definition of science, and what the limits of the establishment clause of the U.S. Constitution were. A crucial witness for the evolutionists was Michael Ruse, a British philosopher of science then at the University of Guelph in Canada. Ruse testified to several different demarcation criteria and contended that accounts of the origins of humanity based on Genesis could not satisfy them. One of the criteria he floated was Popper's. Judge William Overton, in his final decision in January 1982, cited Ruse's testimony when he invoked that falsifiability was a standard for determining whether a doctrine was science—and that scientific creationism did not meet it. (Ruse walked his testimony back a decade later.) Overton's appellate court decision was expanded by the U.S. Supreme Court in *Edwards v. Aguillard* (1987), the Louisiana case; the result was that Popper's falsifiability was incorporated as a demarcation criterion in a slew of high-school biology texts. No matter that the standard was recognized as bad philosophy; as a matter of legal doctrine it was enshrined. (In his 2005 appellate court decision in *Kitzmiller v. Dover Area School District,* Judge John E. Jones III modified the legal demarcation standards by eschewing Popper and promoting several less sharp but more apposite criteria while deliberating over the teaching of a doctrine known as "intelligent design," a successor of creationism crafted to evade the precedent of *Edwards*.)

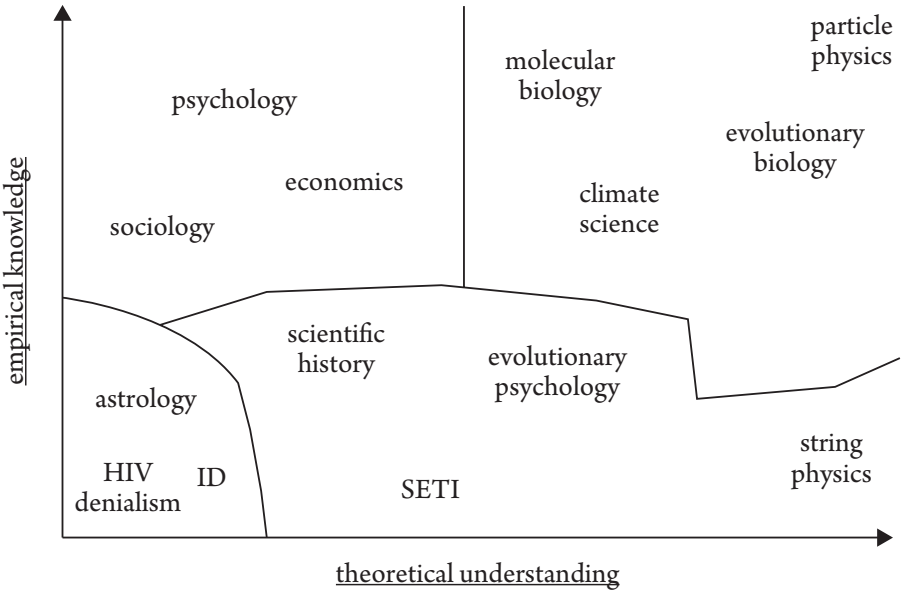
Demarcation after Popper

Larry Laudan's 1983 broadside against demarcation as a topic of philosophical inquiry was elicited by his outrage at Ruse's

invocation of Popper's falsifiability standard despite its clear flaws. Laudan's rejection of all attempts at demarcation as "pseudoproblems," however, in turn evoked incensed replies from philosophers who noted that demarcation was still a vital topic. More to the point, demarcation is *inevitable*. Scientists have finite time and therefore must select which topics are worth working on and which are not, and this implies some kind of demarcation. Indeed, there seems to be a broad consensus about which doctrines count as fringe, although there remains debate about gray areas. Even conceding that Laudan was correct that bright-line demarcations like Popper's were not tenable, other approaches might prove more successful.

Philosopher (and former professor of biology) Massimo Pigliucci, for example, has suggested that the problem with falsificationism is its one-dimensionality. Although a bright line might not be possible, perhaps we could add more dimensions that corresponded to the heterogeneity of scientific practice. Some sciences, he noted, focused on expanding empirical knowledge; others were more concentrated on deepening our theoretical understanding; some sciences did both, but failure to excel on both axes simultaneously did not disqualify a doctrine from being "scientific." However, falling too close to the origin of this graph is a reasonably good indication that the subject is not to be considered scientific, and if partisans of one of these doctrines insist on its scientific status, they might find themselves called pseudoscientists. This approach is not flawless, but it avoids some of the pitfalls that beset Popper.

Instead of trying to develop a criterion that will encompass *all* claims to scientific status—an ambition shared by Popper and Pigliucci—you might instead concentrate on what we can think of as "local demarcation criteria": characterizations that encompass groupings of fringe doctrines without claiming to provide a be-all, end-all solution to the demarcation problem.



Massimo Pigliucci's two-dimensional space of demarcation is an effort to repair overly simplistic one-dimensional criteria like Karl Popper's. *Pigliucci, "The Demarcation Problem: A (Belated) Response to Laudan," in Pigliucci and Maarten Boudry, eds.,* Philosophy of Pseudoscience: Reconsidering the Demarcation Problem *(Chicago: University of Chicago Press, 2013), 23.*

Note: ID = intelligent design

For example, one influential local demarcation criterion is *pathological science,* a term coined by physical scientist (and 1932 Nobel Laureate in Chemistry) Irving Langmuir in a lecture he gave at General Electric's Knolls Atomic Power Laboratory in December 1953—ironically, the same year as Popper's lecture on the demarcation criterion across the Atlantic—but that he chose not to publish. (A transcript circulated widely in the 1960s, and was published in the 1980s.) Langmuir was inspired by a series of notorious episodes in the history of recent science, such as N-rays and extrasensory perception (ESP), which shared certain qualities: they were all highly controversial findings which were detected at the edge of the sensitivity of current measuring apparatus, yet their researchers claimed very high accuracy. In such cases, Langmuir posited, a researcher's own commitment to his or her research program could

turn "pathological": autosuggestion and wishful thinking would take over. This demarcation criterion indeed covers a set of doctrines often labeled "pseudoscience," but it won't do for creationism, or Bigfoot studies, or alchemy. It is a standard designed to specifically rule out ESP research, and therefore it is not surprising that it does so.

In the same fashion, Popper built his falsifiability standard to exclude psychoanalysis, and Ruse and Overton designed theirs to exclude creationism; hence it is no great achievement of their criteria that they successfully do so. All demarcation criteria have this property: they are built inductively out of specific cases, and therefore cannot hope to cover the whole waterfront of possibilities. For this very reason I cannot offer a blanket demarcation criterion of my own—it would flatten out the diversity of the phenomenon under study.

Instead, we might sort fringe doctrines into "families" that can be usefully analyzed together. Four examples would be: vestigial sciences, which are based on past "legitimate" science that is out of date; hyperpoliticized sciences that are yoked to ideological programs; counterestablishment sciences that replicate the sociological structures of mainstream science; and the lineage of theories that have posited extraordinary powers of mind. These categories often overlap, and you might just as easily label a particular doctrine, such as Mesmerism, as a vestigial science or a counterestablishment science instead of as belonging in the lineage of fringe doctrines of mind. No single taxonomy can classify the entirety of the fringe, because the fringe mirrors the heterogeneity of science itself; hence these four categories—in addition to not being properly sealed off from each other—are far from exhaustive. Reflecting upon the diversity of fringe doctrines can provide tools to understand how mainstream science works, and offer some resources to how to think about the inevitable, and imperfect, task of demarcation.