On the Fringe

What’s in it for me? Learn how to distinguish science from pseudoscience.

We’ve all heard of pseudoscience. The term is typically used to describe a theory or belief that resembles science but is actually false, deceptive, or unproven. Many of us can agree that things such as eugenics, UFOlogy, or astrology fall under the category of pseudoscience. But what is it that actually makes these fields “pseudo?” These blinks will guide you through a range of fringe doctrines to give you a better idea of what does and doesn’t count as science. Along the way, you’ll find out how certain doctrines have become demonized as pseudoscientific, how political or cultural contexts have shaped the scientific status quo, and what pseudoscience can teach us about science itself. In these blinks, you’ll learn

how the idea of a flat Earth is a postmodern invention; how classical genetics was considered a pseudoscience for half a century in the Soviet Union; and why reports authored by climate-change denialists don’t qualify as science.

Debates about what counts as pseudoscience are inevitable, but imperfect.

The question of what counts as science has long been debated. Writing about what we now call epilepsy, the fifth-century BCE Greek physician Hippocrates criticized faith-healers, witchdoctors, charlatans, and quacks. In practice, claiming scientific authority inherently excludes rival theories. The debate over scientific criteria is known as the demarcation problem, a term coined by the twentieth-century Austrian philosopher Karl Popper. In his 1934 text The Logic of Scientific Discovery, Popper argued that science should adopt an overall criterion dictating that theories within a field should be falsifiable if that field is to be considered "science." Popper’s demarcation criterion was enshrined in US laws as recently as 2004. But from its onset, philosophers of science knew the theory had limitations. The key message here is: Debates about what counts as pseudoscience are inevitable, but imperfect. Popper’s demarcation criterion falls short in many instances. According to this rule of falsifiability, the Bermuda Triangle theory, Bigfoot, and the flat-Earth model would all qualify as science if adherents of these doctrines conceded that they’d change their minds if solid evidence against them were observed. At the same time, falsifiability negates natural sciences such as geology or cosmology since practices in these fields aren’t executed in terms or claims that can be falsified. So why has Popper’s criterion continued to be so popular? Though an imperfect task, the question of demarcation is essential when it comes to cases such as creation science, or the scientizing of the biblical Judeo-Christian creation story. Demarcation was at the center of the twentieth-century legal battles in the United States to determine whether evolutionary science or creation science should be taught in public schools. In the 1980s, Popper’s demarcation criterion was held up in the US Supreme Court case Edwards v. Aguillard to determine that scientific creationism did not meet the criterion of science and could thus not be taught in schools. As a result,

Popper's theory was enshrined as a legal doctrine and incorporated into high-school biology texts until 2005, when Judge John E. Jones III altered the demarcation criterion to a less-rigid standard. Even with changes, it's inevitable that demarcation criteria will be imperfect. If we want to better our understanding of pseudosciences, we're better off grouping them into loose categories than coming up with a single taxonomy, since pseudosciences are as diverse as science itself.

Many pseudosciences were once held up as science.

Rather than a consistent bank of knowledge, science is constantly evolving. Much of what is published as cutting-edge science today will likely be rendered wrong or irrelevant in the near future. For example, Pluto was considered a planet from its discovery in 1930. But on August 24, 2006, the International Astronomical Union changed its classification to dwarf planet, shocking all who had grown up believing Pluto to be an official planet. The archives of science are filled with discarded doctrines. The author calls such doctrines vestigial sciences, or theories and beliefs once held up as science but later rejected by the mainstream. Today, expired doctrines of science such as alchemy and astrology are recognized by many as classic pseudosciences. But that hasn't stopped some people from upholding their tenets. Here's the key message: Many pseudosciences were once held up as science. Vestigial sciences are useful in revealing the variety of historical ideas that were once considered science. Take astrology. While astrology is still prominent in some parts of the world, such as South Asia, a person who creates horoscopes in the Western world today is unlikely to be respected in scientific circles. But up until the seventeenth century, the majority of Europeans considered astrology to be a science based on empirical knowledge and sophisticated mathematics. Astrology was especially popular at the height of the Italian Renaissance, when wealthy patrons subsidized research in the field, and cities and courts required regular horoscopes to help them make important decisions. Astrologers gathered data from observational astronomers to create maps of the celestial bodies at a client's birth, called genitures. Using state-of-the-art knowledge, the astrologers would then interpret the genitures to help a client make decisions such as an auspicious date for a marriage or whether to mount a military battle. Genitures were constantly being updated and were based on geocentric cosmology, or the idea that the Earth is at the center of the universe. There were always critics who attacked astrology as impious or unscientific, damaging astrology's reputation. But the discipline largely faded from the scientific mainstream during the seventeenth century due to the discovery of the heliocentric system, as well as cultural and religious changes. A similar process of fringing can be observed in other vestigial sciences such as alchemy. Instead of happening instantly, vestigial sciences tend to fall out of fashion gradually. At some point, remaining adherents find themselves advocating a fringe idea and being called pseudoscientists by the mainstream.

Some pseudosciences were espoused to serve particular political ideologies.

All science has the potential to be political. During the Cold War, the United States' policy of demonstrating the superiority of American democracy over Soviet communism

led to the sponsorship of many scientific projects. And in today's battle for abortion rights, for instance, reproductive health has come to involve highly politicized science. But in some cases, scientific doctrines have been hyperpoliticized to serve a particular political ideology. The best-known case of this was Hitler's Germany, where physiology, genetics, medicine, and anthropology were employed to serve Nazi racial policies. The Nazis used science to support the mass genocide of millions of Jewish people as well as thousands of Roma and Sinti, homosexuals, and people with mental and physical disabilities. The key message is this: Some pseudosciences were espoused to serve particular political ideologies. While Nazi racial policies influenced scientific doctrines in Germany, another hyperpoliticized practice unfolded in Stalin's Soviet Union. In 1927, the agronomist Trofim Denisovich Lysenko caught the attention of the scientific community by claiming to have grown winter peas in subtropical Azerbaijan. Lysenko had used a method he later called "vernalization," subjecting the seeds of plants to periods of extreme cold or friction before planting them in a warmer environment. According to Lysenko, vernalization enabled environmental modifications to be transferred to future gene pools. He thereby rejected classical Mendelian genetics, which claimed that genes were unyielding to environmental changes. Lysenko called his doctrine "Michurinism" as well as "agrobiology." But outside of the Soviet Union, his ideas were known as "Lysenkoism." In 1948, Stalin declared Lysenko's Michurinist theories the only valid science of heredity in the Soviet Union. Classical genetics was labeled as pseudoscience and its adherents faced punishment. Lysenko remained dominant in the field until 1965, when academicians found mismanagement and fraud during a forced audit of his farm. In the years that followed, Soviet biologists worked to catch up on a half-century of biology and agronomy. It's clear how the ideological positions of authoritarian governments might extend to the natural sciences. But not all hyperpoliticized doctrines occur under authoritarian regimes. After World War I, the United States disguised race and class biases in the guise of eugenics. In fact, the state of California performed twenty thousand forced sterilizations between 1909 and 1963 on the basis of eugenics. Even after scientists began dismissing the validity of eugenics, policies promoting it were only changed with pressure from the civil rights movement and public disgust at emerging details of Nazi atrocities in Europe.

Adherents of counterestablishment sciences believe they are the defenders of truth.

You'd be hard-pressed to find a pseudoscientist who labels himself as such. More often, adherents of pseudosciences position themselves against the so-called "establishment" of contemporary science. In the crop of pseudosciences known as counterestablishment sciences, adherents believe that they are the proponents of real science. Unlike vestigial sciences or hyperpolitical sciences, which fall out of the mainstream, counterestablishment sciences such as belief in Bigfoot or the Loch Ness Monster have been deemed to be pseudoscientific from their outset. This is also true when it comes to speculation about alien civilizations. The key message here is: Adherents of counterestablishment sciences believe they are the defenders of truth. On June 14, 1947, a foreman named William Brazel spotted clusters of debris on the ranch where he worked near Roswell, New Mexico. Just ten days later, a civilian pilot named Kenneth Arnold saw nine shiny unidentified flying objects, or UFOs, while flying across the Cascade Mountains. The two incidents garnered interest among alien enthusiasts,

especially since the United States Air Force appeared to deny and cover up traces of the events. And over the following decades, a counterestablishment science called UFOlogy gained an extensive following. Alien visitation claims are almost always entwined with conspiracy-theory thinking. UFO claims go hand-in-hand with assertions of government cover-ups. But while the ubiquity of smartphone cameras and high-quality digital images has diminished such claims in recent years, another group of counterestablishment scientists, fueled by more extreme conspiracy thinking, is on the rise. In spite of the overwhelming visual evidence that Earth is round, in recent years, flat-Earth theories have gained widespread prominence. Though there are substantial disagreements within the flat-Earth movement, the leading consensus is that the geography of Earth is organized around the North Pole and surrounded by a rim of ice. Flat-Earth advocates commonly believe that the flat-Earth model of the world is a revival of medievalism. What many people don't realize is that the majority of the Western world has subscribed to the notion that Earth is spherical since at least the early fourth century BCE. The notion that people in the Middle Ages believed that Earth was flat is owed largely to the nineteenth-century American writer Washington Irving. Irving promoted this false idea to bestow on Christopher Columbus the bravado of a revolutionary in his expedition across the Atlantic – which means the flat-Earth model is not a revival of anything. Instead, it's a recent invention.

Skeptics have kept parapsychological research at the fringes of science.

Have you ever had the feeling that something terrible has happened to a loved one, and then found out that it was true? While most people disregard telepathy or psychokinesis, even the American philosopher and psychologist William James, known as the father of American psychology, felt that there was something to be said for the extensive anecdotal evidence of people who sensed the death of a loved one. James was one of the first to experiment in the field that became known as parapsychology, or the study of unusual mental powers. To the dismay of many in the scientific community, parapsychological research has regularly found a place in research universities throughout the twentieth century. Yet it never holds its position for long. Here's the key message: Skeptics have kept parapsychological research at the fringes of science. In the early 1970s, the Israeli mentalist Uri Geller toured Europe and North America demonstrating parapsychological skills such as being able to bend a spoon with his mind. Geller's work caught the attention of two former laser physicists at the Stanford Research Institute, who conducted experiments on him. The researchers found that Geller's skills were veritable and published their findings in the prestigious scientific journal Nature. The research was in part funded by the CIA, who were concerned that they were falling behind the Soviets – who allegedly were recruiting psychics to read secret files using clairvoyance. Skeptics felt increasingly in despair that the scientific community was unable to exclude the expanding output of pseudoscientific research. To combat pseudoscientific claims, a group led by the humanist philosopher Paul Kurtz established the Commission for the Scientific Investigation of Claims of the Paranormal, or CSICOP. But though the institution still exists today as the Committee for Skeptical Inquiry, its efforts haven't been entirely successful in eliminating paranormal claims from the mainstream. Though paranormal activity is usually found to be fraudulent upon closer inspection, efforts such as CSICOP can't keep up with the volume of new claims, and the scientific community has limited time and resources to spend on exposing them. Meanwhile, the interest in parapsychological research by a few outlying members of the

scientific establishment persists. Until 2007, Princeton University had a research program called Princeton Engineering Anomalies Research (PEAR), devoted to parapsychology. And in 2011, the Welsh physicist and Nobel Prize winner Brian Josephson caused an outcry from the scientific community by publishing an article in the Journal of Personality and Social Psychology that claimed he had observed precognition, a type of paranormal foreknowledge.

Denialism shares characteristics with pseudosciences.

Scientists might roll their eyes at contemporary astrologists or parapsychologists. But, for the most part, pseudosciences are harmless. Since time and resources in the sciences are limited and only go to the projects that are deemed most worthwhile, pseudoscience projects are naturally fringed out from the mainstream. But in some cases, fringe sciences can cause considerable public harm. This is the case with groups such as HIV denialists, climate-change denialists, and the anti-vaccination movement. Unlike counterestablishment sciences, denialists don’t aim to establish their own propositions about the world. Instead, they seek to cast doubt on the consensus of the mainstream. The key message is this: Denialism shares characteristics with pseudosciences. The strategy of denialism has its roots in a 1950s public-relations campaign. The firm Hill & Knowlton was hired by the tobacco industry to maintain tobacco sales in the face of mounting scientific evidence that smoking was addictive and potentially deadly. Instead of presenting alternative scientific evidence, Hill & Knowlton called for more research, to sow a seed of doubt about the consensus that smoking was dangerous. This strategy has been adopted by the fossil fuel industry to fuel climate-change denialism, negating the consensus that carbon emissions are causing global temperatures to rise with catastrophic consequences. Climate-change denialists create alternative institutions such as think tanks to promote the production of alternative information. These institutions cloud the reality that their funding comes from corporate sponsorships. But unlike counterestablishment sciences, these institutions don’t present themselves as “outside” establishments. Instead, they mimic scientific institutions to obscure the reality that there’s a clear consensus among scientists that climate change is real. They also exhibit credentialed specialists who use charts and mathematical analyses to support their arguments. These reports look like scientific literature but lack the methodological structure of peer review that’s standard in scientific publications. As a result of these efforts, measures to combat climate change continue to be delayed. Unlike corporate-backed denialists, the anti-vaccination movement is often associated with left-wing movements such as survivalists who are suspicious of government interests. But the movement likewise draws parallels with pseudoscience by frequently citing the debunked claim that the MMR vaccine, which protects against measles, mumps, and rubella, causes autism. In the first nine months of 2019, there were 1,249 outbreaks of measles in the United States – largely due to people not being vaccinated.

The adversarial environment of science makes pseudoscientific claims inevitable.

In the past century, science has progressed more rapidly than at any time in history. We now know more than ever about the natural world. Major discoveries in fields such as neurology and molecular biology are made on a monthly basis. In the face of all of this scientific knowledge, why are pseudosciences so persistent? Answering this question requires us to investigate the nature of modern science itself. The term scientist was first coined in 1831, around the time that studying nature started to become an occupation. The new term implied someone who earned a living from research, published in recently founded scientific journals, and participated in a vibrant community of other science professionals. And it should come as no surprise that around the same time, the term pseudoscience emerged. The key message here is: The adversarial environment of science makes pseudoscientific claims inevitable. In contemporary science, controversy is unavoidable. Researchers put forth new ideas, and competitors try to discredit or debunk them. Even with the progress that science has made in the past decade alone, the very nature of science is that it will keep evolving. There will be winning claims and losing claims. And some of these losing claims will go on to attract adherents even after they've been rejected by the mainstream. Compounding the ever-evolving nature of science is the incentive to publish frequently in scientific journals. There are consistently more researchers in the field than there are resources and high-profile publication opportunities. In order to sustain a career, scientists are required to publish new ideas frequently. It's no coincidence that scientific fraud is more visible than ever before. But while putting tighter restrictions on publications would reduce fraud and potentially limit fringe sciences, it would inevitably suppress scientific innovation as well. Due to the adversarial quality of science, there will always be pseudosciences. Meanwhile, people will continue to follow fringe doctrines for a variety of reasons. They might be seeking community, pursuing an earnest quest for truth, or simply feeling that a certain belief makes more sense to them than what's printed in a science textbook. Whatever the case, pseudosciences will remain a part of a healthy scientific community. By paying closer attention to what characteristics they share, we can become more adept at tackling the few pseudoscientific doctrines that cause public harm.

Final summary

The key message in these blinks: Thanks to mechanisms of modern science, pseudosciences aren't going away any time soon. Understanding the question of demarcation can better our understanding of how science functions. Most pseudosciences are harmless, but examining the processes that create scientific movements at the fringe can help us address doctrines that cause significant public harm, such as climate-change denialism or the anti-vaccination movement. Got feedback? We'd love to hear what you think about our content! Just drop an email to with On the Fringe as the subject line, and share your thoughts!