# Popper and Kuhn on Science and Pseudoscience

In everyday life, we often want to make distinction between arguments that are founded in *genuine* “science” versus those that “look” scientific, but really aren’t. These so-called **pseudoscientific** claims involve everything from fad diets and astrology to claims of a vaccine-autism link. In this lecture, we’ll be looking at how two famous philosophers—Karl Popper and Thomas Kuhn—tried to characterize the difference between “real science” and these other theories.

## Two Examples of Scientific Theories

Most people would consider the following theories to be **scientific** theories:

* **Newton’s theory of mechanics and his law of gravity.** Newton described the relationship between *forces, acceleration,* and *mass.* He also described one specific force that he called *gravity.* Newton and his scientific acolytes used his three laws of mechanics and his law of gravity to make specific predictions about the motions of both heavenly bodies (like the moon, the sun, the planets, and comets) and bodies near the earth (like apples falling off of trees).
* **Einstein’s theories of special and general relativity.** Einstein claimed that there was an absolute limit to the speed of light, and that a light beam traveling through a vacuum would *always* appear to be traveling at this maximum speed, regardless of how fast (or in what direction) the person trying to measure the light’s speed was moving. In order for the speed of light to be “absolute” in this way, though, it meant things like “the time from event A to event B” or “the distance from point C to point D” could *not* be absolute. He used this theory to predict a number of surprising predictions about the way light would curve around planets and stars, and the effect that sun would have on the orbit of planets like Mercury.

## Mythology, Religion, and Pseudoscience

In contrast to the theories just mentioned above, most philosophers of science and logicians would consider the following theories to NOT be scientific theories, even if they might have other legitimate applications:

* **Religious and mythic claims.** Most cultures have numerous popular religious or mythological theories that purport to explain things such as (1) how the world was made, (2) what kind of being/beings were in charge of making the world, and what their motivations were, and (3) what happens to people (and maybe animals) after they die.
* **Freudian psychoanalysis.** According to Freud, humans have three parts to their minds: the id, the ego, and the superego. Each part of the mind has distinct *beliefs, desires,* and *intentions.* However, we are only aware of the ego and the superego—the id is hidden from our conscious minds. Freud’s claim was that every human action or thought (however “irrational” it seemed) was due to some belief, desire, or intention. Freud wrote a number of essays showing how this theory could be used to explain almost every conceivable type of human behavior—all that one need to do to “explain” a behavior was to assign the “right” sorts of intentions, desires, and beliefs to the id (famously, the id often believes that the same-sex is a sexual rival and desires that it be eliminated). The problem? When trying to applying Freudian theory to a particular case, it seems like “anything goes”: there is literally *no possible behavior* that a Freudian analyst couldn’t chalk up to whacky desire on the part of your id.
* **Astrology and Horoscopes.** Many newspaper and websites promise to predict your future based on your “astrological sign.” However, the predictions they give are often quite vague. For example, a typical horoscope might predict that you will encounter “conflicts” in your professional or romantic life, or counsel you to expand on your “strength” in choosing your friends. The people who rely on these suffer from a sort of **confirmation bias**—they focus on the things that the horoscope “gets right,” without noticing that these are generally the sorts of things that could apply to *everyone.*

## Karl Popper’s Proposal: Scientific Theories are Falsifiable

Karl Popper proposed a simple, easy to remember criterion for distinguishing between scientific and nonscientific theories. He first proposed it around 1930, and it has proved very popular, especially with practicing scientists:

**Popper’s Demarcation Criteria.** A theory is scientific to the degree that it can be **falsified**. That is, a scientific theory (unlike a non-scientific theory) *clearly describes ways that it could be proven wrong.*

* **Science!:** Edmund Haley used Newton’s theory to predict that particular comet (“Haley’s Comet”) would appear at a very particular time in a very particular place. If he had been wrong (he wasn’t), this would have been bad news for Newton.
* **Not Science!** Many religions predicted that a God (or gods) created the “best of all possible worlds.” However, they do not specify *any possible observation* that would prove this claim wrong. For example, this does not rule out things like massive natural evils (disease, starvation, etc.). Without a clear prediction of the form “If bad thing X happens, then God really doesn’t exist” these religious claims don’t count as scientific.

While Popper’s criterion (which he labels **D**) is simple, he emphasizes several caveats:

1. **D is vague, and that’s OK.** While many theories are clearly scientific and others are clearly not, there is also a large “grey area.” For example, Copernicus claimed that the earth orbited the sun, but failed to make any concrete predictions resulting from this. Many theories start out as “metaphysics” or “non-science” and become science once measuring equipment has been developed. In general, the more “risks” a theory takes (the more ways that it can be “falsified”), the more scientific it is.
2. **There are (sometimes) legitimate reasons to use non-scientific theories.** Popper argues that most scientific theories started out as pseudoscience, and that there are many domains of human inquiry (including philosophy, logic, and religion) which do NOT make falsifiable claims. Popper’s idea about falsification is meant to reflect a broader rule about thinking: when we make claims, we should have in mind *what it would take to convince us that we are wrong.* Popper thinks think many of humanity’s worst ideas—religious dictatorships, Fascism, Russian Communism, etc.—were all based on theories defined so that they \*couldn’t\* be proven wrong.
3. **It’s (sometimes) OK to revise a falsified theory.** If your theory is falsified, it’s OK to revise it and try again. However, you need to make a **legitimate revision** and not an **ad hoc revision**. A legitimate revision produces a *new* theory that makes *new* testable predictions. An ad hoc revision produces a new theory, but does not make new testable predictions.
4. **Just because a theory hasn’t been falsified does not mean that it is true.** Popper notes that Newton’s theory was false, and that Einstein himself thought that his theory would eventually be replaced by a unified field theory. Popper emphasizes that this is OK. What separates science from non-science is not that the former is TRUE and the latter FALSE. Instead, scientific theories take risks—a scientific theory contains a clear claim of the form “If the following thing is observed, you need to reject me, and find a better theory.” According to Popper, this is why science makes *progress*, while non-scientific theories are essentially *static.*
5. **“Creativity” involves bold risk tasking.** Popper emphasizes the importance of being willing to “go it alone” and to come up with a completely new scientific theory in response to an experiment that falsified an old scientific theory. He recognizes that this sort of thinking is not unique to science, but he thinks that it is most valuable when you take a risk of being shown wrong—that is, of having your theory falsified.

Popper’s basic idea can be summarized as follow: “real” science takes risks by making concrete predictions *that might actually be proven wrong*, while pseudoscience does not. Pseudoscience is marked by a sort of blind acceptance of the theory in question, along with a refusal to subject this theory to any real tests that might show it to be wrong.

## An Alternative View: Thomas Kuhn on Paradigms

**Thomas Kuhn** was another famous philosopher of science who tried to explain what was “unique” about science. He didn’t agree with Popper, though, because he thought that Popper’s theory really only worked to explain “revolutionary” science (what Popper calls “heroic” science). He didn’t think Popper’s view accurately captured day-to-day science, in which it would be absolutely crazy for someone to give up on theory just because it got one bad experimental result. Here’s Kuhn’s solution:

**Kuhn’s Paradigms.** A mature science (unlike pseudoscience or mythology) has a **paradigm** that is shared by all of its scientists. This paradigm consists of a vocabulary, specific testing methods, and a shared sense of what it is important. If two scientists share a paradigm, they will agree on how to use the theory to solve problems, how to deal with predictions that don’t “turn out,” and so on. Learning how to work with a paradigm is a big part of scientific education. Some important points.

* **Prescientific and pseudoscientific theories don’t have paradigms.** For example, two Freudian psychologists will rarely agree on what specifically is wrong with a patient, and what can be done to treat him or her. Even skilled theologians disagree on what “predictions” about the future can be deduced from their holy texts. No two astrological websites will give you the same horoscope. (And this is all very different from physics, chemistry, or biology, where different textbooks give *identical* results when discussing how to solve the same problems).
* On Kuhn’s view, scientists **very rarely entertain the thought that their paradigm is “falsified.**” Instead, they assume that something else has gone wrong—e.g., that there has been an error in measurement, or that some factual assumption was wrong.
* **“Creativity” in science involves problem-solving WITHIN a paradigm**. Popper emphasizes the importance of bold risk takers, and “thinking outside the box.” Kuhn thinks this is a flawed idea of how science (and even creativity more generally) actually works. In order to actually make any progress, Kuhn thinks that young scientists have to spend *lots* of time learning how the dominant paradigm actually “works.” They need to know important equations, concepts, testing methods, problems of current interest, and so on. Kuhn actually argued creative work in many scientific fields requires something like a doctoral-level education. Again, this is very different from pseudoscience: no (reputable) university awards PhDs in astrology, and there is no generally accepted distinction between “skilled” astrologists and unskilled one.

A music analogy: Popper thinks that a “great scientist” is like someone who invents an entirely new genre of music. So, if you’re sick of country, you invent rock; if you’re sick of rock, you invent hip hop, and so on. Kuhn emphasizes that this is pretty unusual, and that most of the great scientists were working *within* paradigms, just as most great musicians were working within their chosen genre of music. Both of them would emphasize the not every random collection of sounds deserves to be called music, even if the person making the sounds claims “But I’m a musician!”

**Review Questions.** (1) Take a few minutes, and to write down your OWN distinction between “science” and “pseudoscience” using the ideas of Popper and Kuhn. (2) Try to come up with (at least) THREE different ideas or theories that you think might be “pseudoscientific.” Why do you think this? What kind of evidence could you look for to confirm/disconfirm your suspicion?