

How Can We Differentiate Between Science and Pseudoscience?

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By [Steven Novella, M.D., Yale School of Medicine](#)

In the Age of Information, differentiating between real science and pseudoscience seems to be simultaneously easier and harder. How can we separate the two and acknowledge a grey area in between?

Is anthropogenic global warming a legitimate science or a pseudoscience, as some claim? What about cryptozoology, the study of unusual creatures unknown to current science, such as Bigfoot, the Lochness Monster, or the Chupacabra, or how about string theory that is held by prominent cosmologists of today or ESP, psi research? Are these legitimate sciences, are they on the fringe of science or are they pseudosciences?

What is Pseudoscience?

The term pseudoscience refers to beliefs and practices that claim to be scientific but lack the true method and essence of science. They have the patina of legitimate science, but something has gone terribly wrong.

In essence, pseudoscientists use the processes of science, these superficial processes or similarities of science to science, in order to rationalize, scientifically rationalize a conclusion that they wish to be true, rather than using the methods of science to determine if their belief is true or not. What they have failed to do is make a concerted effort, therefore, to prove their own theories wrong. That should always be the first step of any scientist. When you come up with a new idea, a new hypothesis, the first thing you should do is everything possible, in order to disprove your own theory. Find every way possible to conduct an experiment or an observation that can falsify the theory. When the theory or the hypothesis has survived every attempt you can think of to prove it wrong, only

then is it reasonable to give it provisional assent, to think, all right, now this is a theory that may be true. Then it's a good idea to check with your colleagues, publish your results in peer reviewed journals and see what other scientists believe, other experts. Can they think of any ways that maybe you missed that could be an alternate to the theory that you have or that could potentially prove it wrong?

Q: How can we tell the difference between pseudoscience and science?

We can easily discern **pseudoscience from science** as the former is careless, results cannot usually be reproduced, the study does not rely on empirical evidence but rather appeals to emotion, and practitioners generally refuse or buckle under peer review.

Q: What exactly is pseudoscience built on?

Pseudoscience is composed of beliefs and theories that are not based on scientific literacy and have not been organized with thorough, empirical facts and evidence but rather stories, feelings and shifting data.

Some Facts, and Many Misconceptions of Modern Science

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By **Don Lincoln, Ph.D., University of Notre Dame**

What is science? Many people would say that science is a collection of facts, like the Earth is four and a half billion years old or the Egyptian pyramids were made by aliens using UFOs, the latter leading into the core essence of what science is? Science isn't a series of facts, but, a way of observing the world and generating

testable hypotheses, which can be confirmed, like the age of the Earth, or falsified, like the whole UFO/pyramid connection. Once confirmed, hypotheses are taken as facts, which in science can be soft things. Those are not facts like for example, George Washington was the first President of the United States, but more malleable, like Newton's law of gravity, a good scientific theory that can be used to calculate orbital parameters and rocket trajectories, and accurately send a probe to Pluto. When Newton's theory of gravity was proven to be incomplete, it was replaced by Einstein's theory of general relativity. Scientific facts and ideas keep changing as new information comes in, the flexibility of which gives it such power. Ideas work to a needed level of accuracy, as long as they work, but are discarded when new information comes in or a higher level of accuracy is needed.

Q: What are the characteristics of modern science?

The main characteristics of modern science are that it is a collection of facts (observable and always right, proved and reproducible), hypotheses, flexibility, and ever-evolving science for a higher level of accuracy.