Why should we place our faith in science?

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Lots of scientists see things in different ways, but that doesn't undermine its authority. Credit: Dan Tentler/Flickr, CC BY-NC

Most of us would like to think scientific debate does not operate like the comments section of online news articles. These are frequently characterised by inflexibility, truculence and expostulation. Scientists are generally a little more civil, but sometimes not much so!

There is a more fundamental issue here than politeness, though. Science has a reputation as an arbiter of fact above and beyond just personal opinion or bias. The term "scientific method" suggests there exists an agreed upon procedure for processing evidence which, while not infallible, is at least impartial.

So when even the most respected scientists can arrive at different deeply held convictions when presented with the same evidence, it undermines the perceived impartiality of the scientific method. It demonstrates that science involves an element of subjective or personal judgement.

Yet personal judgements are not mere occasional intruders on science, they are a necessary part of almost every step of reasoning about evidence.

Among the judgements scientists make on a daily basis are: what evidence is relevant to a particular question; what answers are admissible *a priori*; which answer does the evidence support; what standard of evidence is required (since "extraordinary claims require extraordinary evidence"); and is the evidence sufficient to justify belief?

Another judgement scientists make is whether the predictions of a model are sufficiently reliable to justify committing resources to a course of action.

We do not have universally agreed procedures for making any of these judgements. This should come as no surprise. Evidence is something experienced by persons, and a person is thus essential to relating evidence to the abstractions of a scientific theory.

This is true regardless of how directly the objects of a theory are experienced – whether we observe a bird in flight or its shadow on the ground – ultimately it is the unique neuronal configurations of an individual brain that determine how what we perceive influences what we believe.

Induction, falsification and probability

Nevertheless, we can ask: are there forms of reasoning about evidence that do not depend on personal judgement?

Induction is the act of generalising from particulars. It interprets a pattern observed in specific data in terms of a law governing a wider scope.

But induction, like any form of reasoning about evidence, demands personal judgement. Patterns observed in data invariably admit multiple alternative generalisations. And which generalisation is appropriate, if any, may come down to taste.

Many of the points of contention between Richard Dawkins and the late Stephen Jay Gould can be seen in this light. For example, Gould thought Dawkins too eager to attribute evolved traits to the action of natural selection in cases where contingent survival provides an alternative, and (to Gould) preferable, explanation.

One important statement of the problem of induction was made by 18th-century philosopher David Hume. He noted the only available justification for inductive reasoning is that it works well in practice. But this itself is an inductive argument, and thus "taking that for granted, which is the very point in question".

Hume thought we had to accept this circularity, but philosopher of science Karl Popper rejected induction entirely. Popper argued that evidence can only *falsify* a theory, never *verify* it. Scientific theories are thus only ever working hypotheses that have withstood attempts at falsification.

This characterisation of science has not prevailed, mainly because science has not historically proceeded in this manner, nor does it today. Thomas Kuhn observed that:

No process yet disclosed by the historical study of scientific development at all resembles the methodological stereotype of falsification by direct comparison with nature.

Scientists cherish their theories, having invested so much of their personal resources in them. So when a seemingly contradictory datum emerges, they are inclined to make minor adjustments rather than reject core tenets. As physicist Max Planck observed (before Popper or Kuhn):

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it.

Falsification also ignores the relationship between science and engineering. Technology stakes human lives and personal resources on the reliability of scientific theories. We could not do this without strong belief in their adequacy. Engineers thus demand more from science than a working hypothesis.

Some philosophers of science look to probabilistic reasoning to place science above personal judgement. Prominent proponents of such approaches include Elliot Sober and Edwin Thompson Jaynes. By these accounts one can compare competing scientific theories in terms of the likelihood of observed evidence under each.

However, probabilistic reasoning does not remove personal judgement from science. Rather, it channels it into the design of models. A model, in this sense, is a mathematical representation of the probabilistic relationships between theory and evidence.

As someone who designs such models for a living, I can tell you the process relies heavily on personal judgement. There are no universally applicable procedures for model construction. Consequently, the point at issue in scientific controversies may be precisely how to model the relationship between theory and evidence.

What is (and isn't) special about science

Does acknowledging the role played by personal judgement erode our confidence in science as a special means of acquiring knowledge? It does, if what we thought was special about science is that it removes the personal element from the search for truth.

As scientists – or as defenders of science – we must guard against the desire to dominate our interlocutors by ascribing to science a higher authority than it plausibly possesses. Many of us have experienced the frustration of seeing science ignored or distorted in arguments about climate change or vaccinations to name just two.

But we do science no favours by misrepresenting its claim to authority; instead we create a monster. A misplaced faith in science can and has been used as a political weapon to manipulate populations and impose ideologies.

Instead we need to explain science in terms that non-scientists can understand, so that factors that have influenced our judgements can influence theirs.

It is appropriate that non-scientists subordinate their judgements to that of experts, but this deference must be earned. The reputation of an individual scientist for integrity and quality of research is thus crucial in public discussions of science.

I believe science is special, and deserves the role of arbiter that society accords it. But its specialness does not derive from a unique mode of reasoning.

Rather it is the minutiae of science that make it special: the collection of lab protocols, recording practices, publication and peer review standards and many others. These have evolved over centuries under constant pressure to produce useful and reliable knowledge.

Thus, by a kind of natural selection, science has acquired a remarkable capacity to reveal truth. Science continues to evolve, so that what is special about science today might not be what will be special about it tomorrow.

So how much faith should you put in the conclusions of scientists? Judge for yourself!

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