

Supernatural Explanations: Science or Not?

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Abstract

Contrary to the advice of supposedly authoritative sources, the a priori exclusion of supernatural explanations or claims from scientific scrutiny is not appropriate. This paper shows how supernatural hypotheses or claims should be treated by science and, in the process, differentiates scientific and non-scientific hypotheses or claims. Educational strategies are provided to help reduce the widespread belief in claims that have been contradicted by scientific testing and to help students avoid advancing hypotheses that are unlikely to be supported by empirical evidence. Both science and religion appear to play a role in societies, and there need be no conflict between these two very different domains.

Students need to be provided with opportunities to apply the scientific method (or hypothetico-deductive approach) during science classes. An outline of the scientific method may be found in, for example, Eastwell (2010). During this process they will likely be asked to suggest one or more hypotheses (i.e., proposed explanations) for an observed phenomenon and test it or them. What hypotheses are acceptable for consideration in science classes? Are there restrictions? In particular, what is the status of a supernatural hypothesis in science? This paper addresses these questions and, in so doing, provides the best answer to the following multiple-choice question:

Which of the following appears to be the best choice?

- A. Science cannot test a supernatural explanation or claim.
- B. Science can test a supernatural explanation or claim.
- C. Science can test some supernatural explanations and claims but not others.

A Confused Landscape

My reading of the literature, together with conversations with other science educators around the globe, on the relationship between science and the supernatural has been characterised by confusing and contradictory information. I have come to appreciate how readily teachers, as a result of exposure to selective reading only in this area, could adopt what appears to be a misguided position. This would be most unfortunate, as it would impact negatively on the effectiveness of these teachers to guide student scientific inquiry appropriately.

As an additional check on the clarity, or lack thereof, of thinking in this area among science educators, I surveyed readers of *The Science Education Review (SER)* about the following, more concrete, scenario:

Imagine students arriving at school after a weekend to find that plants have sprung from the soil in a pot. As part of the science curriculum, their teacher asks: "Why has this happened?" One student hypothesises that angels visited during the weekend and initiated the plant growth. Would you encourage this student to test this hypothesis as a part of doing science, or not? If yes, would you kindly exemplify how you think the student investigation might proceed. If not, would you please provide your reasoning.

The responses proved illuminating. Only 16 of the 8,000 readers on the journal mailing list responded to the survey question, with these responses split roughly evenly between the *yes* and *no* positions (some responses did not make the responder's position clear in this respect) and characterised by conflicting views. The following comment from one university educator is particularly noteworthy: "I passed that question about angels to many of my fellow faculty and they did not want to touch it. I have no problem talking about it! Interesting!" In addition, 2 readers were critical of the journal--and, by implication, me as Editor--for even asking what they perceived to be such a "silly" question in the first place. So, I hypothesised that many did not feel confident in responding to the angel-hypothesis question and that this, together with the fact that those who did respond held differing, and even contradictory, views, suggested that there was indeed an issue here that would likely benefit from deliberation and clarification.

The Angel Hypothesis

The supernatural/metaphysical is characterised by descriptors such as outside the observable universe, violating natural laws, and pertaining to god or a deity and is commonly associated with things like spirituality, occultism, spirits, the divine, the miraculous, fairies, vampires, ghosts, goblins, and other unearthly beings, including angels. In preparing to respond to the foregoing angel-hypothesis survey question, one might first check on what is advocated on the issue of science and the supernatural by what might readily be assumed to be authoritative sources. Consider the following:

- "Supernatural entities, by definition, operate outside of natural laws and so cannot be investigated using scientific methods" (American Association for the Advancement of Science [AAAS], n.d.b, p. 12).
- "Because 'intelligent design' theories are based on supernatural explanations, they can have nothing to do with science" (Alberts [President of the National Academy of Sciences], 2005).
- "Questions that deal with supernatural explanations are, by definition, beyond the realm of nature--and hence, also beyond the realm of what can be studied by science" (Understanding Science, n.d., ¶ 5; part of a website produced by the UC Museum of Paleontology of the University of California at Berkeley, in collaboration with a diverse group of scientists and teachers, and funded by the National Science Foundation).
- "It [intelligent design] invokes supernatural causes, and ... hypotheses involving reference to supernatural causes are not within the purview of science" (Fales, 2009, ¶ 5, commenting on a United States judicial ruling concerning the teaching of intelligent design in public school classrooms).

A common theme across these quotes is that science deals with the natural, not the supernatural, and so an angel hypothesis cannot play a role in science. However, this position does not appear to stand up to scrutiny. Could it not be that what at present appears to be a supernatural phenomenon might rather be a natural phenomenon that is yet to be recognised? The a priori exclusion of supernatural-based explanations or claims from science would therefore unnecessarily impede the further development of our understanding of the natural world. Surely it is better for science to keep an open mind to all possible explanations and to simply go where the evidence leads.

Further, one of the features of the nature of science is that scientific explanations and claims must lend themselves to being both empirically testable and contradictable (Eastwell, 2002). Please

note that, by testable, I do not mean that, for whatever reason (e.g., a lack of technological means), the explanations or claims must lend themselves to being testable right now, but rather that they are testable in principle. Therefore, a better approach to the angel-hypothesis scenario would be to ask the student to try to generate a test for the hypothesis that, in accord with the scientific method, needs to include explicitly-stated predictions that can be checked. There now appears to be three possible pathways by which to proceed:

1. The student might elaborate on his or her hypothesis in such a way as to make it empirically testable and contradictable, and now we have a scientific hypothesis. For example, the student might suggest that angels are visible entities, and one can envisage testing this by keeping a vigil or using video cameras or some other form of angel detector. Or, the student might suggest that angels leave angel dust, so once again this could be tested by searching for such dust. Or, if it is hypothesised that angels make sounds, a microphone could be used as a probe. Then, in the light of our existing scientific knowledge, after conducting such tests we expect that the student would conclude that his or her angel-based hypothesis is contradicted, thus encouraging this student to pursue alternative hypotheses for the observed plant growth that may have been suggested by other members of the class.
2. Alternatively, the student's notion of an angel could be so non-specific as to not allow a test of the hypothesis to be generated, as in the case of an angel being considered an invisible entity that does not make a noise and whose presence cannot be detected empirically in any other way. Because the angel hypothesis is empirically untestable, we would need to deem it a non-scientific hypothesis and recognise that science cannot say anything more about it. That is, science cannot reach a conclusion about (i.e., cannot support or contradict) an explanation or claim that cannot be tested. In this case, angels may or may not have caused the plants to spring from the soil; science simply cannot know.
3. In a third option, the student might elaborate by describing an angel as, for example, an entity that is capable of facilitating anything. This would again lead to the student's hypothesis being a non-scientific one because, although it is testable, it is not contradictable (i.e., does not lend itself to producing predictions that can be refuted by evidence) because it is so broad as to predict all possible outcomes.

So, explanations or claims should not be excluded a priori from science, including school science, simply because they appear to be supernatural, paranormal, or even religious in nature. Creationism and intelligent design (ID), for example, make claims that can be, and have been, tested empirically. These claims should not be dismissed from science simply because they have a supernatural or religious element and are therefore supposedly unscientific, but rather because the scientific testing has contradicted them (Fishman, 2009). For example, Lawson (1999) produced a superb lesson plan that allows students to use fossils to compare the theory of evolution and the alternative explanations of special creation and spontaneous generation and to conclude that the evidence supports the former only and contradicts the other two explanations. However, those explanations or claims that in principle cannot be both tested empirically and contradicted, such as God-based hypotheses that are so general as to explain everything (i.e., the notion that God can be used to explain the presence, or absence, of anything) need to be considered non-scientific explanations or claims about which science can say nothing more. It follows, then, that the best response to the multiple-choice question that introduced this paper is Option C; namely, "science can test some supernatural explanations and claims but not others" (i.e., science can test scientific explanations and claims but not non-scientific ones).

While acknowledging that some supernatural claims are beyond the scrutiny of science, we are left with the question of why supposedly authoritative sources such as those identified earlier in this paper advocate that all supernatural claims are beyond scientific testing. I am writing to some of these sources seeking the reasoning for their position and intend to report the responses in a future issue of this journal. Surely the rationale could not be as shallow as wanting to avoid conflict between science and religion and thus the political risk of religious taxpayers withdrawing their desire to support science financially! However, although a supernatural hypothesis such as the angel-based one considered here may indeed be a legitimate scientific hypothesis, later in this paper I will suggest two science education strategies that may beneficially result in students not being inclined to propose such a hypothesis in the first place.

Evaluating the Probable Truth of an Explanation

If supernatural explanations can play a role in science, one might ask why we do not see them being proposed and tested more often in the science research literature. In short, it is because spending time on investigating a supernatural explanation of an observed phenomenon is unlikely to produce support for it, as I will now explain, and most prefer to devote time and effort to producing something that is more likely to “work.”

Just because something is possible does not mean that it is probable. Fishman (2009) draws on Bayesian confirmation theory to provide three ways by which science can evaluate the probable truth of an explanation or claim; namely, by a consideration of:

1. The prior probability of the explanation or claim being true.
2. The empirical evidence for or against the explanation or claim.
3. Plausible alternative explanations.

If I was to claim to have a car in my garage, nobody would pay much attention. However, the claim that I had a fire-breathing dragon in my garage would likely attract much doubt (i.e., be given a low probability) because it conflicts so extremely with our present knowledge of nature and how it works. Supernatural explanations or claims are likely to similarly have low initial probabilities, particularly in light of the long history of such explanations or claims having been either contradicted and/or replaced by alternative, non-supernatural explanations, as exemplified by the following:

- Lotteries are not consistently won by psychics, thus contradicting the claim that some people possess extrasensory perception.
- There was a time when lightning was considered to be a tool used by the Gods to punish evil people, with Benjamin Franklin’s lightning rod even being condemned on the basis that it was an attempt to interfere with God’s will. However, the evidence suggests that lightning does not discriminate on moral grounds!
- Astrology does not make detailed and accurate predictions.
- Kepler had angels beating their wings to drive the planets forward (D. Sathe, personal communication, April 10, 2011).
- Intercessory prayer has not been shown to improve patient outcomes (Aviles et al., 2001; Benson et al., 2006).
- The biblical account of the Earth being less than 10,000 years old has been contradicted.

- Before being contradicted by the theory of evolution by natural selection, even Darwin (1876/2000) was convinced by Paley's (1802/2006) argument for intelligent design.
- According to legend, puzzled by the absence of mention of a Creator in Laplace's work on celestial mechanics, Napoleon was told by Laplace that he had no need for that hypothesis (Center for History of Physics, 2011).
- Many illnesses were once attributed to supernatural entities, and considered punishment for sins or the result of the whimsical behaviour of gods or spirits. So, for thousands of years, treatments consisted of appealing to these supernatural powers through offerings, sacrifice, and prayer. However, the introduction of germ theory in the 19th century radically changed both the explanation and the treatment (AAAS, n.d.a).

So, as time has progressed, the world has become increasingly "naturalised." Natural explanations, based on our background knowledge, are appealing because they have proven to be very effective in improving our understanding of the natural world. Most adults prefer a more mundane, alternative explanation for why the milk and biscuits disappeared than an appeal to Santa Claus. Perhaps the fact that science can have a role in commenting on the supernatural explains why the vast majority of scientists who are members of the National Academy of Sciences are atheists (Larson & Witham, 1998). All this is, of course, not to say that some supernatural explanation, or even a supernatural world view, might not come to be supported at some future time. However, with such a claim that is characterized by a low initial probability will come a very high burden on the claimant to provide convincing evidence.

Two Useful Educational Strategies

If scientists are inclined to steer away from low-probability supernatural hypotheses, and school science investigations are supposed to mirror real science, then it would seem desirable that school students do similar. I suggest two strategies to help achieve this goal. The first is exemplified by an activity that I continue to use as I visit schools in my role as a visiting science presenter, as summarised in the following:

1. Administer the Beliefs Questionnaire, found in "How Sceptical" (2002), to students (after omitting the item about aliens having visited Earth). The items include the consequence of breaking a mirror, astrology, wearing certain jewellery to promote health, palmistry, telepathy, clairvoyance, and telekinesis and represent beliefs that can be easily refuted. Religious beliefs have been purposely avoided, not because they need be but to avoid the group becoming "bogged down" in more complicated, contentious distractions. In this way, connections to religion are left implicit.

My experience with especially lower-secondary students is that beliefs in superstitions and supernatural and pseudoscientific claims that do not hold up under scientific scrutiny is "alive and well," which is in accord with the findings of others for not only school students but also tertiary science students and the public in general, including even science educators (e.g., Impey, Buxner, Antonellis, Johnson, & King, 2011; Martin, 1994; Preece & Baxter, 2000; Toynbee, 1998). That such beliefs are widespread throughout societies must surely reflect poorly on science education.

2. Invite students to consider how they might test some of the beliefs in the questionnaire, and steer them towards testing telepathy. Select a student (with whom I have previously met, unbeknown to the rest of the students), who will correctly read the minds of other students in the class.

3. Challenge students to design tests to determine whether this student really does have telepathic abilities or whether some kind of fraud is at play (which, of course, it is).
4. Conclude by telling students that science has contradicted all the beliefs in the questionnaire.

This activity serves the roles of promoting critical thinking, teaching how science can be used to evaluate claims, and sharing the present state of scientific knowledge about such claims. My experience is that students find the activity engaging, and that the outcomes are rewarding, as exemplified by the following recent comment by a Year 9 girl in Australia: “I don’t like science, but I enjoyed this lesson. I’ll certainly sleep much better tonight!”

The second strategy I suggest is to provide opportunities for students to appreciate the history of the development of our understanding in certain areas. A classic might be the story of how we came to accept that the Earth (and other planets) revolves around the Sun, including the competition between geocentrism and heliocentrism and the pressures exerted on Galileo, by the Catholic Church, for promoting heliocentric theory. Other useful areas might be disease, including how the germ theory emerged, and why the ideas of phlogiston and the luminiferous aether were superseded (Fishman, 2009).

God-Based Beliefs

It would seem appropriate, in a paper dealing with science and the place of supernatural explanations, to devote a little space to addressing the issue of science and religion specifically, because it is topical. I preface my thoughts, though, by declaring that my background is in science and science education rather than spirituality and religion, so my comments may best serve the purpose of encouraging others with appropriate expertise to take up the conversation.

Science and religion are two distinctly different domains, with very different purposes and methods. Science is based on perceptions of our senses (i.e., empirical evidence) and attempts to understand our experiences by using testable and contradictable explanations or claims that are always tentative. Meaning in science involves bringing order to our understanding, as in the case of understanding the cause of an epidemic and how it is spread. On the other hand, religious experiences are more internal, with religion often relying on tradition, authority, and revelation and involving eternal truths that are not open to revision. Religion attempts to give meaning to our experiences and addresses more abstract questions and questions of ultimate significance.

Conflict between science and religion has typically arisen as a result of statements by religious authorities being contradicted by science. With the content of the previous paragraph as background, and in accord with the thinking of, for example, Derry (1999) and Gould (1992, 1997/2001), it seems that there is no need for conflict between science and religion, provided religion learns from history and refrains from making statements about nature that are empirically contradictable (which is the province of science) and science likewise refrains from making statements having a spiritual dimension (which is the province of religion), as in the case of the physicist who declared: “The more the universe seems incomprehensible, the more it seems pointless” (Derry, 1999, p. 127). Advancing religious/God-based hypotheses concerning the composition of the universe and how nature works that are sufficiently detailed to be contradicted is fraught with danger for religion, because this can only be setting religion up for failure. If the God-based hypothesis predicts correctly, nobody takes much notice, but if it does not, the religious teaching is contradicted, and religion does not have a self-correcting mechanism in-built as science does.

More than other cultures, the major past conflicts between science and religion have involved the Christian West, although the Koran does provide for microevolution but not macroevolution. That the lesson from history about the dangers of religion making empirically-contradictable claims has not been learned by some appears to be exemplified by those educational institutions that continue to teach, for example, that the Earth is only a few thousand years old, and I fail to comprehend the wisdom of doing so.

So, based on the foregoing, what are we to make of religious beliefs? An example might be the "God created me" hypothesis, which does not seem to be testable and hence is non-scientific, provided one does not elaborate on the nature of God in such a way as to make it empirically testable. An entity becomes testable if it can be detected or if its effects or consequences can be observed and, as Fishman (2009) has argued, as soon as one elaborates on the characteristics of God using descriptors such as omniscient, benevolent, and omnipotent (i.e., all-knowing, doing good, and able to do anything) we have a testable claim that appears to be contradicted by the evidence. Similarly, a description/claim such as God has infinite benevolence to let us learn from our own mistakes is non-scientific, because while it is testable, it is also so broad as to predict all possible outcomes and is therefore not contradictable (i.e., does not lend itself to producing predictions that can be refuted by evidence). To take one extreme, then, there will be those who hold the view that, because religious beliefs cannot be tested or contradicted, believing such is on a par with believing in any absurdity, including the Flying Spaghetti Monster (Church of the Flying Spaghetti Monster, n.d.), thus reflecting an epistemological position that knowledge can result only from hypothetico-deductive (scientific) reasoning.

However, the evidence suggests that such a position undervalues the role and value of religion in many, if not most, people's lives. For example:

- A very small minority of the world's population is atheist (Wikipedia, 2011a).
- I was struck by the recent testimony of Sudanese refugees on the radio about how valuable their religious faith had been in helping them to cope with the atrocities they had been forced to witness.
- Former British Prime Minister Tony Blair, who converted to Catholicism after leaving office, acknowledges that it is his religious belief that motivates him to try to contribute to the greater good rather than to personal gain alone (Monk Debates, n.d.).

Indeed, biologist Freeland (2010) is "happy to accept that humans are a 'religious' species, having evolved sufficient intellectual capacity to postulate the possible existence of an intelligent creator" (p. 41) and regards what some anthropologists have called our religious instinct to be "as much a part of being human as thinking logically or carrying out scientific experiments" (p. 41).

Why is it that humans typically have some sense of spirituality and some form of supernatural worldview, even in the absence of support for their beliefs from scientific testing and, what is more, the long history of supernatural claims that can be tested having been contradicted? Why does the notion of God persist? Why is the Pope, for example, still doing good business? Various hypotheses have been advanced, including the following described in Fishman (2009). Perhaps we have a subconscious desire for attachment and security. Perhaps we have an emotional longing for the care provided by our parents during our infant years. Perhaps the potential of religion to alleviate anxieties and fears offers powerful motivation to believe. Perhaps religious rituals and

prayer provide an apparent degree of control over events. Perhaps inferring the existence of supernatural entities is a by-product of processes that evolved to assist survival.

The natural inclination of humans to believe in supernatural entities, or at least be prone to acquiring such concepts from their culture, is not universal, though. The saying that “there are no atheists in trenches/foxholes” is “used to argue that in times of extreme stress or fear, such as when participating in warfare, all people will believe in or hope for a higher power” (Wikipedia, 2011b, ¶ 1), but the evidence contradicts this. For example:

Joe Simpson, author of the book *Touching the Void*, explicitly addresses the issue in the film adaptation of his nearly fatal climb of the Siula Grande mountain. Referring to the moment he lay at the bottom of a deep crevasse, dehydrated, alone and with a broken leg, he states: “I was totally convinced I was on my own, that no one was coming to get me. I was brought up as a devout Catholic. I'd long since stopped believing in God. I always wondered if things really hit the fan, whether I would, under pressure, turn round and say a few Hail Marys and say ‘Get me out of here.’ It never once occurred to me. It meant that I really don't believe and I really do think that when you die, you die, that's it, there's no afterlife.” (Wikipedia, 2011b, ¶ 9).

Both science and religion can be used for good or for evil, and both scientific and religious experiences appear to play a valid role in societies, although their relative validity is a matter for personal determination, perhaps not unlike how, for example, some will view a wind farm as an aesthetic beauty while others will view it as an eyesore. I do not have difficulty with others having spiritual beliefs that they find helpful, but do draw a sharp line when, for example, a group wants to exterminate the rest of us who do not share the same view!

In summary:

- All explanations and claims, including those that appear to be supernatural, paranormal, or religious, should be open to scrutiny by science.
- Explanations or claims that in principle cannot be tested empirically because they lack specificity are non-scientific explanations or claims. Science cannot reach a conclusion about (i.e., cannot support or contradict) an untestable explanation or claim. Explanations that are testable but not contradictable are also non-scientific.
- Science education has a duty to teach students how to distinguish scientific claims (i.e., those that are both testable and contradictable) and non-scientific ones, and to make an impact on reducing the widespread belief in claims that have been contradicted by scientific testing.
- There is no need for conflict between science and religion, provided religion does not make statements about nature that can be empirically contradicted (which is the province of science) and science does not provide commentary having a spiritual dimension.
- Both scientific and religious experiences appear to contribute to the human experience, although their relative validity is a matter for personal determination.

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