

Science denial: a guide for scientists

Joshua Rosenau

National Center for Science Education, Oakland, CA, USA

Evolution, climate change, and vaccination: in these cases and more, scientists, policymakers, and educators are confronted by organized campaigns to spread doubt, denial, and rejection of the scientific community's consensus on central scientific principles. To overcome these threats, scientists not only need to spread scientific knowledge, but must also address the social drivers of science denial.

You do not expect to see Draco Malfoy carrying a Hermione Granger poster, let alone one in which she touts the whooping cough vaccine. Yet at the Dragon*Con science fiction and fantasy convention, fans of Harry Potter, Star Wars, Star Trek, Battlestar Galactica, and Buffy the Vampire Slayer love to dress as their favorite characters. Some of them even don costumes to spread the word about a vaccine clinic, attracting hundreds of their fellow attendees to get immunized. Who could say no to Draco?

The effort was a response to an organized campaign of science denial aimed specifically at vaccination, one of the greatest public health accomplishments in human history. In part because of this form of science denial, the USA now faces the largest whooping cough outbreak in 50 years, with over 11 000 cases and at least a dozen deaths reported to the Centers for Disease Control in 2012 alone.

Microbiologists are at the forefront in defending vaccination. Yet they are also in a position to combat creationism, climate change denial, rejection of the link between HIV and AIDS, and many other science denials. Winning on any of these fronts requires an understanding of what science denial is and where it comes from. Science denial is wrong and harmful, but not antisience nor irrational. It is driven by genuine fears and deep personal values.

For scientists, it is especially easy to get caught up in countering the factual falsehoods of science denial. For instance, creationists dismiss antibiotic resistance as evidence of the power of evolution. They claim that antibiotic-resistant alleles confer no advantage in the wild, and that microbiologists have never seen the evolution of new bacterial species, despite extensive research showing the opposite (<http://ncse.com/explore-evolution>). Such scientific corrections are important, but do not fully address the root causes of science denial.

Science denial is less about science and more about deep fears and core personal identity. 'Creationism is a moral theory that the idea of evolution is intimately involved in immorality', wrote anthropologist Chris Toumey [1]. The shift from scientific claims to moral claims can be seen in

the creationist 'evolution tree' reproduced in Figure 1, and in conversations with creationists. The conversation might begin with a dispute about the evolution of the bacterial flagellum, the significance of antibiotic resistance, or the veracity of *Archaeopteryx* fossils, but before long the discussion leaps to the implications of evolution for the human soul, morality, or religious truth. Discussions about vaccines may open with fears about autism, heavy metals in preservatives, or how many antigens a baby's body can handle, but rapidly shift to anger about limits on parents' rights to make choices for their children. Climate change conversations rapidly shift from science to free market capitalism and private citizens' right to make decisions about their families and their homes. Without addressing these fears first, it is impossible to correct scientific errors and undo the harm caused by science denial.

The rise of deadly whooping cough epidemics is not the only harm caused by science denial. Public debate about the greatest global challenge of the 21st century has been derailed by a campaign of misinformation about the science of climate change. Students around the world are deprived of lessons on evolution – the foundation of modern biology – leaving them without the tools to understand and participate in the revolutions in biotechnology, biomedicine, and genomics that will define society in this century.

The harm goes deeper. Science denial is, fundamentally, a misrepresentation of how science works. Science advances by testing hypotheses, rejecting ideas that fail such tests, community review of results and methods, and building a consensus on the basis of the successful ideas. By dismissing the knowledge produced by scientific processes and touting ideas that are untestable or have failed such tests, science denial misleads the public about how science works, opening the door to other pseudoscientific beliefs.

Science denial is not antisience, as shown in part by the fact that it is often presented as science even though it is not about science at root. Science deniers accept and even celebrate most knowledge produced by scientific processes. They dress science denial in the trappings of science, loudly promoting petitions signed by PhDs or the rare denialist paper that survives peer review in a mainstream journal. Creationists even launch their own journals and conferences, mimicking the scientific infrastructure to mask their pseudoscientific nature. Science denial imitates science to piggyback on the cultural and epistemic authority of science, and a desire to use that authority to bolster nonscientific beliefs.

Although science denial claims often seem absurd to scientists in relevant fields, they make sense when viewed from an insider's perspective. For example, creationist journals run their own version of peer review, but require

Corresponding author: Rosenau, J. (rosenau@ncse.com).

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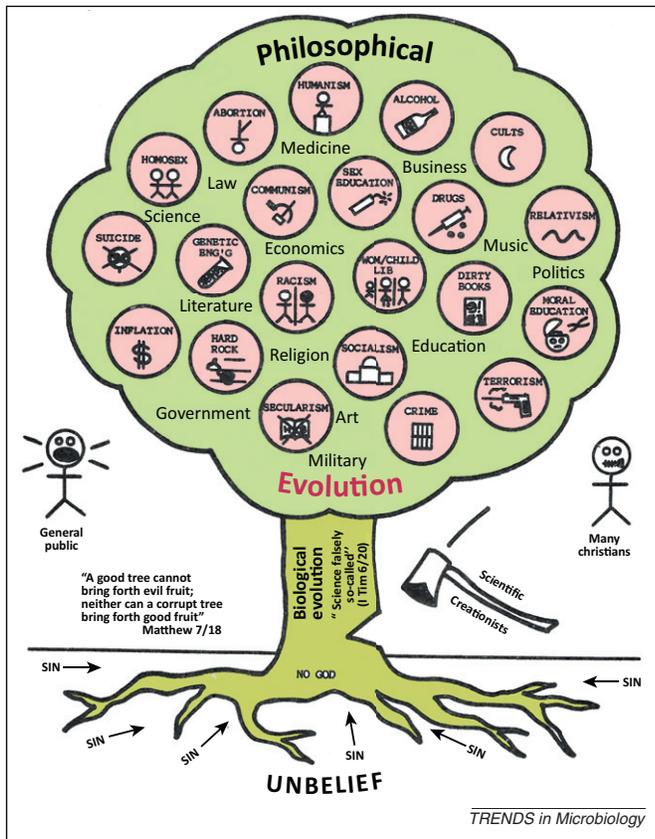


Figure 1. A creationist ‘evolution tree’. Unlike scientific evolutionary trees, which show the common descent of species, this tree makes a moral argument that evolution is the common origin of many social evils. In his caption, creationist engineer Richard Elmendorf wrote: ‘if evolution is destroyed, these ideas will fall.’ Creationism serves as a moral force, chopping down the evolutionary tree trunk, to destroy the ‘evil fruit’. In responding to creationism, it is crucial to remember that it is a moral theory, not a scientific one, and is driven by deep, serious fears and an internally consistent logic. Reproduced, with permission, from [1].

authors, editors, and reviewers to commit themselves to a statement of faith. Their challenge is to find geological and biological evidence to justify their antecedent beliefs, and the results yield a vision of geology and biology that is internally consistent, albeit at odds with the result of genuine scientific investigation.

This internal consistency is also enforced by a common psychological process. Audiences judge the credibility of those presenting scientific claims by how well the claims match their existing beliefs [2]. When people are presented with scientific claims they disagree with, the scientist making that claim is deemed less credible. Deniers thus perceive a consensus (among experts they deem credible) that is at odds with the actual consensus, and use this selective consensus to reinforce their prior beliefs.

Such psychological strategies are not irrational. Non-specialists often, wisely, defer technical decisions to experts who share their background and values. This heuristic allows individuals to make rapid decisions about complex phenomena without having to become an instant expert, minimizing cognitive dissonance, and – especially – decreasing social conflict [3,4].

Humans are social animals, and science denial often emerges when a scientific idea becomes linked to the

identity of a social group. For instance, although the founding writers of fundamentalism in the 1910s had a range of views on evolution, antievolutionism became a defining feature of fundamentalism after the 1925 Scopes Trial [5]. In contemporary US politics, climate change denial is increasingly linked to conservative political identity; politicians such as Tim Pawlenty, who once advocated action on climate change, later recanted their past stance on science and policy to maintain conservative credibility (<http://www.nationaljournal.com/politics/pawlenty-running-from-his-past-moves-on-environmental-policy-20110623>). Similarly, parents of autistic children may be offered more support, concern, and certainty at anti-vaccine events than in medical offices [6]. Acceptance of the pseudoscience of these groups may seem a small cost for such solidarity.

Recognizing and defusing the social pressures underlying science denial are key in convincing people that it is even worth considering scientific ideas that seem contrary to those of their social identity. When science denial becomes entwined with group identity, the risk of social ostracism is probably costlier than scientific error.

Scientists and science communicators can use these lessons to improve their outreach to audiences sympathetic to science denial. The messengers most likely to break through will be those who share a social identity with the science-denying audience. Their mere existence undercuts the belief that an individual cannot belong to this group and accept the science. When they discuss how they accommodate their scientific understanding and their social identity, they offer the audience a possible roadmap towards acceptance of the science.

Consider Francis Collins. As director of the National Institutes of Health, and previously of the Human Genome Project, his record as a scientist and advocate for science is stellar, and he has spoken out in support of evolution, stem cell research, and other socially contentious scientific topics. He is also an evangelical Christian and has written extensively about how he relates his scientific identity to his religious and cultural identity, and why he sees no conflict [7].

You do not have to be Francis Collins, or even an evangelical Christian, to work that magic. By citing examples of people who share the audience’s background without rejecting the science, it is often possible to divert the inevitable objections from ‘I’m an evangelical, I can’t accept evolution!’ to the more productive ‘I’m an evangelical, how can I accept evolution?’ [8]. Resources such as *Voices for Evolution* [9] from the National Center for Science Education (NCSE) and the Clergy Letter Project (<http://www.theclergyletterproject.org/>) provide additional examples of religious, scientific, educational, and civil liberties groups who have spoken out in support of evolution education. Conservative scientists such as Kerry Emanuel and Richard Alley play a similar role for climate change.

When leaders in a community – such as clergy from the Clergy Letter Project and Interfaith Power and Light, and political leaders from groups such as ConservAmerica that organize conservatives concerned about climate change – speak out for evolution and climate change, they remind their communities that

rejection of science is not a prerequisite for membership, and make it acceptable to accept the scientific consensus.

The vaccine drive at Dragon*Con fits this model beautifully. The pro-vaccination message came not from people speaking as doctors or scientists, but from fellow members of a community promoting the public understanding of science, with a syringe in one hand and a wand in the other.

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