# 3 Science denial

## Psychological processes underlying denial of science-based medical practices

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### Introduction

> *Unvaccinated children are much healthier than vaccinated children. You can line up the doctors from here to down the block refuting me, but I'm not gonna change my mind.*
>
> Sarah Pope, blogger, *The Daily Show* interview, 2014

Overwhelming scientific evidence supports the safety of vaccinations (Maglione et al. 2014), dangers of tobacco use (Landman and Glantz 2009), and science-based prevention and treatment strategies for HIV/AIDS (Bogart et al. 2008). Nonetheless, public opinion frequently is incongruent with the scientific consensus. Individuals and groups continue to doubt and deny scientific findings in various areas. Denial of science, sometimes also labeled 'denialism' or 'rejection of science', can be defined as dismissal of established scientific evidence for non-scientific reasons (Lewandowsky et al. 2013d; Diethelm and McKee 2009). It is important to distinguish denial from scientific skepticism. Genuine scientific skepticism is based on relevant theoretical predictions and empirical evidence. It is an integral part of the scientific method and leads to reliable and valid conclusions (Jacques 2012). On the other hand, science denial is often unaffected by accurate scientific information, persevering even in the face of overwhelming empirical evidence and clear scientific consensus (Lewandowsky et al. 2013d).

In some cases, denialist beliefs are innocuous. For example, some of the members of the Flat Earth Society (which currently consists of over 500 people from the US, the UK, and other countries) still sincerely believe that the earth is a flat disc surrounded by a 150-foot wall of ice at its outer edge (The Flat Earth Society 2019). In other cases, science denial costs lives. Despite clear scientific evidence supporting the effectiveness and safety of vaccinations (Maglione et al. 2014), unfounded concerns about potential harmful side effects of vaccines led a number of parents in the US and the UK to delay or refuse vaccination (Poland and Spier 2010). Clusters of intentionally under-vaccinated children have triggered outbreaks of vaccine-preventable diseases such as pertussis (Atwell et al. 2013) and measles (Sugerman et al. 2010), causing a major public health risk. A tragic example of what can happen when science denial is governmentally



supported can be observed in post-apartheid South Africa. President Mbeki championed a small group of AIDS denialists who claimed that AIDS is caused by poverty and malnutrition, not by HIV (Bateman 2007). Mbeki's government recommended local vegetables as a treatment for AIDS and banned the use of antiretroviral drugs in public hospitals, promoting the idea that antivirals are a part of a white conspiracy to reduce the black African population. These inappropriate policies guided by science denial are thought to be responsible for around 171,000 HIV infections and 343,000 deaths between 1999 and 2007. Examples such as these leave no doubt that science denial is dangerous—it can endanger lives of both denialists and non-denialists.

An intriguing aspect of science denial is that it is often accompanied by anger and aggression towards scientists. Researchers from a wide range of disciplines have reported being targeted by similar kinds of personal and professional attacks, including complaints, legal threats, intimidation, cyber-bullying, and public abuse (Lewandowsky et al. 2013c). Some of these aggressive strategies are highly organized—e.g., the tactics used by the tobacco industry to discredit researchers and cast doubt on the evidence that smoking causes cancer (Landman and Glantz 2009; Nature 2010). Other aggressive actions (such as insulting email messages) seem more impulsive, have the immediate goal to hurt scientists personally, and seem to be rooted in denialists' feelings of anger and hostility in response to threatening research findings (Lewandowsky et al. 2013a; Nauroth et al. 2014). Both types of attacks can have far-reaching negative consequences: personal attacks cause emotional distress and take up time, interfering with researchers' work, whereas organized professional attacks have the potential to derail the scientific process by delaying or stopping publication of manuscripts (Lewandowsky et al. 2013c).

What factors and processes lead to science denial? According to the public irrationality thesis (Kahan 2013), denial stems from a lack of comprehension of scientific methods and evidence among the general public. The deficit model of science communication assumes that increased communication about scientific issues will lead to a shift in public opinion toward scientific consensus (Hart and Nisbet 2011). However, a number of studies suggest that this is not always the case. In fact, providing scientific evidence sometimes backfires, causing denialists to become even more entrenched in their initial beliefs and behaviors (Hart and Nisbet 2011; Lord et al. 1979). For example, Nyhan and colleagues (2014) tested interventions intended to reduce vaccine misperceptions among parents and increase vaccination rates. The pro-vaccine messages did not work as planned—some of the messages actually decreased intent to vaccinate among parents who held the most negative attitudes towards vaccination.

This research demonstrates that science denial is not a simple product of deficits in information or understanding of scientific methodology. Instead, more complex psychological processes are at play. Several areas of research in psychology help explain the roots of denial and elucidate why simply bombarding denialists with accurate scientific information does not lead to attitude change (see also Chapter 12).

*Table 3.1* Factors and mechanisms leading to science denial

| *Individual* | *Group* | *Intergroup* |
|---|---|---|
| Belief perseverance | Threatened social identity | Intergroup emotions |
| Confirmation bias, myside bias | Values and ideology | Intergroup threat |
| Cognitive dissonance | Cultural cognition | Intergroup conflict |
| Reactance | System justification | |
| 'Forbidden fruit' effects | Social dominance orientation | |
| Boomerang effects (aka 'backfire effects') | | |
| Defensiveness, the psychological immune system | | |
| Self-affirmation | | |
| Conspiratorial thinking | | |
| Scientific expertise, training in research methods and rational thinking | | |

This chapter reviews the psychological mechanisms that lead to science denial (shown in Table 3.1), including processes affecting individuals (such as belief perseverance, confirmation bias, and cognitive dissonance), groups (such as social identification), and intergroup relations (such as intergroup threat). Special attention is given to predictors of angry denial and aggressive actions towards scientists. Finally, avenues for prevention and intervention are reviewed that can help combat science denial and reduce the risk of non-science-based medical practices.

## Individual-level mechanisms leading to science denial

A rich research literature in the fields of cognitive and social psychology reveals a number of individual-level factors that contribute to science denial. The review presented here is not meant to be extensive—it highlights seven individual-level processes key to understanding science denial: (1) belief perseverance; (2) confirmation bias and myside bias; (3) reactance, boomerang effects, and 'forbidden fruit effects'; (4) cognitive dissonance; (5) defensiveness, the psychological immune system, and self-affirmation; (6) conspiratorial thinking; and (7) training in research methods and rational thinking. Illustrations are given both from empirical studies and from real-life examples of science denial.

### *Belief perseverance*

People tend to cling strongly to their prior beliefs about how the world works—their *social theories*—even when such beliefs are no longer warranted (Anderson 1983; Anderson and Kellam 1992). Initial perceptions, opinions, and attitudes persevere in the face of disconfirming evidence. For example, Anderson et al. (1980) informed participants that a positive or negative association exists between risk taking and firefighters' job performance. Some were led to believe that high risk-takers made better firefighters; others were led to believe the opposite was true. Participants continued to believe that a true relationship exists between risk preference and job performance even when they were told that the initial information was fabricated.



Paradoxically, stronger belief perseverance occurs after exposure to weak but vivid and concrete case history data rather than stronger but abstract statistical summaries (Anderson 1983). These effects are mediated, at least in part, by the accessibility of causal explanations and formulation of causal scripts (Anderson 1983; Anderson et al. 1985). After being given the initial information, people spontaneously generate causal explanations for it. Causal explanations can then become independent of the data on which they were originally based and fuel people's beliefs even once the initial evidence is refuted (Anderson et al. 1980; Anderson 1983; McFarland et al. 2007).

A tragic real-life example of belief perseverance occurred when Andrew Wakefield and colleagues (1998) published a paper suggesting that measles-mumps-rubella (MMR) vaccine causes autism. Numerous subsequent studies using larger samples and stronger methodology disproved this finding (Taylor et al. 1999; Gerber and Offit 2009). Furthermore, an award-winning investigation by *Sunday Times* reporter Brian Deer revealed evidence of fraud—Wakefield misreported findings and had failed to disclose considerable financial conflicts of interest (Deer 2004). Finally, the Wakefield article was retracted from the *Lancet* (The Editors of the Lancet 2010). Despite these developments, panicked parents in the UK, the US, and many other countries have continued to fear that vaccinations may increase the risk of autism, leading them to delay or stop vaccinating their children (Poland and Spier 2010). A single fraudulent publication led to widespread risk to public health.

### *Confirmation bias, myside bias*

A set of phenomena closely related to belief perseverance are confirmation biases. People tend to perceive, interpret, and use information that confirms their beliefs, while ignoring disconfirming information (Klayman and Ha 1987; Kleiman and Hassin 2013). Confirmation biases help fuel belief perseverance by prompting people to find evidence that supports views, while overlooking evidence that supports a different position.

In a classic demonstration of these processes, Lord et al. (1979) showed supporters and opponents of capital punishment two supposed studies, one that proved and one that disproved their existing belief. Both proponents and opponents of capital punishment rated the results and procedures that confirmed their own beliefs to be more convincing and better conducted. Reading this mixed evidence made them more confident in their beliefs and led to polarization of their attitudes instead of convergence.

A subtype of confirmation biases especially relevant to science denial is myside bias—the tendency to evaluate evidence and test hypotheses in a way

that is biased towards one's own opinions (Stanovich et al. 2013). Unfortunately, it seems that myside bias is one of the rare cognitive processes that are completely independent of intelligence (Stanovich and West 2008; Stanovich et al. 2013). For instance, smokers underestimate health risks of secondhand smoke, heavy alcohol drinkers underestimate health risks of alcohol consumption, and these biases are not attenuated by cognitive ability (Stanovich and West 2008).

### *Reactance*

When people feel that their freedom to engage in a behavior is threatened, they experience an aversive state of arousal (reactance) and are motivated to restore that freedom (Brehm and Brehm 1981). Therefore, if scientific findings threaten people's sense of freedom, they are likely to be denied. For instance, warning labels on tobacco products have been found to be ineffective and even lead to forbidden fruit effects, making the forbidden item more attractive to consumers (Willemsen and De Zwart 1999).

Psychological reactance also leads to behavioral change. People attempt to reaffirm their freedom by acting in opposition to a perceived threat to freedom. Results by the previously mentioned study of pro-vaccination messages by Nyhan and colleagues (2014) can also be interpreted within the framework of reactance theory. It is possible that anti-vaccination parents experienced persuasive messages as a threat to their personal freedom and responded by reducing their intentions to vaccinate.

### *Cognitive dissonance*

Classic research within the framework of cognitive dissonance theory (Festinger 1957) is highly relevant to understanding science denial. For example, a number of studies examined cognitive dissonance among smokers and found that smokers reduce the dissonance produced by the realization that they are engaging in a risky behavior by underestimating risks of smoking and questioning the validity of studies linking smoking with negative health consequences (Lawton and Goldman 1961; Feather 1962, 1963; Pervin and Yatko 1965; Johnson 1968). One might hope that, in more recent decades, increased public awareness of risks associated with smoking would have made science denial an untenable means of dissonance reduction. Unfortunately, newer studies in this area demonstrate that this is not the case—in spite of increased awareness of scientific evidence, smokers still tend to underestimate the health risks associated with smoking (Gibbons et al. 1991, 1997).

### *Defensiveness, the psychological immune system, and self-affirmation*

People strive to maintain their perceived worth and integrity and respond defensively to information that threatens a valued self-image (Sherman and Cohen 2006). We have a 'psychological immune system' that uses various



cognitive strategies and distortions, enabling us to interpret a situation as less threatening to personal worth and well-being.

Defensive processing fuels science denial, as shown by research examining responses to threatening health information (Reed and Aspinwall 1998; Harris and Napper 2005). In one set of such studies, sexually active students responded to AIDS prevention films by lowering their perceptions of risk for sexually transmitted diseases (Morris and Swann 1996). Highest threat was experienced in response to films that depicted HIV-positive individuals who were similar to the viewers. Authors concluded that AIDS prevention films might trigger denial, especially when they hit 'too close to home'.

How can such defensiveness be reduced? Promising results have been obtained by researchers working within the framework of self-affirmation theory. People are more willing to examine and accept threatening information when their self-worth is strengthened by an affirmation of another part of their identity (e.g., receiving positive feedback about a valued self-image or writing about a value important to them, see Sherman and Cohen 2006). Self-affirmation enables people to cope with threatening information and maintain their self-worth without resorting to defensive responses, increasing the effectiveness of health messages. For instance, in a study by Sherman et al. (2000), self-affirmed participants were more receptive to health messages about HIV and purchased condoms more often.

Similarly, priming secure attachment thoughts and memories can temporarily reduce negative outgroup emotions and thereby reduce harmful behaviors and interactions with outgroup people (Saleem et al. 2015). For example: having people imagine a scene with a close friend; recall a time when someone close to them was available, supportive, and loving; or visualize a person 'who accepts and loves you and helps you in times of need' decreases the tendency to use their negative social theories about outgroup members.

### *Conspiratorial thinking*

Conspiratorial thinking, or conspiracist ideation, involves explaining events as a result of secret machinations of powerful people or organizations (Lewandowsky et al. 2013d). A number of authors have pointed to conspiracist ideation as a key predictor of science denial (Diethelm and McKee 2009; Lewandowsky et al. 2013b). Endorsement of conspiracy theories predicts opposition to a number of well-established scientific findings, including doubts about vaccine safety, disbelief in climate change, and rejection of the link between tobacco and cancer and of the link between HIV and AIDS (Lewandowsky et al. 2013a).

Several mechanisms have been proposed that may underlie the relationship between conspiracist ideation and science denial. Whereas scientists use disconfirming evidence to reject hypotheses and revise theories, such information is often viewed as confirmation of a conspiracy theory by its followers (Lewandowsky et al. 2013b). The peer-review process is interpreted as a system of censorship (Diethelm and McKee 2009). Because of this, researchers

recommend battling conspiracist ideation via indirect means, such as using self-affirmation to reduce defensiveness prior to persuasion attempts (Sherman and Cohen 2006).

#### *Scientific expertise, training in research methods and rational thinking*

Increasing people's knowledge of research methodology and statistical reasoning through graduate training can increase people's ability to use statistical and methodological reasoning about everyday life events (Nisbett et al. 1987; Lehman et al. 1988). Such improvements in reasoning could also decrease the risk of science denial. In support of this hypothesis, experienced scientists show an increased ability to reject hypotheses in response to disconfirming evidence (Dunbar 1995). Unfortunately, it seems that scientific reasoning skills are not a 'cure all' for science denial. For example, science comprehension is unrelated to people's assessments of climate change risk (Kahan 2013).

## Group-level mechanisms leading to science denial

Although most psychological research has focused on individual-level causes of science denial, individual-level explanations are only a part of the picture. Recent studies suggest that group-level processes may also play a key role in science denial (Kahan et al. 2010; Lewandowsky et al. 2013d; Nauroth et al. 2014). This section reviews findings in two core areas: (1) social identity processes and (2) ideology, cultural values, and cultural cognition.

#### *Social identity processes*

According to social identity theory (Tajfel and Turner 1986), individuals have personal identities (differentiating the self from others) and social identities based on group memberships (differentiating 'us' from 'them'). Ingroup favoritism is a key feature of social identification (Brewer 2007). When a valued social identity is threatened, group members may respond with anger and hostility, protect the ingroup, and aggress against the threat (Ellemers et al. 2002; McCoy and Major 2003).

An area of science denial in which social identity may play a key role is the anti-vaccine movement. For instance, Hoffman and colleagues (2019) found that Facebook serves as an effective platform for anti-vaccine groups to form and spread harmful denial messages (e.g., 'poliovirus does not exist' and 'pesticides caused clinical symptoms of polio'). Such messages are most likely to be influential if posted by ingroup members while opposing views from outgroup members are likely to be denied. For instance, preliminary experimental evidence suggests that priming social identity among members of the anti-vaccine community increases science denial of research showing vaccine safety, especially among highly identified group members (Prot et al. 2019).



#### *Ideology, cultural values, and cultural cognition*

Ideology and cultural worldviews also play a role in science denial. For instance, free-market ideology predicts rejection of climate science as well as rejection of other well-supported scientific findings (e.g., effects of smoking on lung cancer and effects of HIV on AIDS; Lewandowsky et al. 2012, 2013a, d).

Cultural cognition affects not only what people believe but also whom they believe. In a study by Kahan and colleagues (2010), participants were more likely to view experts as credible and to be persuaded by them if they believed that the experts shared their cultural values. For example, when a hierarchical and individualistic expert defended the HPV vaccine as safe, participants who shared those values were more likely to adopt a more positive attitude towards the vaccine. Egalitarian participants were more easily persuaded by an egalitarian expert.

This line of research provides the basis for developing more effective methods of science communication. It suggests that persuasion attempts will be most effective when information is presented in ways that affirm people's cultural values and ideologies instead of threatening them (Cohen et al. 2000, 2007). It also helps to involve a diverse set of experts as public advocates, ensuring that within the set at least one expert is viewed as credible by people with different worldviews (Kahan et al. 2010).

## Intergroup processes leading to science denial

An intergroup perspective may be especially useful when searching for the roots of angry denial and aggression towards scientists. At first, the anger and hostile behaviors that often go hand-in-hand with science denial may seem puzzling. However, these emotional reactions and behaviors are no longer surprising when considered from an intergroup conflict perspective. Among some denialists, scientists are viewed as a hostile outgroup that derogates and threatens the ingroup (Lewandowsky et al. 2013a; Nauroth et al. 2014).

Two theoretical perspectives from the area of intergroup conflict are discussed which offer valuable insights into possible origins of angry science denial and aggression towards scientists: (1) intergroup emotions theory and (2) intergroup threat theory.

#### *Intergroup emotions theory*

When social identity is salient, group-relevant events elicit intergroup emotions (e.g., football fans experiencing elation after their team wins; see Mackie et al. 2000). Highly identified group members experience and express stronger group emotions.

Group-level emotions are shared within the ingroup—people's emotions converge towards those prototypical of their group (Smith et al. 2007). Strength

of group-level emotions depends on the level of social identification. People who are highly identified with the ingroup tend to experience and express stronger group emotions than weak identifiers (Smith et al. 2007). For example, in the area of science denial, Nauroth and colleagues (2014) found that strongly identified video gamers experienced greater anger in response to research showing video game violence increases aggression, suggesting that this may be a group-level emotion. Prot and colleagues (2019) found greater feelings of distrust towards vaccine researchers among strongly identified members of the anti-vaccine community.

Group-level emotions motivate and regulate intergroup attitudes and behaviors (Mackie et al. 2000; Smith et al. 2007). Different types of ingroup and outgroup appraisals lead to different emotions, causing different behaviors towards outgroups (Mackie et al. 2000). For example, when an outgroup is appraised as threatening, this elicits distinct emotional responses—fear leading to avoidance of the outgroup or anger leading to confrontation (Mackie and Smith 2014).

Intergroup emotions theory (Mackie et al. 2000; Mackie and Smith 2014) provides a valuable conceptual framework for understanding angry science denial. When emotional reactions that denialists express towards research findings and researchers are examined at an individual level, distinct emotional responses can be difficult to explain. It would seem surprising that denialists have heated emotional reactions to research findings and public policy that have no impact on them personally. Intergroup emotions theory suggests a clear explanation—research and researchers should engender such responses if they influence one's valued ingroup.

### *Intergroup threat theory*

When ingroup members perceive that outgroup members are in a position to harm them, they experience intergroup threat (Stephan and Stephan 2000; Stephan et al. 2002). Realistic threats jeopardize the physical or material well-being of the ingroup. In contrast, symbolic threats endanger the ingroup worldview. They arise from perceived group differences in morals, values, standards, beliefs, and attitudes (Stephan et al. 2002). Intergroup threat theory is compatible with the framework of intergroup emotions theory and contributes to predicting discrete emotional reactions towards outgroups (Cottrell and Neuberg 2005). For instance, physical and safety threats tend to predict fear and contamination threats predict disgust, whereas threats to freedom predict anger.

It is likely that intergroup threat plays a key role in angry science denial. Preliminary experimental findings show that perceived threat from scientists increases science denial, anger, and aggressive intentions (Prot et al. 2019). The type of threat perceived by denialists is likely to differ between groups. For example, parents who oppose vaccinations may view vaccines and pro-vaccine researchers as a realistic threat to their children's health and safety (Hoffman et al. 2019).



## Conclusive thoughts

Doubt and denial of scientific evidence in areas such as vaccination safety, dangers of tobacco use, and effectiveness of HIV prevention strategies lead to detrimental outcomes both to individuals and to our society. It might seem hard to understand why such denial persists in the face of clear evidence and scientific consensus and why it is often accompanied by anger and aggression towards scientists. Science denial is a complex phenomenon that is influenced by a number of individual-level, group-level, and intergroup processes. Understanding the complex set of factors causing science denial can help develop more effective intervention strategies to combat science denial and bolster trust in science-based medical practices.

Research on psychological mechanisms of science denial offers a basis for developing effective prevention and intervention strategies. Several studies on individual-level causes of science denial point to effective ways of combating belief perseverance, including discussing the perseverance process with participants (Ross et al. 1975), manipulating self-awareness (Davies 1982), and prompting participants to consider the opposite position (Lord et al. 1984) or to generate causal theories in both possible directions (Anderson 1983). Self-affirmation through bolstering a valued self-image has been found to lower defensiveness and promote responsiveness to health messages such as smokers' reactions to graphic cigarette warning labels (Harris et al. 2007) and women's acceptance of warnings of cancer risk from their alcohol consumption (Harris and Napper 2005). Importantly, self-affirmation has also been effective in promoting positive health behaviors (Sherman et al. 2000). Self-affirmation and priming attachment thoughts and memories could provide quick and effective ways to lower the risk of health messages causing boomerang effects (such as those observed by Nyhan et al. 2014).

When science denial is bolstered by group-level and intergroup-level factors, interventions targeting group- and intergroup-level causes may be more effective. For instance, to combat vaccine myths spread among the anti-vaccine communities via Facebook, Hoffman et al. (2019) have prompted health professionals to use social networks to deliver targeted messages to different groups at risk. Interventions aimed at reducing intergroup conflict could be especially helpful when trust in the scientific community is low and scientists are instead viewed as a hostile group. Such interventions could help lower fear and anger towards scientists, lowering risk of harassment towards scientists carrying out controversial research (Lewandowsky et al. 2013c).

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