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Deconstructing Climate Science Denial

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Introduction

Numerous studies have found overwhelming scientific consensus on human-caused global warming both in the scientific community (Anderegg et al., 2010; Carlton et al., 2015; Doran & Zimmerman, 2009) and in the scientific literature (Cook et al., 2013; Oreskes, 2004). Conversely, a small minority of climate scientists reject the consensus position, and climate denial has a vanishingly small presence in the scientific literature.

The small number of published studies that reject mainstream climate science have been shown to possess fatal errors. Abraham et al. (2014) summarized how papers containing denialist claims, such as claims of cooling in satellite measurements or estimates of low climate sensitivity, have been robustly refuted in the scientific literature. Similarly, Benestad et al. (2016) attempted to replicate findings in contrarian papers and found a number of flaws such as inappropriate statistical methods, false dichotomies, and conclusions based on misconceived physics.

Given their lack of impact in the scientific literature, contrarians instead argue their case directly to the public. Denialist scientists self-report a higher degree of media exposure relative to mainstream scientists (Verheggen et al., 2014), and content analysis of digital and print media articles confirms that contrarians have a higher presence in media coverage of climate change relative to expert scientists (Petersen, Vincent, & Westerling, 2019). The viewpoints of contrarian scientists are also amplified by organizations such as conservative think-tanks, the fossil fuel industry, and mainstream media outlets (organizations that generate and amplify climate change denial are examined further in Chapter 4 by Brulle & Dunlap).

Negative impacts of climate misinformation

Misinformation promoted by contrarian scientists and other denialist sources cause a number of negative impacts on the public. Higher levels of CO2 emissions per capita is associated with lower acceptance of climate change (Tranter & Booth, 2015), leading scholars to conclude that fossil-fuel funded misinformation is a driver of public attitudes about climate change (Hornsey, Harris, & Fielding, 2018).

At an individual level, misinformation has been experimentally shown to foster misconceptions (Ranney and Clark, 2016), reduce support for mitigation policies (Ranney and Clark, 2017; van der Linden et al., 2017), and polarize the public (Cook et al., 2017). As a result, public polarization about climate change has been increasing over time (Dunlap, McCright, & Yarosh, 2016) and currently the U.S. public are deeply polarized, with political liberals much more accepting of the reality of global warming relative to political conservatives (Leiserowitz et al. 2019). Polarization on basic climate science has also increasing among climate policy elites since the U.S. 2016 election (Jasny & Fischer, 2019).

Misinformation direct affects the scientific community. Attacks on the integrity of climate science erodes public trust in scientists and forces scientists to respond to endless waves of unhelpful demands (Biddle & Leuschner, 2015). This in turn influences how climate scientists report their results. Scientists are already predisposed to avoid Type I errors or false positives (Anderegg, Callaway, Boykoff, Yohe, & Root, 2014) but prolonged stereotype attacks, such as being branded as an alarmist, have influenced scientists to adopt behaviour that avoids the accused stereotypical behaviour (Lewandowsky et al., 2015). One example of scientists “erring on the side of least drama” (Brysse, Oreskes, O'Reilly, & Oppenheimer, 2013) is the observation that Intergovernmental Panel On Climate Change

(IPCC) predictions are 20 times more likely to underestimate climate impacts than overestimate them (Freudenburg and Muselli, 2010).

Climate change denial also affects how the public talk about climate change. While only 12% of Americans are dismissive of climate change (Leiserowitz et al., 2019), this vocal minority is perceived to be a much larger proportion of the public. As a consequence, the misconception of pluralistic ignorance—the lack of awareness among people concerned about climate change that most people share their concern—is the strongest predictor of whether people talk about climate change with friends and family (Geiger and Swim, 2016; Maibach et al., 2016). Fear of pushback from climate change deniers is a major contributor to climate silence.

An insidious aspect of misinformation is its potential to cancel out accurate information. Denialist frames reduce the positive effect of climate frames such as economic opportunity and public health (McCright, Charters, Dentzman, & Dietz, 2016). Misinformation featuring dissenting scientists neutralizes communication of the scientific consensus on climate change (Cook, Lewandowsky, & Ecker, 2017; van der Linden, Leiserowitz, Rosenthal, & Maibach, 2017). Highlighting even a small proportion of dissenting voices has been found to reduce public perception of scientific consensus (Koehler, 2016).

The various impacts of misinformation, particularly its ability to neutralize accurate information, underscore the imperative of developing interventions to neutralize these negative influences. However, understanding the rhetorical arguments of climate denial is necessary in order to develop effective responses.

The landscape of climate misinformation

A growing body of literature has documented and categorized the different arguments proposed by climate change deniers. Early work focused on scientific topics, with Rahmstorf (2004) listing three types of skepticism: trend (global warming isn't happening), attribution (humans aren't causing global warming), and impact (climate impacts aren't serious). Doubt about the human role in causing climate change is strongly linked to other forms of climate skepticism (Akter, Bennett, & Ward, 2012), and the importance of natural cycles in driving climate change is a central idea in climate denial (Connor & Higginbotham, 2013).

In addition to dismissal of scientific aspects of climate change, skepticism about policy responses is also important (Bonds, 2016). Akter, Bennett, & Ward (2012) list aspects of policy skepticism such as mitigation and global cooperation skepticism. Mitigation skepticism may take the form of warning against the economic risks of climate policies (McCright and Dunlap, 2000) or arguing that mitigation is useless as climate change is inevitable (Shrubsole, 2015).

Capstick and Pidgeon (2014) characterize the two overarching types of climate misinformation as epistemic (related to climate science) and response (climate solutions). Within the category of epistemic skepticism, they include doubts about the conduct of science, the reliability of mainstream climate expertise, and the portrayal of climate science. However, Van Rensburg (2015) argues that criticisms of scientific processes, described as "process scepticism", require a distinct conceptual status. Topic analysis of conservative think-tank articles found that one prominent topic of climate denial texts is the issue of scientific integrity (Boussalis and Coan, 2016). These types of text typically are written with the goal of delegitimizing climate science (Cann, 2015). A major theme of conservative think-tank publications in the early 1990s was emphasizing uncertainty (McCright and Dunlap, 2000). An insidious aspect of this form of uncertainty-based misinformation is that

its implicit nature makes it harder to correct than explicit misinformation (Rich & Zaragoza, 2015).

In addition to attacks on climate science, another form of climate misinformation is direct attacks on climate scientists. This can take the form of demonizing climate scientists with exaggerated stereotypes (Brisman & South, 2015). A striking characteristic of online discourses about climate change is the assertion that climate science is corrupt (Jacques & Knox, 2016). Similarly, Roper, Ganesh & Zorn (2016) identified three denialist framings being climate scientists being deeply corrupt, hysterical, and working in the interest of the powerful. Climate science is often couched in religious terms in order to frame it as based on unscientific belief (Nerlich, 2010; Woods, Fernandez, and Coen, 2010).

The studies listed above that content analyse and categorize denialist texts tend to focus in piece-meal fashion on specific aspects of climate misinformation. A comprehensive taxonomy of the entire climate misinformation landscape was developed by Coan, Boussalis, & Cook (2019), displayed in Figure 1 and summarized with five overarching categories: it's not real, it's not us, it's not bad, climate solutions won't work, and the experts are unreliable. These five categories mirror the five key climate beliefs identified by psychology researchers: it's real, it's us, the experts agree on the first two points, it's bad, and there's hope (Ding, Maibach, Zhao, Roser-Renouf, and Leiserowitz, 2011).

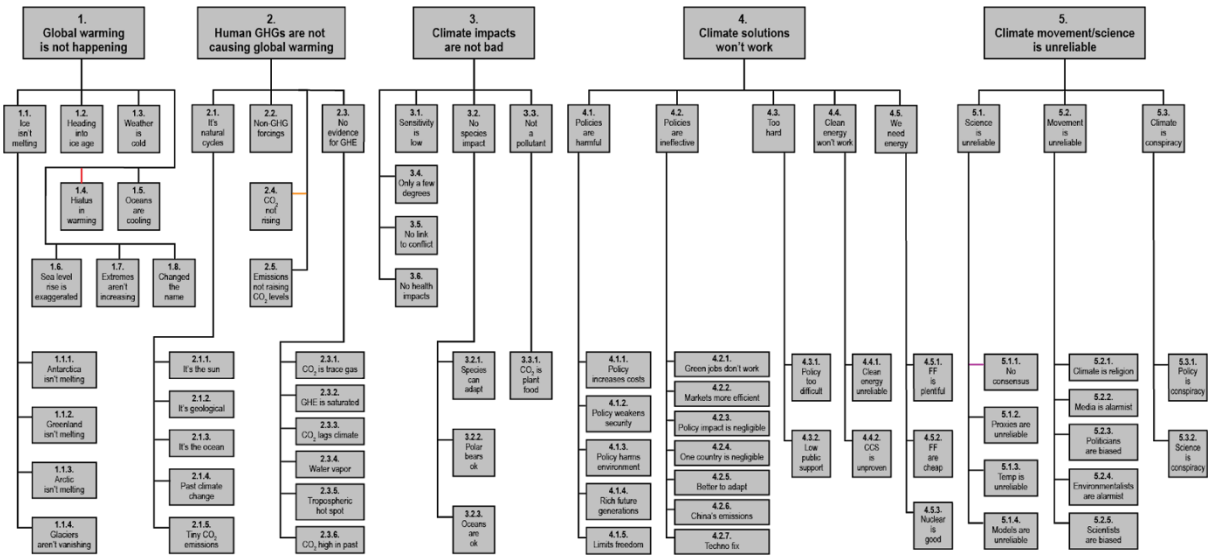

Figure 1: Taxonomy of Climate Misinformation Claims (Coan, Boussalis, & Cook, 2019).

Denialist Rhetorical Strategies

Given the broad and complex landscape of denialist claims, how does one assess the veracity of each claim (and in the case of false claims, neutralize the misinformation)? Cook, Ellerton, & Kinkead (2018) provide a critical thinking methodology for deconstructing denialist claims and apply this approach to 50 of the most common climate myths, finding that they all contain either false premises or flawed logic.

The rhetorical strategies that appear in climate misinformation appear in denialist arguments across a range of scientific issues (Ceccarelli, 2011) and can be summarized with five techniques of denial: fake experts, logical fallacies, impossible expectations, cherry picking, and conspiracy theories, summarized with the acronym FLICC (Diethelm & McKee, 2009; Hoofnagle, 2007). Hansson (2017) proposes four alternative characteristics of science denialism which have some overlap with Hoofnagle's FLICC framework: cherry picking, neglect of refuting information, fabrication of fake controversies, and demanding impossible levels of scientific proof. Figure 2 outlines a taxonomy of denial techniques and informal fallacies, extending Hoofnagle's framework with the reasoning fallacies identified in climate misinformation (Cook, Ellerton, & Kinkead, 2018).

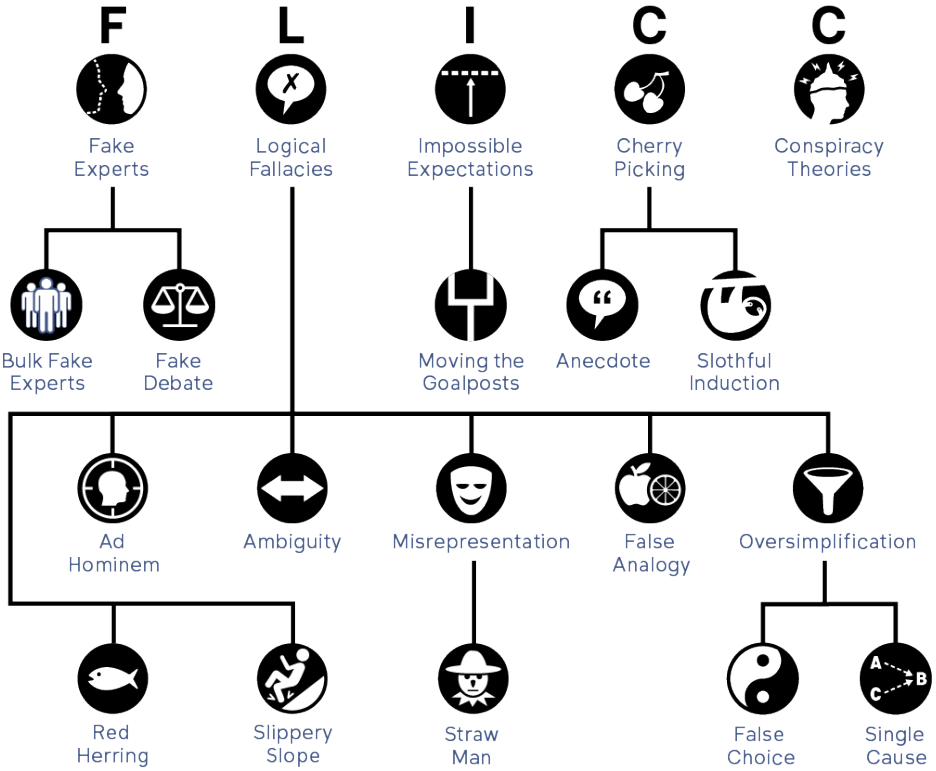

Figure 2: Taxonomy of denialist techniques and logical fallacies in climate misinformation.

Fake experts

Fake experts are spokespeople that convey the impression of expertise on a topic while possessing little to no relevant expertise. A common characteristic of science denialists are that the vast majority are "private researchers" without the credentials required to public climate research in peer-reviewed journals (Hannson, 2017). Fake experts are typically deployed to cast doubt on the expert consensus on human-caused global warming. For more details on the psychology of scientific consensus and why expertise is such an important concept, see Chapter 6 by van der Linden & Vraga). Two forms of the fake expert strategy are bulk fake experts and fake debate.

Bulk fake experts are one of the most potent incarnations of the fake expert technique. These typically involve declarations or letters signed by a large number of signatories who convey the impression of expertise, but rarely possess the relevant expertise. The most prominent example is the Global Warming Petition Project, which features over 31,000

science graduates signing a statement that humans aren't disrupting climate. This myth is one of the most effective denialist arguments in reducing acceptance of climate change (van der Linden et al., 2017). However, over 99% of the signatories possess no research expertise in climate science (Anderson, 2011).

Fake debate is when the journalistic norm of giving both sides of a contentious issue equal weight is applied to issues of scientific fact, also referred to as false balance media coverage. This has allowed the minority of denialist scientists to obtain disproportionate coverage (Boykoff & Boykoff, 2004). While false balance media coverage has improved in the U.S. prestige press (Schmid-Petri, Adam, Schmucki, & Haussler, 2015), the problem still persists in U.S. television coverage of climate change (Boykoff 2008) and the UK tabloid press (Painter and Gavin, 2015).

Logical fallacies

Logical fallacies occur in arguments where the premises or starting assumptions do not logically lead to the conclusion. Cook, Ellerton, & Kinkead (2018) described how arguments can be logically flawed by committing fallacies of relevance (the premises are not relevant to the conclusion), scope (not all evidence is considered), or presumption (the argument contains false premises). Strictly speaking, denialist techniques such as fake experts (otherwise known as argument from false authority), impossible expectations, cherry picking, and conspiracy theories are also logical fallacies. However, they are so common in science denial that in the FLICC framework outlined in Figure 2, they have been "elevated" to one of the five main denialist techniques. The next section lists denial techniques listed in the logical fallacies category.

Ad hominems (Latin for "to the person") attempt to discredit a person's conclusions by personally attacking the person. In the context of climate misinformation, this typically takes the form of demonizing climate scientists with exaggerated stereotypes (Brisman &

South, 2015). Online discussions often focus on the character of climate scientists rather than scientific issues (Matthews, 2015).

Ambiguity in language can be exploited for misleading purposes. Climate change is vulnerable to this technique, as the science is complex and difficult to understand, making the issue inaccessible to the vast majority of the public (Hansson, 2017). Scientists use many words with different meanings to how the public understand them (Hassol, 2008). For example, scientific uncertainty refers to an estimated range of values, while to the lay public, uncertainty means we don't know if something will happen.

False analogy occurs when one assumes that because two things are alike in one way, they are alike in other ways also. For example, contrarians liken themselves to Galileo who defied the consensus that the Sun revolves around the Earth. The implication is that because Galileo and climate deniers are alike in defying a consensus, they are also alike in being correct while the consensus is incorrect. However, this particular analogy fails as Galileo's conclusions were based on empirical observations, while climate denial rejects empirical observations. Climate deniers more closely resemble the ideologically-driven opponents of Galileo (Sherwood, 2011).

Misrepresentation of a situation can be used to distort understanding. For example, one denialist claim is that scientists switched from the term "global warming" to "climate change" because global warming stopped happening. In reality, there never was any such switch and the term "climate change" has been more prevalent since the early 1990s (Jacobs, Jokimäki, Rice, Green, & Winkler, 2016). Ironically, it was political strategist Frank Luntz who advised conservatives to switch to the term "climate change" because it was less frightening than "global warming" (Luntz, 2002).

Straw man is one form of misrepresentation, where a person or group's position is misrepresented in order to more easily discredit them. One example is the claim that climate

scientists predicted an ice age in the 1970s (with the implication being that their predictive error discredits climate science in general). However, this misrepresents the state of scientific understanding in the 1970s, when the vast majority of published scientific papers predicted warming (Peterson, Connolley, & Fleck, 2008).

Oversimplification involves simplifying a situation to the extent that it distorts understanding. An example is the claim that CO2 is plant food therefore burning fossil fuels is good for plants. This argument oversimplifies the nature of plant growth, which requires not only CO2 but also a regular water supply and healthy temperature range. Global warming intensifies the hydrological cycle, causing more extreme weather events such as floods, droughts, and heat waves, all of which are disruptive to plant growth. Two common forms of oversimplification found in climate misinformation are the false choice and single cause fallacies.

Single cause fallacy is a form of oversimplification that assumes there is a single cause of a phenomena when multiple factors may be at play. The most common example of this fallacy is the argument that climate has changed naturally in the past, therefore modern climate change must be natural also. This argument contains the unspoken false assumption that because natural factors have caused climate change in the past, then they must always be the cause of climate change (Cook, Ellerton, & Kinkead, 2018), when human influence may also be a factor.

False choice, also known as false dichotomy, is a form of oversimplification that forces a choice between two options when there may be other possibilities or both options might both be viable. For example, deniers argue that either CO2 causes warming, or warming causes CO2. As Antarctic ice core records show CO2 lagging temperature, this shows that warming causes CO2 and therefore CO2 does not cause warming. In reality, both

options are true and act as a reinforcing feedback, with greenhouse warming amplifying the modest warming from changes in the Earth's orbit.

Red herrings divert attention to an irrelevant point in order to distract from a more important point. For example, deniers claim that CO2 is a trace gas comprising only 0.04% of the atmosphere so its warming effect is minimal. However, there are many examples of active substances causing a strong effect in minute amounts (e.g., arsenic in water, or alcohol in the blood stream). Similarly, we know that CO2 has a warming effect on the climate from many lines of empirical evidence, such as satellite and surface measurements of the infrared spectrum. The fact that CO2 is a trace element is irrelevant to whether it can have a strong effect on the climate.

Slippery slope fallacy assumes that taking a minor action will eventually lead to major, negative consequences. The slippery slope fallacy plays a foundational role in climate change denial, underlying the free-market belief that even modest policies to address climate change will inevitably lead to socialism and the removal of civil liberties.

Impossible expectations

Impossible expectations demand unrealistic or unattainable standards of scientific proof. This technique, alternatively described as the "Scientific Certainty Argumentation Method" by Freudenberg, Gramling, & Davidson (2008), exploits the probabilistic nature of the scientific method. This rhetorical tactic can be persuasive due to lay public's misperception that science provides absolute proofs.

Moving the goalposts is one version of the impossible expectations strategy, involving demanding higher levels of evidence after receiving requested evidence. This approach is often seen when it comes to sea level data, which along with ocean heat offers one of the clearest signals of global warming (Cheng et al., 2017). Consequently, deniers shift the focus

to whether sea level rise is accelerating, a tacit acknowledgement that sea level rise is happening.

Cherry picking

Cherry picking involves selectively focusing data that leads to a conclusion different from the conclusion arising from all available data (Cook, Ellerton, & Kinkead, 2018). This technique can be a form of paltering, involving claims that are strictly true but lead to misleading conclusions (Schauer & Zeckhauser, 2009). Paltering is refuted by providing the full context (Lewandowsky, Ballard, Oberauer, & Benestad, 2016). Two forms of cherry picking are anecdote and slothful induction.

The most prominent example of climate cherry picking is the argument that global warming has stopped in recent years, referred to as the "pause" or "hiatus" (Boykoff, 2014). The surface temperature record is vulnerable to exploitation of this sort due to the noisy nature of the signal, with temperature fluctuating from year-to-year as the oceans exchange heat with the atmosphere. Statistically, there is no evidence of any pause in global warming (Rahmstorf, Foster, & Cahill, 2017) but nevertheless, the scientific community responded to persistent denialist claims with an undue focus on hiatus narratives (Lewandowsky, Risbey, & Oreskes, 2016).

Anecdote is a form of cherry picking that relies on isolated examples rather than scientific evidence in order to draw misleading conclusions. The most common example of a climate anecdote is the argument that cold weather disproves global warming. Senator James Inhofe argued in early 2015 that global warming wasn't happening via a demonstration with a snowball, despite the fact that 2014 had been the hottest year on record.

Slothful induction ignores relevant evidence when coming to a conclusion. While this is similar to cherry picking, the emphasis is on neglecting inconvenient information while cherry picking emphasizes confirming information. One example of slothful induction is the

argument that the sun is causing global warming. In order to come to this conclusion, one must overlook the more recent data finding that sun and climate have been moving in opposite directions. Over the last few decades, global temperatures have increased while solar activity decreased. While changes in the Sun's brightness do affect Earth's climate, any influence from the Sun in recent decades would be a slight cooling (Lockwood 2008).

Conspiracy theories

Conspiracy theories involve the suggestion of secret plans to implement nefarious schemes, and are a common theme in climate misinformation. Climate science expertise has been characterized by deniers as a "climatism cartel" of scientists, regulators, activists, and business entities (Bohr, 2016). Conspiratorial thinking is self-sealing and immune to refutation: when confronted with evidence disproving a conspiracy theory, deniers broaden their conspiracy to include the source of the evidence (Lewandowsky et al., 2015a).

The danger of conspiracy theories is that people underestimate the influence they have on their beliefs (Douglas and Sutton, 2008). While conspiracy theories may fail to convince, they nevertheless influence people by reducing intent to reduce one's carbon footprint (Jolley and Douglas, 2014), decreasing trust in government (Einstein and Glick, 2014), and lowering support for climate action (van der Linden, 2015).

The most prominent climate change conspiracy theory is "climategate", referring to an incident in 2009 when climate scientists' emails were stolen and claimed to prove that scientists were fraudulently manipulating climate data in order to deceive the public. Climategate may have contributed to the decrease in public concern about climate change over that period (Brisman, 2012). Nine investigations were conducted into the scientists' conduct, with all investigations concluding that there was no evidence of wrongdoing by climate scientists. However, the self-sealing nature of conspiratorial thinking resulted in deniers expanding their conspiracy theories to include the investigators. Interest in

climategate has intensified among denier blogs over time (Lewandowsky, 2014), while public and media interest has decreased (Anderegg & Goldsmith; 2014).

Lastly, it must be pointed out that informal fallacies are not necessarily mutually exclusive. A single argument can contain multiple fallacies, and while an argument may best match a specific fallacy, it may also match other fallacies to lesser degrees. For example, the argument "some glaciers are growing, therefore global warming is not happening" is an anecdotal argument, a form of cherry picking. However, this argument also commits the single cause fallacy, a form of oversimplification. It assumes that only temperature drives glacier length, when other factors such as changes in local precipitation can also play a role. When deconstructing misinformation, it is important to recognise that clear categorization of informal fallacies is not always clear-cut. Table 1 features definitions of each denialist technique or logical fallacy, as well as examples in climate misinformation.

Table 1: Climate denial techniques, definitions, and examples

Technique	Definition	Example
Ad Hominem	Attacking the person/group instead of addressing their argument.	"Climate scientists can't be trusted because they're biased."
Ambiguity	Using ambiguous language in order to lead to a misleading conclusion.	"Thermometer readings have uncertainty which means we don't know whether global warming is happening."
Anecdote	Using personal experience or isolated examples instead of sound arguments or compelling evidence.	"The weather is cold today—whatever happened to global warming?" "Some glaciers are growing so glaciers are not in danger from global warming."

Bulk Fake Experts	Citing large numbers of seeming experts to argue that there is no scientific consensus on a topic.	"31,487 Americans with a science degree signed a petition saying humans aren't disrupting climate."
Cherry Picking	Carefully selecting data that appear to confirm one position while ignoring other data that contradicts that position.	"Global warming stopped in 1998." "Global warming is good."
Conspiracy Theory	Proposing a secret plan to implement a nefarious scheme such as hiding a truth or perpetuating misinformation.	"Climategate proves that climate scientists have engaged in a conspiracy to deceive the public."
Fake Debate	Presenting science and pseudoscience in an adversarial format to give the false impression of an ongoing scientific debate.	"Giving climate deniers equal weight with climate scientists creates the misleading impression that there is an ongoing scientific debate about basic climate facts such as human-caused global warming."
Fake Experts	Presenting an unqualified person or institution as a source of credible information.	"A retired physicist argues against the climate consensus, claiming the current weather change is just a natural occurrence."
False Analogy	Assuming that because two things are alike in some ways, they are alike in some other respect.	"Climate skeptics are like Galileo who overturned the scientific consensus about geocentrism."
False Choice	Presenting two options as the only possibilities, when other possibilities exist.	"CO2 lags temperature in the ice core record, proving that temperature drives CO2."

Impossible Expectations	Demanding unrealistic standards of certainty before acting on the science.	“Scientists can’t even predict the weather next week. How can they predict the climate in 100 years?” “Climate models are imperfect and therefore unreliable.”
Logical Fallacies	Arguments where the conclusion doesn’t logically follow from the premises. Also known as a non sequitur.	“Climate has changed naturally in the past so what’s happening now must be natural.”
Misrepresentation	Misrepresenting a situation or an opponent's position in such a way as to distort understanding.	“They changed the name from ‘global warming’ to ‘climate change’ because global warming stopped happening.”
Moving the Goalposts	Demanding higher levels of evidence after receiving requested evidence.	“Sea levels are rising but they’re not accelerating.”
Oversimplification	Simplifying a situation in such a way as to distort understanding, leading to erroneous conclusions.	“CO2 is plant food so burning fossil fuels will be good for plants.” “Human CO2 emissions are tiny compared to natural CO2 emissions so our influence is negligible.”
Red Herring	Deliberately diverting attention to an irrelevant point to distract from a more important point.	“CO2 is a trace gas so it’s warming effect is minimal.”
Single Cause	Assuming a single cause or reason when there might be multiple causes or reasons.	“Climate has changed naturally in the past so what’s happening now must be natural.”

		"Polar bear numbers have increased so they're in no danger from global warming."
Slippery Slope	Suggesting that taking a minor action will eventually lead to major consequences.	"If we implement even a modest climate policy, it will start us down the slippery slope to socialism and taking away our freedom."
Slothful Induction	Ignoring relevant evidence when coming to a conclusion.	"There is no empirical evidence that humans are causing global warming." "The sun is causing currently observed climate change on Earth."
Straw Man	Misrepresenting or exaggerating an opponent's position to make it easier to attack.	"In the 1970s, climate scientists were predicting an ice age."

Psychological biases resembling denial techniques

An important feature of climate change denial is that genuinely held misconceptions are usually indistinguishable from intentionally deceptive disinformation. This is because the psychological biases arising from ideologically-induced denial result in the same fallacious reasoning that are implemented in denialist rhetorical arguments. The following section lists the psychological biases associated with specific denialist techniques.

Fake experts can arise from the tendency of people to attribute greater expertise to people they agree with (Kahan, Jenkins-Smith, & Braman, 2011). People who are dismissive about climate change tend to have a lower perception of expert consensus (Leiserowitz et al., 2019). This may be due to the fact that contrarian scientists are more salient to dismissives, leading to misperception that dissenting scientists are a larger proportion of the scientific community.

Logical fallacies can arise from a variety of motivational biases (Correia, 2011). The psychological tendency to focus on opponents' weaker arguments can result in the straw man fallacy (Talisse and Aikin 2006). There is a privileged link between the phenomenon of fretful thinking, also known as 'counterwishful thinking' or 'twisted self-deception', and the fallacy of slippery slope (Correia, 2014).

Impossible expectations results from disconfirmation bias, where people resist evidence that they are motivated to reject (e.g., it threatens their pre-existing beliefs, worldview, or identity). A non-climate example of disconfirmation bias was when Republicans were shown conclusive evidence that Saddam Hussein wasn't connected to 9/11, with many strengthening their false beliefs through counter-arguing (Prasad, 2009).

Cherry picking can arise from confirmation bias, the flip side of disconfirmation bias. People tend to attribute greater weight to information that confirms prior beliefs relative to disconfirming evidence. For example, when people were shown information about a nuclear breakdown, nuclear opponents focused on the fact that the breakdown happened while nuclear supporters focused on the success of safeguards (Plous, 1991).

Anecdote is a particularly persuasive form of misinformation, due to the highly influential nature of personal experience. A number of studies find an association between the outdoor temperature and beliefs in global warming (Bergquist & Warshaw, 2018; Donner & McDaniels, 2013; Joireman, Truelove, & Duell, 2010; Li, Johnson, & Zaval, 2011). Even dead indoor plants strengthen belief in global warming (Guéguen 2012).

Conspiracy theories have been historically synonymous with science denial, with relativity deniers in the 1930s proposing Jewish conspiracy, creationists seeing atheist conspiracies, and climate change deniers seeing liberal conspiracies (Hansson, 2017). There is a significant association between climate denial and conspiratorial thinking (Lewandowsky, Gignac, & Oberauer, 2013), and conspiracies are the most common theme

when climate deniers are prompted to respond to climate change (Smith & Leiserowitz, 2012). Lewandowsky, Lloyd, & Brophy (2018) suggest that conspiratorial thinking is characterized by certain patterns of reasoning that are less truth-seeking or reliable. These include the assumption of questionable motives, persecution-victimization, nihilistic degrees of skepticism towards the "official" account, the belief that nothing occurs by accident, and self-sealing reasoning.

Due to the difficulties in distinguishing misinformation from disinformation, caution is often recommended before ascribing motives behind climate denial. When motivation is unclear, it is recommended that focus is directed towards the techniques of denial or the scientific content relevant to denialist arguments where more reliable assessments can be made.

Conclusion

Misinformation about climate change features a wide range of claims containing a large set of rhetorical techniques and logical fallacies. This misinformation has been shown to cause a range of negative societal impacts, with the ultimate effect of decreasing public support for mitigation policies and delaying climate action. A particularly important impact of misinformation is its ability to cancel out accurate information, which means that communication outreach and education efforts must take into account the role of misinformation when developing educational or informative content. Consequently, it is imperative that scientists, educators, and communicators develop and implement interventions that neutralize the influence of climate misinformation.

Most educational material or communication campaigns in response to climate misinformation has focused on explaining scientific content such as rising global temperatures (Lewandowsky, Risbey, & Oreskes, 2016) or the overwhelming scientific

consensus (Cook & Lewandowsky, 2016). However, Cook, Ellerton, & Kinkead (2018) demonstrate that a basic understanding of argumentation is sufficient to refute a large number of climate denialist claims, consistent with the Aristotelian approach of inoculating against false arguments with rational argumentation (Compton, 2005).

Schmid & Betsch (2019) found that providing scientific facts or explaining the rhetorical techniques typical for denialism were both effective in neutralizing misinformation. Given that denialist techniques are common across scientific issues, this indicates that uncovering their rhetorical techniques as an effective and efficient communication approach. This is replicated in inoculation research that finds that explaining the misleading techniques in misinformation are an effective intervention (van der Linden et al., 2017), even with general inoculations without mention of specific examples of misinformation (Cook et al., 2017).

Correcting misperceptions involves complicated psychological processes and can backfire if the refutation is perceived to threaten a person's worldview (Hart and Nisbet, 2012; Nyhan and Reifler, 2010) or if the misinformation is emphasised more than accurate information (Peter and Koch, 2016). Consequently, it is recommended that communicators an educators developing responses to misinformation consult the recommended best-practices advised by research in order to effectively counter misinformation. This research is further explored in Chapter 6 (van der Linden & Vraga).

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