Quantifying the Impact of Skeptical Science Rebuttals in Reducing Climate Misperceptions

John Cook[1,2], Bärbel Winkler[2], Collin J.H.M. Maessen[2], Timo Lubitz[2,3], Doug Bostrom[2], Dana Nuccitelli[2,4]

[1] Melbourne Centre for Climate Change, University of Melbourne, 800 Swanston St, Parkville VIC 3053, Australia

[2] Skeptical Science Inc., 12345 Lake City Way NE #2026/ Seattle, WA 98125

[3] German Citizens' Climate Lobby, Germany - Citizens' Climate Lobby Germany e.V. (CCL-D), Urbanstraße 20, D-81371 München

[4] Citizens' Climate Lobby, PO Box 181020 Coronado, CA 92178, USA

Correspondence to: Bärbel Winkler (baerbelw@skepticalscience.com)

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[1] Melbourne Centre for Climate Change, University of Melbourne, Melbourne, Australia
[2] Skeptical Science, USA
[3] German Citizens' Climate Lobby, Germany
[4] Citizens' Climate Lobby, USA

Correspondence to: Bärbel Winkler (baerbelw@skepticalscience.com)

Abstract. Misinformation about climate change causes societal damage in a number of ways and consequently, resources are required to support interventions that counter their influence. Aiming to meet this need, Skeptical Science is a highly-visited website featuring 250 rebuttals of misinformation about climate change. The rebuttals are written at multiple levels—basic, intermediate, and advanced—in order to reach as wide an audience as possible. This study collects survey data from visitors to the website, assessing the effectiveness of rebuttals in reducing acceptance in climate myths and increasing acceptance of climate facts. Our data found that nearly half of visitors were already highly convinced regarding climate facts. We found that the rebuttals were effective in reducing belief in climate myths but that some rebuttals show a concerning reduction in belief in climate facts. The greatest improvement occurred with visitors who began with the most inaccurate climate perceptions. This indicates that the website is useful for two main audiences - those who are convinced about climate change but looking for material to support their own climate communication efforts, and those who disagree with climate facts but are open to new information. We examine potential ways that Skeptical Science rebuttals could be updated to improve their performance in raising climate literacy and critical thinking skills.

1 Introduction

Despite the overwhelming scientific consensus on human-caused climate change (Cook et al., 2013; Cook et al., 2016), there is still public confusion over the severity of climate change and therefore insufficient public demand for climate action. A significant contributor to this lack of progress is climate misinformation, which damages society in a number of ways. The obvious impact of climate misinformation is the instilling of false beliefs or lowering of accurate beliefs, with even just a few misleading statistics reducing people's acceptance of the reality of climate change (Ranney & Clark, 2016). However, climate misinformation has more subtle and subversive impacts beyond simply fostering misperceptions. One subversive effect in the cognitive domain is misinformation's tendency to cancel out efforts to communicate facts. When people are confronted with conflicting pieces of information (e.g., facts and misinformation) and have no way to resolve the conflict, they tend to disengage and believe neither (McCright et al., 2016; van der Linden et al., 2017; Vraga et al., 2020). This impact is highly consequential for educators, scientists, and communicators, as it means that any efforts to communicate facts can be cancelled out by misinformation.

Other subversive effects are seen in the social domain, with climate misinformation polarizing the public, having a disproportionate impact on political conservatives. This means that after being exposed to misinformation, people with different political backgrounds end up further from each other in their climate perceptions (Cook et al., 2017). Another social effect is on scientists who, when attacked, can be influenced to downplay how they report their scientific results, lest they appear to resemble the stereotypes of biased scientists made in attacks made about them (Lewandowsky et al., 2015). This chilling effect extends beyond

the scientific community, with the general public less likely to talk about climate change with friends and family, largely because of fear of pushback (Geiger & Swim, 2016).

Climate misinformation in the form of conspiracy theories also causes damage spilling beyond the issue of climate change. One study found that when people were exposed to a conspiracy theory about global warming, they were less likely to sign a petition in support of measures to reduce global warming and less likely to donate to a charity (van der Linden, 2015). Conspiracy theories also increase people's feelings of powerlessness, uncertainty, and disillusionment, which reduces their intention to engage in politics more broadly (Jolley & Douglas, 2014). This myriad of negative impacts necessitates the need to develop resources and interventions to counter climate misinformation.

Much psychological research has been conducted into effective ways to refute misinformation. One strategy is to dislodge myths with a "replacement fact" that possesses at least the same explanatory relevance as the myth (Ecker et al., 2010; Seifert, 2002). However, factual information alone may not be enough as when people are presented with both facts and myth countering the fact, the two can cancel each other out (McCright et al., 2016; van der Linden et al., 2017; Vraga et al., 2020). This risk can be mitigated by explaining the misleading rhetorical techniques or logical fallacies used by the misinformation to cast doubt on the facts (Cook et al., 2017a). These disparate strategies have been synthesised in the Debunking Handbook 2020 which suggests that debunkings should adopt a fact-myth-fallacy-fact structure (Lewandowsky et al., 2020). A complementary approach that often incorporates these approaches is misconception-based learning (McCuin, Hayhoe, & Hayhoe, 2014) or agnotology-based learning (Bedford & Cook, 2013), which involves teaching scientific facts through directly debunking science misconceptions.

An increasingly important concept in misinformation research is *discernment* – the ability to distinguish factual information from misinformation. Discernment is commonly measured by taking the difference between agreement with facts and agreement with misinformation (Pennycook & Rand, 2021). This is important because concerns have been raised that some anti-misinformation interventions have resulted in reducing discernment, not only reducing agreement with misinformation but also reducing agreement with facts (Modirrousta-Galian & Higham, 2023). Anti-misinformation interventions should seek to raise discernment by increasing the gap between fact agreement and misinformation agreement.

1.1 Skeptical Science

Skeptical Science is an international website and non-profit science education organization founded by John Cook in 2007. The main purpose of the website is to debunk misconceptions and misinformation about human-caused climate change, featuring more than 250 rebuttals of climate myths. The website is maintained by a team of academics and volunteers from around the globe who actively contribute to published research. One highlight of Skeptical Science research output is an often-cited 97% consensus paper (Cook et al., 2013), which was affirmed by a subsequent synthesis of consensus studies (Cook et al., 2016).

Other researchers have also drawn upon or analysed Skeptical Science's content. For example, one study analysed user comments on skepticalscience.com, finding that one third of posts indicated a desire to communicate facts or educate (Metcalfe, 2020). The website's encyclopedic list of climate myths has also been influential, with Elsasser & Dunlap (2013) drawing upon the 103 listed rebuttals (at the time) in order to identify the prevalence of specific climate myths in newspaper op-eds. A later analysis of climate denial referenced Skeptical Science's 193 rebuttals (at the time), indicating the steady accumulation of debunkings (Hansson, 2017). The taxonomy of myths also served as the starting point in the inductive development of a comprehensive taxonomy of contrarian claims about climate change (Coan et al., 2021). The website content is currently being used to train models that use generative AI to automatically debunk climate misinformation (Zanartu et al., 2024).

The rebuttals are written at multiple levels, offering basic, intermediate, and advanced versions. They tackle common misconceptions about climate change such as "global warming is not happening", "It's not caused by human activity", "Climate

impacts are not bad", and "Climate solutions are too hard". The rebuttals receive most of the website's traffic, with some individual rebuttals viewed more than 20,000 times per month. They are listed by popularity, fixed numbers (for ease of reference), or taxonomic categories for ease of access.

Over time, the design of the rebuttal content has evolved to be brought more in line with debunking best-practices recommended from psychological research. The myth rebuttals initially led with and emphasized the myth that was being debunked (Fig. 1a). Subsequently, the rebuttals were adapted using a format to de-emphasise the myth according to Schwarz et al. (2016)(Fig. 1b).

In late 2022, a thorough rebuttal revision project was initiated, motivated by the years that had passed since some rebuttals had been written and the advances in climate science that had occurred during that time. Given the important role of readability on reading comprehension (Zainurrahman et al., 2024), the rebuttals were made accessible to a wider range of readers with an 'at a glance' primer section added to the start of the basic version of selected rebuttals (Fig. 1c).

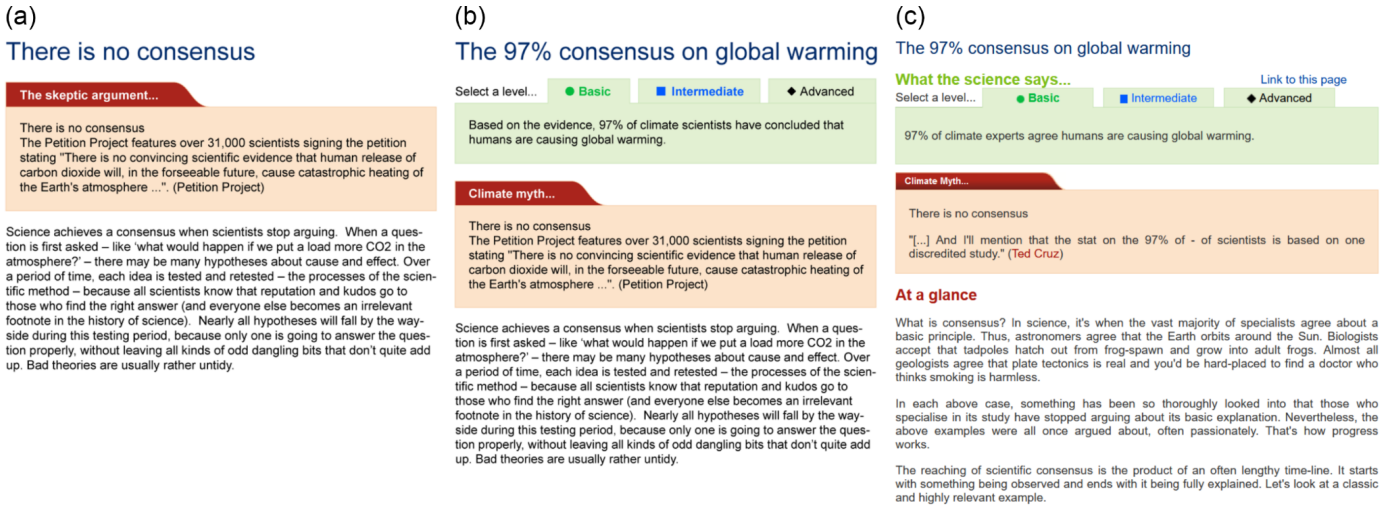

Figure 1: (a) First version of rebuttal, (b) Second version of rebuttal with initial fact and basic/intermediate/advanced levels, (c) Current version with "At a glance" section.

Despite much effort gone into rebuttal creation and revision over many years, no research had been conducted assessing the effectiveness of the rebuttals in countering climate misinformation. Such an analysis could inform development of future rebuttals and revision of existing rebuttals. Consequently, this study explores the research question: how effective are the Skeptical Science rebuttals in reducing acceptance in climate myths and increasing acceptance of climate facts?

2 Methods

This study collected survey data from a selection of visitors to skepticalscience.com. Specifically, visitors who arrived directly at a rebuttal having come from google.com, google.co.uk, or google.com.au were invited to participate in research. In other words, users who conducted a search on Google then clicked on a link to a Skeptical Science rebuttal in the organic search results.[1] Users who arrived at a non-English rebuttal were excluded from the final analysis as the research was conducted in English. Invited visitors were shown a modal (an industry term for a pop-up box overlaying the webpage) asking if they wanted to participate (Fig. 2a). Visitors who indicated they wanted to participate were shown a consent form informing them about the experiment design and how data would be handled (Fig. 2b).

[1] Analysing the search phrases used to find us are beyond the scope of this study. However, we do speculate on the purpose of most readers in coming to Skeptical Science in the Results and Discussion section.

If users consented, they were shown a single statement about climate change and asked to indicate their level of agreement on a 6-point Likert scale from "Strongly agree" to "Strongly disagree" (Fig. 2c). “Strongly agree” answers were assigned value 1 while “strongly disagree” answers were assigned value 6. Users were randomly shown either a factual or misinformation statement relevant to the rebuttal (all statements listed in Table A1). Answers to factual statements were reverse scored so that higher values equated to more accurate answers. Once they completed this single survey item, participants proceeded to read the rebuttal. If they scrolled to the end of the rebuttal, indicating that they had read the rebuttal, another modal screen was displayed, inviting them to again indicate their level of agreement with the same factual/misinformation statement. Users who failed to scroll to the end of the rebuttal were not shown the second survey question, and were excluded from the research data. After answering the final question, participants were thanked for their participation and could close the survey (Fig. 2d).

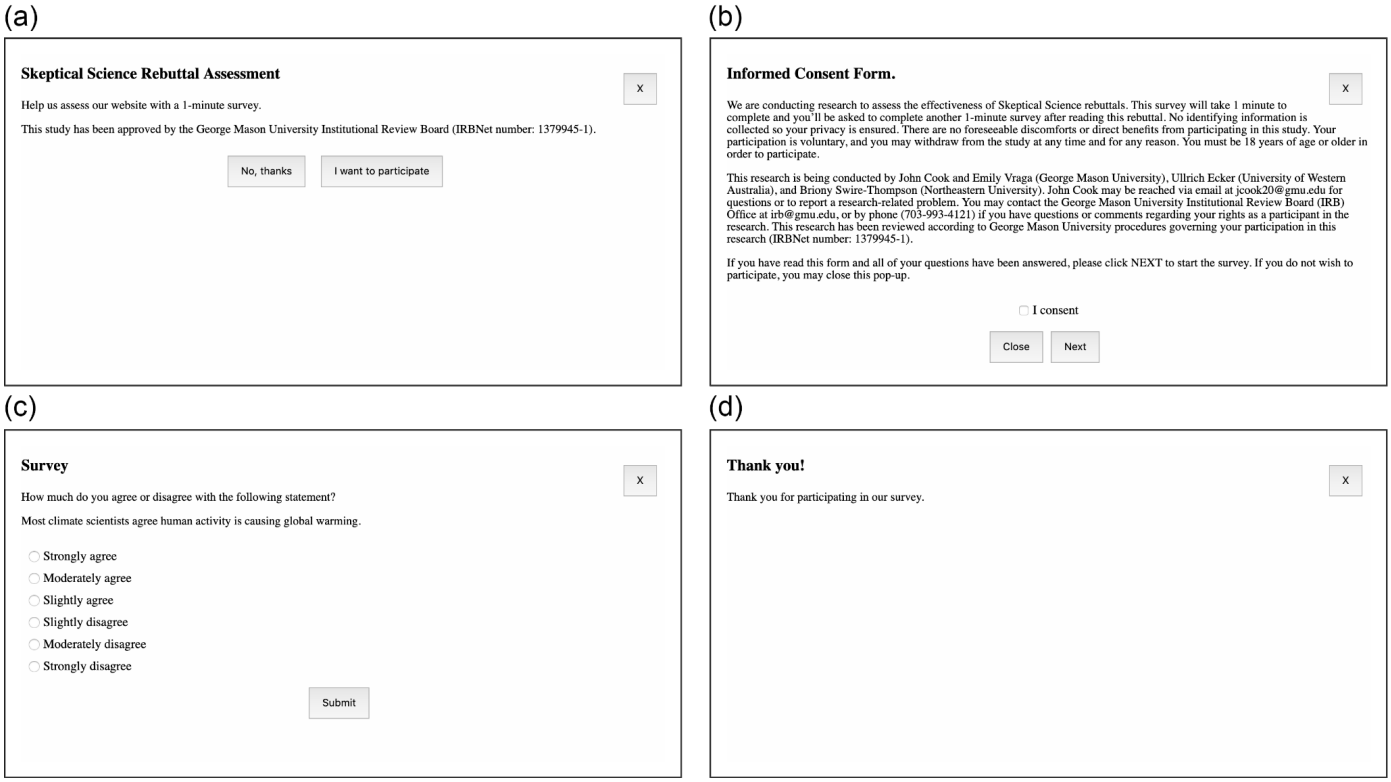

Figure 2: Screenshot of modals used in experiment design. (a) Invitation to participate in research. (b) Informed consent form detailing research design. (c) Survey question. (d) Final thank you modal.

As well as the answer to the survey question, the user’s IP address was recorded so that users whose IP address was already listed among existing research participants were not invited upon any subsequent visits (however, IP addresses were deleted in the anonymised version of the dataset). We also recorded Start Time (when the first survey question was loaded) and End Time (when the end survey was loaded). Time Spent was calculated as the difference between End Time and Start Time, noting that this also included the time spent filling out the pre-rebuttal survey. Data collection occurred from November 2021 to July 2025. Over this period, 858,016 visitors were shown the pop-up invitation to participate in research.

3 Results

Among the 13,432 people that consented to participate in the research and filled out the pre-rebuttal survey, 6,261 people (46%) went on to fill out the post-rebuttal survey. 3,146 participants were shown a factual statement in the survey quiz while 3,115 were shown a myth statement. The average time spent looking at the rebuttals was 4 minutes, with the median being 1 minute, indicating that readers scrolled through the rebuttal quickly (see Figure A7.1 in the Appendices for a distribution of reading times and speeds).

While some participants showed fast reading speeds, they weren't excluded from the analysis as they were representative of real-world skimming behaviour and hence offered external validity.

The majority of participants came to the website already convinced about climate change. Figure 3 shows the distribution of pre-rebuttal beliefs, revealing that nearly half of the participants (46.3%) showed full agreement with the climate fact or full disagreement with the climate myth. In this figure and throughout our results, we refer to the single measure *accuracy* where strong agreement with the factual statement and strong disagreement with the myth statement are designated the most accurate response. Interestingly, the distribution of users was bi-modal with peaks at the extreme ends of the spectrum, indicating that most visitors had a strong opinion about climate change one way or the other, with a minority of undecided visitors.

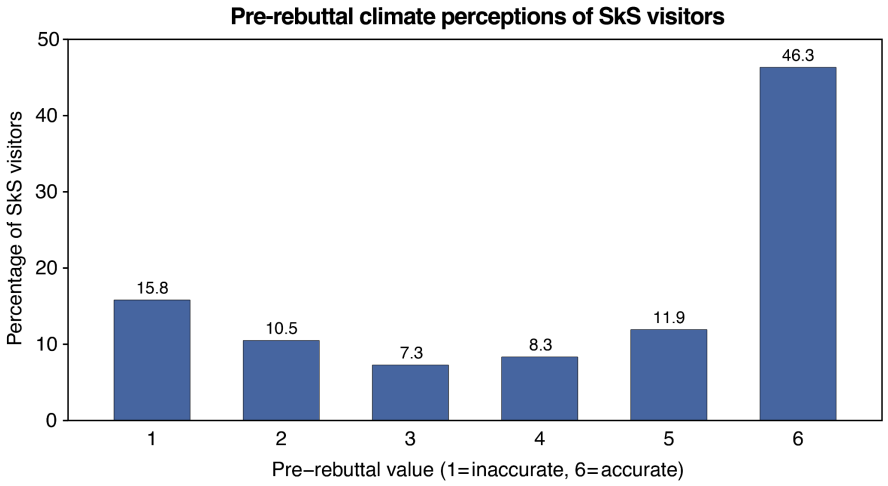

Figure 3: Distribution of climate perceptions in pre-survey. 1 shows inaccurate answer, 6 shows accurate answer.

Comparing the pre-rebuttal and post-rebuttal scores showed that overall (e.g., including participants that were shown fact statements or myth statements), there was a small but non-significant improvement in accuracy. This was conducted through a Wilcoxon Signed-Rank Test, using the Common Language Effect Size (CLES) as a measure of effect size, finding a non-significant difference between pre- and post-test scores with a small effect size ($p = 0.49$, $CLES = 0.05$). To examine the change in perceptions in greater detail, we looked at the response to either factual statements or myth statements individually, shown in Fig. 4a and 4b. Overall, there was a significant decrease in agreement with factual statements ($p = .006$, $CLES = .05$) and a significant decrease in agreement with myth statements ($p = .001$, $CLES = .08$). While overall accuracy improved, the change was non-significant because the decrease in accuracy in response to the factual statements partially canceled out the more accurate response to the myth statements.

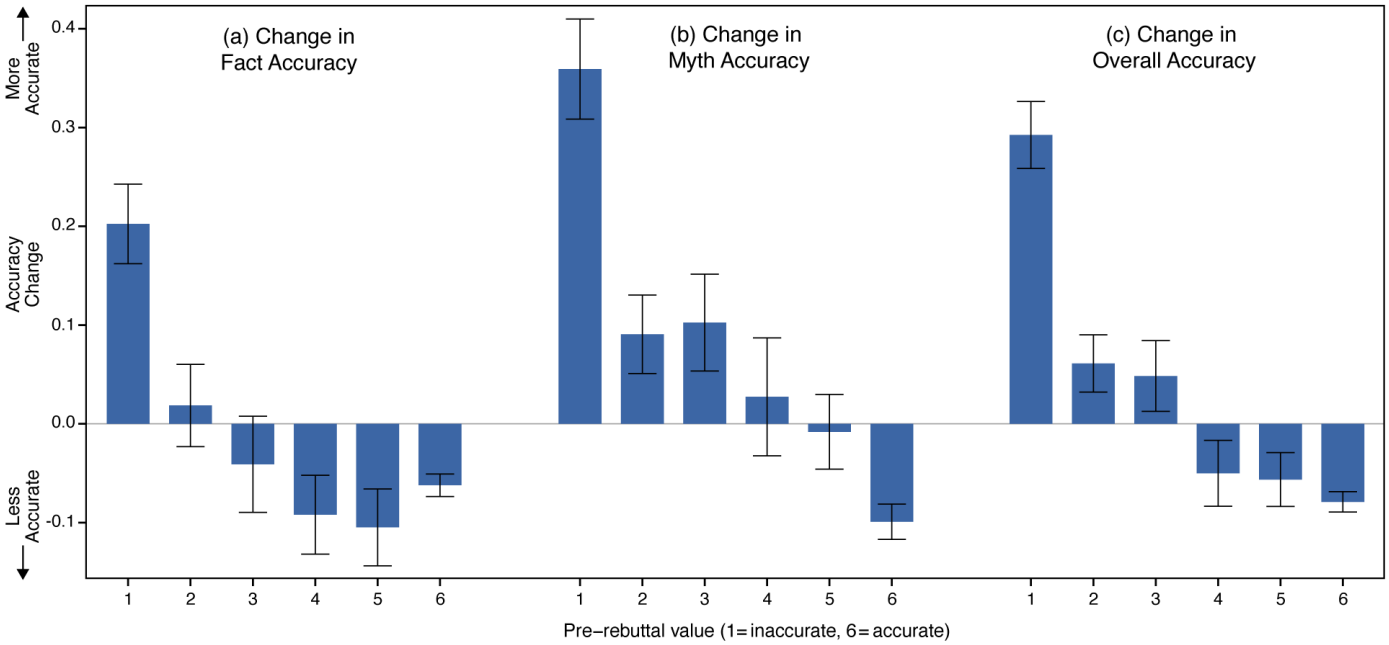

Figure 4: Change in accuracy among participants at varying pre-rebuttal values (positive value means increase in accuracy). (a) Change in accuracy for participants shown factual statement (e.g., change in agreement with factual statement), (b) Change in accuracy for participants shown myth statement (change in disagreement with misinformation statement), (c) Average change in accuracy for fact and myth statements combined.

The change in accuracy significantly depended on pre-existing accuracy. To explore this, a hierarchical regression analysis was conducted to examine the moderating effect of pre-rebuttal accuracy on the change in accuracy, where B represents the slope of the relationship between pre-rebuttal accuracy and change in accuracy and t is the t-test statistic. The results indicated a significant interaction ($B = .14$, $t(6258) = 77.7$, $p < .001$). Figure 4c visualizes this dynamic, showing how the improvement in accuracy was greatest for those with the lowest pre-rebuttal accuracy. Among the people who gave an inaccurate value in the pre-rebuttal survey (1-3), 7.2% switched to an accurate value (4-6) in the post-rebuttal survey.

In order to better understand reader response to rebuttals, the change in perception was examined across different individual rebuttals. Figure 5 shows the changes in myth and fact accuracy for 20 rebuttals that recorded at least 50 participants, with positive values representing a shift towards greater accuracy. Consistent with Fig. 4, this shows that myth accuracy has on average a more positive improvement compared to fact accuracy.

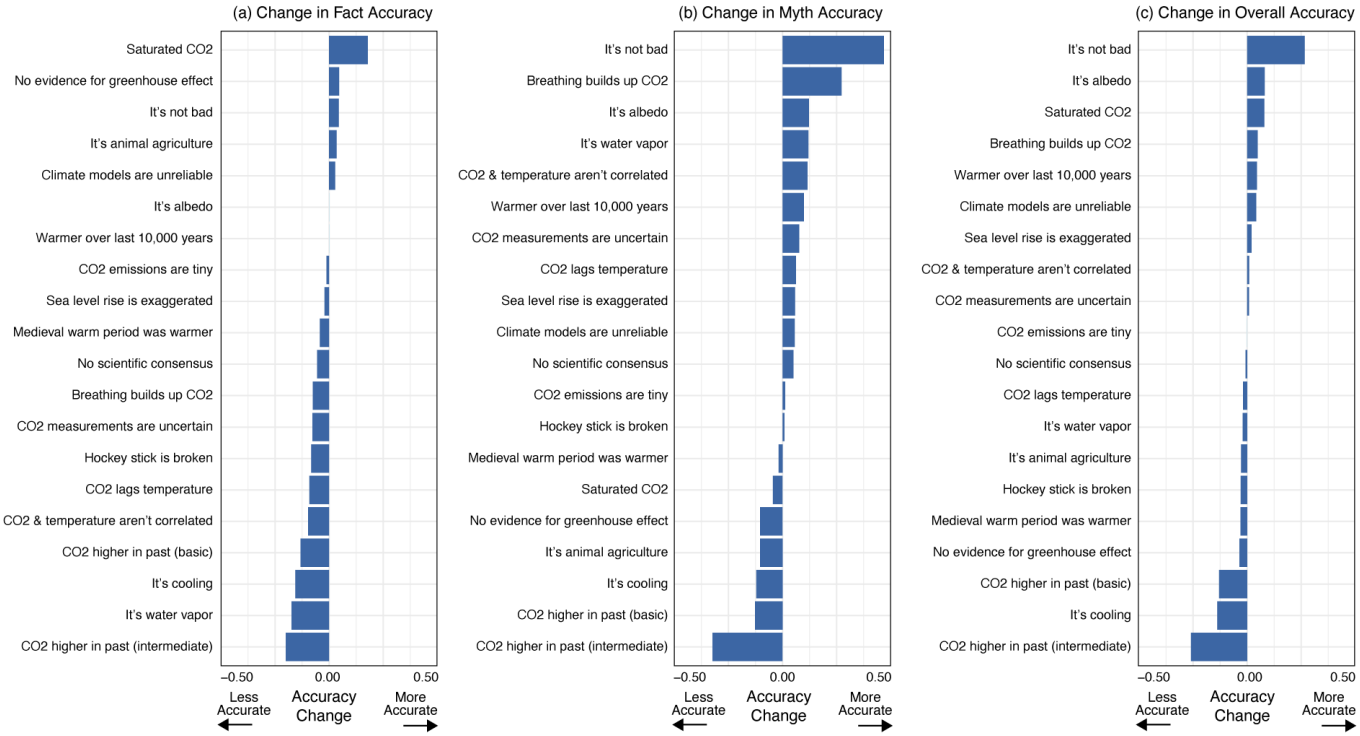

Figure 5: Change in accuracy with regard to (a) fact, (b) myth perceptions, and (c) myth and fact combined, for the 20 rebuttals with most data (positive values mean increase in accuracy).

Some rebuttals consistently perform well for both fact and myth (e.g. "climate impacts aren't bad", see Appendix A6 for links) while other rebuttals perform badly for both fact and myth (e.g., basic and intermediate versions of "co2 was higher in past"). In the case of the water vapor rebuttal, the change in myth accuracy is one of the better results while the change in fact perception is the second worst result.

To more closely explore potential explanations for the varied results, the content of the top three and bottom three rebuttals listed in Fig. 5c were qualitatively examined. In particular, the rebuttals were inspected to see whether they possessed a factual explanation that possessed at least the same explanatory relevance as the myth (Ecker et al., 2010) and an explanation of the fallacy the myth used to distort the facts (Cook et al., 2017a). Overall, the top three rebuttals clearly explained replacement facts, while the bottom three rebuttals failed to clearly explain replacement facts. All but one rebuttal included a fallacy explanation. The top three rebuttals span three categories of climate misinformation casting doubt on the reality, cause, and impacts of global warming. The most effective rebuttal debunked the myth "climate impacts are not bad", with the next most effective rebuttals countering the myths "climate change is caused by albedo changes" and "greenhouse effect is saturated."

In the rebuttal of "climate impacts are not bad", the replacement fact was that the negative impacts of global warming far outweighed the benefits. This fact is clearly and simply communicated, and reinforced repeatedly as the rebuttal compares negative impacts to benefits across different aspects of the climate (e.g., agriculture, health, polar melting, etc). However, the rebuttal fails to explicitly explain the myth's fallacy, which is cherry picking benefits of climate change while ignoring negative impacts.

The rebuttal of "climate change is caused by albedo changes" does explain the relevant fact which is that albedo is a feedback that amplifies climate change rather than a forcing that drives climate change. However, this fact is not highlighted in the "what the science says" box and could have been made more prominent, which may explain why belief in the fact did not increase from this rebuttal. The fallacy in this myth involves cherry picking short periods in order to find spurious correlations between albedo and temperature trends. While the rebuttal does show the long-term trend data which implicitly exposes this fallacy, it fails to explicitly explain the misleading technique.

For the rebuttal of the myth "greenhouse effect is saturated," the relevant fact is that more heat is being trapped high up in the atmosphere where the air is thinner (Cook et al., 2015). The rebuttal implicitly alludes to this fact, mentioning the need to consider the greenhouse effect at all levels of the atmosphere, but does not explicitly explain the fact. The rebuttal fails to explain the fallacy of oversimplification, considering the atmosphere as a single layer when it consists of multiple layers (Cook et al., 2018; Flack et al., 2024).

The worst and third-worst performing rebuttals were the basic and intermediate rebuttals of "CO2 was higher in the past." This myth argues that because CO2 has been much higher in the Earth's deep past (e.g., over ten times current levels during the Ordovician-Silurian period) without the world burning up, this casts doubt on the warming effect of CO2. The relevant fact is that in the Earth's deep past, the sun was cooler when CO2 was higher with the two forcings roughly balancing each other out (Cook et al., 2015). The myth commits single cause fallacy, a form of oversimplification that fails to consider both factors. Both the basic and intermediate debunkings fail to explain either the fact or the fallacy.

The second worst performing rebuttal addressed the myth "it's cooling." The replacement fact communicated in the "What the Science Says" box simply says "it's warming", which is essentially just a negation of the myth without producing any substantive details. The factual explanations delve into complicated details regarding ocean cycles and statistical methods without a clear articulation of how these details relate to the key fact. The rebuttal does explain the fallacy of cherry picking committed by this myth, the only rebuttal examined among both the top three and bottom three rebuttals that explicitly explains the fallacy.

4 Discussion

Our experimental data shed light on the nature of Skeptical Science visitors with most visitors (66.5%) already agreeing with climate facts, and 46.3% of visitors showing strong agreement with the fact or strong disagreement with the myth (Fig. 3). Understanding the reason why these visitors come to the site is beyond the scope of this study (which we address further in the discussion of limitations), but o ne possible interpretation is that a large proportion of visitors may be coming to the website not because they were unsure about a particular climate fact or myth but because they were looking for information to assist them in responding to climate misinformation (again, we clarify that we have collected no data to justify this interpretation). In analysing comment threads on Skeptical Science, Metcalfe (2020) concluded that commenters seeking out like-minded users was an example of "chanting to the choir." However, a more constructive interpretation is that Skeptical Science content is "teaching the choir to sing," providing resources that empower people to respond to climate misinformation (Swim, Fraser, & Geiger, 2014). Such a service is particularly important given that a major reason why people self-censor and avoid talking about climate change with friends and family is due to fear of push-back from climate contrarians (Geiger & Swim 2016). This avoidance of climate change as a discussion topic, known as climate silence, is self-reinforcing leading to a "spiral of silence" (Maibach et al., 2016). On the other hand, discussing climate change raises awareness of the issue, which leads to more discussion in a positive feedback loop (Goldberg et al., 2019).

Also conflicting with the "chanting to the choir" interpretation is the finding that the greatest improvement in accurate perceptions was observed among those with the strongest disagreement with climate facts or strongest agreement with climate myths. This was an encouraging result, showing the website is effective in changing the minds of those most dismissive about climate change. However, a concerning result was that overall, there was a decrease in agreement with climate facts. Inspection of the top three and bottom three rebuttals offers insights into how rebuttals could be made more effective. The better performing rebuttals identified relevant replacement facts that offered equal or greater explanatory relevance than the myths, explained clearly and simply, while the worst performing rebuttals failed to clearly explain replacement facts. In addition, explicit explanations of the fallacies used by climate myths should also be integrated into the rebuttals, offering a seamless fact-myth-fallacy debunking structure (Lewandowsky et al., 2020). Currently, the website is being redesigned with plans to integrate fallacy explanations into

the updated content infrastructure and rebuttal design, in line with research showing the effectiveness of fallacy explanations (Cook et al., 2017a). By incorporating existing resources documenting fallacies in climate misinformation (Cook et al., 2015; Cook et al., 2018; Flack et al., 2024), it is expected that this might have a greater impact on lowering agreement with myths than on increasing agreement with facts. Future research should assess the updated effectiveness of rebuttals that are more intentional in including replacement facts and fallacy explanations.

One limitation of our study was the measurement of just one outcome variable: agreement with a fact/myth statement. Future studies should aim to gain deeper insight into the impact of rebuttals on readers. One approach would be to collect open-ended feedback from participants in the post-rebuttal survey. Qualitative data with the user reflecting on the readability or comprehensibility of the rebuttal might offer guidance on potential problems with specific rebuttals. Questions specifically targeting motivations could address more definitively why readers visited Skeptical Science, better informing the website creators to meet readers' needs. Another limitation of this study is that it examined the impact of a single exposure to debunking text, a challenging situation given that the effects of misinformation interventions decay over time (Maertens et al., 2025) while the public are often exposed to multiple cases of misinformation over time. Unfortunately given the real-world field test aspect of this research, with the corresponding lack of control over participant behaviour, addressing this limitation is beyond the scope of our research capability.

However, controlled laboratory experiments are capable of addressing some of these limitations, such as testing the impact of repeated exposure to corrective messages (Maertens et al., 2025) or offering messages that vary in a more controlled fashion to avoid confounds (e.g., exposing participants to the same debunking with or without the presence of replacement facts and/or fallacy explanations). In particular, controlled laboratory experiments can address the major weakness of field tests that rely on convenience sampling, which is to provide participant samples that represent the general population. Such research design would offer more generalizable findings for science communicators although in the case of this field test, the biased sample matched the readership of the website so provided external validity for this research.

A key goal of misinformation interventions is to increase reader discernment, the difference between belief in facts and belief in myths (Pennycook & Rand, 2021). While there was overall an increase in discernment, with the decrease in agreement with myths greater than the decrease in agreement with facts, the result that belief in climate facts decreased for at least some rebuttals is unwelcome and counter to the goal of Skeptical Science. A recent meta-analysis found that overall, inoculation against misinformation increases discernment between reliable and unreliable news (Simchon et al., 2025).

A purely fact-based approach to debunking misinformation operates under the assumption of the information deficit model, which assumes that public controversy about climate change can be resolved if enough information is supplied to people. This assumption has been criticised as simplistic, resulting in ineffective climate communication (Suldovsky, 2017). Alternative approaches have been proposed such as relationship-building between scientists and the public (Cook & Overpeck, 2019), participatory models (Pearce et al., 2015), or the CAUSE model which has a strong emphasis on building credibility and establishing trust with target audiences (Rowan et al., 2021). Alternatively, inoculation theory – and in particular, logic-based inoculation – offers a psychological framework for reducing the influence of misinformation in a way that overcomes some of the cultural barriers such as political ideology (Cook et al., 2017a). This underscores the importance of incorporating fallacy explanations in rebuttals, and measuring their effectiveness in increasing reader discernment between facts and myths.

Lastly, the rebuttals examined in this study all focused on climate science myths, which has been a particular focus of Skeptical Science to date. However, recent research indicates that climate misinformation is transitioning from science denial to arguments against climate solutions (Coan et al., 2021), with increasing attention being paid to the so-called "discourses of delay" – framings and narratives designed to delay climate action (Lamb et al., 2020). Further, solutions misinformation has been found to be one of the most polarizing forms of climate misinformation, having a disproportionate effect on political conservatives (Lieu et al., in

press). Due to this growing threat, Skeptical Science has recently begun incorporating more rebuttals of solutions myths. A collaboration with The Sabin Center for Climate Change Law at Columbia Law School involved adapting their rebuttals of 33 renewable myths into Skeptical Science rebuttals (Eisenson et al., 2023). However, the effectiveness of rebuttals in response to solutions misinformation is understudied. Experimentally testing the impact of these rebuttals would be a useful area of future research.

In summary, collecting quantitative survey data on a live website is technically and scientifically challenging but offers the opportunity to gain deep insights into pre-existing and updated perceptions of visitors after reading website content. In this study, we obtained insights into climate perceptions of visitors as they arrived at the website. We also learned that our rebuttals decreased belief in climate myths and improved discernment – the difference between belief in facts and myths. However, we also observed a decrease in agreement with climate facts, an unwelcome result necessitating investigation into possible causes. In turn, the subsequent analysis offered guidance on ways that the rebuttals could be updated to be more effective, by including explanations of "replacement facts" that dislodge the myths being debunked, bringing the rebuttals in line with the recommendations of psychological research.

Appendix

A1 Table of Fact and Myth Statements

Table A1: Factual and misinformation statements used in pre-rebuttal and post-rebuttal surveys.

Myth	Factual Statement	Misinformation Statement
"It's cooling", "DMI show cooling Arctic"	I am certain that global warming is really happening.	The climate is not really warming.
"Ice isn't melting", "Arctic sea ice loss is matched by Antarctic sea ice gain"	Ice is melting at an accelerating rate.	Ice is not in danger of melting.
"We're heading into cooling", "We're heading into an ice age", "A grand solar minimum could trigger another ice age"	Earth's climate is headed into future warming.	Earth's climate is headed into another ice age.
"It's freaking cold!", "Record high snow cover was set in winter 2008/2009", "Record snowfall disproves global warming", "2009-2010 winter saw record cold spells"	Global warming makes hot days more likely and cold days less likely.	Recent cold weather is evidence that the climate is not warming
"No warming in 16 years", "Phil Jones says no global warming since 1995", "It hasn't warmed since 1998", "BEST hides the decline in global temperature", "IPCC admits global warming has paused", "They changed the name from 'global warming' to 'climate change'", "Oceans are cooling", "Springs aren't advancing", "Global warming stopped in ~~1998~~,~~1995~~, ~~2002~~, ~~2007~~, ~~2010~~, ????", "Trenberth can't account for the lack of warming", "Satellites show no warming in the troposphere", "It's not happening"	Over the past few decades, the world's average temperature has been increasing.	Over the past few decades, the world's average temperature has not been increasing.
"Sea level rise is exaggerated", "Sea level rise is decelerating", "Sea level rise predictions are exaggerated", "Scientists retracted claim that sea levels are rising", "Sea level is not rising", "Sea level fell in 2010", "Tuvalu sea level isn't rising"	Sea level rise has been steadily accelerating over the past century.	The seriousness of sea level rise is exaggerated.
"Climate change isn't increasing extreme weather damage costs", "Extreme weather isn't caused by global warming", "Heatwaves have happened before", "Hurricanes aren't linked to global warming", "The connection between Hurricane Sandy and global warming"	Climate change is increasing the risk of extreme weather.	Extreme weather is not increasing, there is just more reporting of it in the media these days.
"There's no correlation between CO2 and temperature", "It's El Nino", "Animal agriculture and eating meat are the biggest causes of global warming", "It's methane", "It's microsite influences", "It's satellite	Human activities are changing the climate	Climate change is just a result of natural

microwave transmissions", "Nuclear testing is causing global warming", "It's the ocean", "It's ozone", "It's Pacific Decadal Oscillation", "It's planetary movements", "It's a climate regime shift", "It's soot", "It's a climate shift step function caused by natural cycles", "Underground temperatures control climate", "It's internal variability", "A drop in volcanic activity caused warming", "It's waste heat"		variation in the climate.
“Mt. Kilimanjaro's ice loss is due to land use”, “It's land use”	Most of the warming over the last 50 years is due to the increase in greenhouse gas concentrations	Climate change is due to non- greenhouse gas factors like land use.
"Greenhouse effect has been falsified", "Increasing CO2 has little to no effect", "There's no tropospheric hot spot", "We didn't have global warming during the Industrial Revolution", "CO2 was higher in the late Ordovician", "CO2 was higher in the past", "Postma disproved the greenhouse effect", "Removing all CO2 would make little difference", "CO2 has a short residence time", "CO2 effect is saturated", "2nd law of thermodynamics contradicts greenhouse theory", "CO2 is just a trace gas", "Water vapor is the most powerful greenhouse gas", "Venus doesn't have a runaway greenhouse effect"	Greenhouse gases in the atmosphere affect the average global temperature of the Earth.	Increasing greenhouse gases in the atmosphere has little to no effect on climate.
"Breathing contributes to CO2 buildup", "CO2 emissions do not correlate with CO2 concentration", "CO2 increase is natural, not human-caused", "Murry Salby finds CO2 rise is natural"	CO2 emissions from fossil fuel burning have caused atmospheric CO2 levels to increase by over 40%.	CO2 emissions from fossil fuel burning is not the cause of the increase in CO2 levels in the atmosphere.
"It's only a few degrees", "It's not bad", "An exponential increase in CO2 will result in a linear increase in temperature", "It's not urgent"	The effects of climate change are likely to be catastrophic.	I do not believe climate change is a real problem.
"Clouds provide negative feedback", "Humidity is falling", "Infrared Iris will reduce global warming", "Lindzen and Choi find low climate sensitivity", "No long tail means climate sensitivity is low", "Roy Spencer finds negative feedback", "Positive feedback means runaway warming", "Schmittner finds low climate sensitivity", "Climate sensitivity is low", "Water vapor in the stratosphere stopped global warming", "Tropical thermostat limits sea surface temperature to 30C"	The climate is highly sensitive to changes in heat.	Negative feedbacks mean climate sensitivity is low.
“Animals and plants can adapt”	Global warming will harm animal and plant species.	Global warming is no danger to animal and plant species.
“CO2 is not a pollutant”	Rising carbon dioxide in the atmosphere presents a danger to people and the environment.	Carbon dioxide is natural; therefore, it is safe.
"Adapting to global warming is cheaper than preventing it", "It's too hard"	Humans can reduce global warming, and we are going to do so successfully.	Humans can’t reduce global warming, even if it is happening.
"CO2 limits will harm the economy", "Renewable energy investment kills jobs", "CO2 limits will hurt the poor"	The economic benefits of climate action outweigh the costs.	Climate action is bad for the economy.
“CO2 limits won't cool the planet”	With strong climate action, we can make significant impact on slowing climate change.	Climate action will have little impact on slowing climate change.
"Renewables can't provide baseload power", "Renewable energy is too expensive"	We need many different strategies to reduce CO2 emissions and avoid climate change.	Renewable technology like solar power cannot help us reduce global warming.
"Climate 'Skeptics' are like Galileo", "The science isn't settled"	There is a strong body of evidence for climate change.	The evidence for climate change is unreliable.

"CO2 measurements are suspect", "Tree-rings diverge from temperature after 1960", "Dropped stations introduce warming bias", "Satellite error inflated Great Lakes temperatures", "Hockey stick is broken", "Ljungqvist broke the hockey stick", "Mauna Loa is a volcano", "Satellite record is more reliable than thermometers", "Plant stomata show higher and more variable CO2 levels", "Temp record is unreliable", "UAH atmospheric temperatures prove climate models and/or surface temperature data sets are wrong", "It's Urban Heat Island effect"	Climate measurements are accurate.	Climate measurements are unreliable.
"Climategate CRU emails suggest conspiracy", "Scientists tried to 'hide the decline' in global temperature", "Freedom of Information (FOI) requests were ignored", "Climate scientists are in it for the money", "Climate science peer review is pal review", "Peer review process was corrupted", "CRU tampered with temperature data"	Climate scientists are sincere in their research into climate.	Climate change is a hoax to generate money for scientists.
"Antarctica is gaining ice", "Southern sea ice is increasing", "Antarctica is too cold to lose ice"	Antarctica is losing land ice at an accelerating rate, contributing to sea level rise.	Antarctica is gaining ice, casting doubt on global warming.
"Greenland is gaining ice", "Greenland ice sheet won't collapse", "Greenland has only lost a tiny fraction of its ice mass", "Ice Sheet losses are overestimated"	Greenland is losing ice at an accelerating rate.	Greenland is not in danger of melting.
"Melting ice isn't warming the Arctic", "Arctic sea ice has recovered", "Arctic icemelt is a natural cycle", "Arctic Storm Caused the 2012 Record Sea Ice Minimum"	Arctic sea ice is in long-term retreat, losing half its coverage in only 40 years.	Arctic sea ice is not in danger of melting.
"Glaciers are growing", "Himalayan glaciers are not shrinking"	Glaciers are in long-term retreat.	Glaciers are not in danger of melting.
"The sun is getting hotter", "Solar Cycle Length proves its the sun", "Solar cycles cause global warming", "It's the sun", "Water levels correlate with sunspots", "Jupiter is warming", "Mars is warming", "Neptune is warming", "Other planets are warming", "Pluto is warming"	Over the last few decades of global warming, the sun has been cooling and cannot be causing recent warming.	Other planets showing warming means the sun is causing global warming.
"It's a 1500 year cycle", "CO2 only causes 35% of global warming", "It's aerosols", "It's not us", "Akasofu Proved Global Warming is Just a Recovery from the Little Ice Age", "It's albedo", "It's global brightening", "CERN CLOUD experiment proved cosmic rays are causing global warming", "It's CFCs", "It's cosmic rays", "It's a natural cycle", "CO2 is not the only driver of climate", "There's no empirical evidence", "Greenland was green", "We're coming out of the Little Ice Age", "Loehle and Scafetta find a 60 year cycle causing global warming", "It cooled mid-century", "Medieval Warm Period was warmer", "Northwest passage has been navigated in the past", "Climate's changed before", "It warmed before 1940 when CO2 was low", "Humans are too insignificant to affect global climate", "Soares finds lack of correlation between CO2 and temperature", "Humans survived past climate changes", "It warmed just as fast in 1860-1880 and 1910-1940"	Most of the warming over the last 50 years is due to the increase in greenhouse gas concentrations.	The climate is always changing and what we are currently observing is just natural fluctuation.
"Most of the last 10,000 years were warmer", "1934 - hottest year on record", "Arctic was warmer in 1940"	Modern climate change is abrupt and driven by human activity, setting it apart from past climate change.	It's been hotter in the past, therefore humans are not the cause of current global warming.
“CO2 lags temperature”	More CO2 causes more warming and warming causes more CO2, combining to create a reinforcing feedback.	CO2 lagged temperature in the past, disproving the warming effect of CO2.
"Human CO2 is a tiny % of CO2 emissions", "CO2 is coming from the ocean", "Volcanoes emit more CO2 than humans", "Warming causes CO2 rise"	CO2 emissions from fossil fuel burning have upset the carbon cycle which was in natural balance.	Nature produces more carbon dioxide than humans.
“CO2 is not increasing”	CO2 emissions from fossil fuel burning have caused atmospheric CO2 levels to increase by over 40%.	CO2 levels in the atmosphere are not increasing appreciably.
“Polar bear numbers are increasing”	Global warming will	Global warming is no

	harm polar bears.	danger to polar bears.
"Ocean acidification isn't serious", "Coral atolls grow as sea levels rise", "Corals are resilient to bleaching", "Great Barrier Reef is in good shape"	Global warming will harm ocean ecosystems.	Global warming is no danger to ocean ecosystems
“CO2 is plant food”	Plants need the right amount of water to flourish - climate change upsets that balance.	CO2 is plant food so CO2 emissions are good for plants.
"500 scientists refute the consensus", "There is no consensus", "Deniers are part of the 97%", "The IPCC consensus is phoney", "Over 31,000 scientists signed the OISM Petition Project", "Naomi Oreskes' study on consensus was flawed", "97% consensus on human-caused global warming has been disproven", "Royal Society embraces skepticism", "Less than half of published scientists endorse global warming"	Most climate scientists agree human activity is causing global warming.	There is a lot of disagreement among climate scientists about whether human activity is causing global warming.
"Earth hasn't warmed as much as expected", "Models are unreliable", "Climate is chaotic and cannot be predicted", "Scientists can't even predict weather"	Climate models have been successful at predicting global warming over long time periods.	Scientists’ computer models are too unreliable to predict the climate of the future.
“Ice age predicted in the 70s”	Most climate research in the 1970s predicted future global warming.	Scientists were wrong about ice age predictions in the 1970s so can’t be trusted now.
“Al Gore got it wrong”	Al Gore is trustworthy in how he treats climate research.	Al Gore is not trustworthy in how he treats climate research.
"Hansen's 1988 prediction was wrong", "Hansen predicted the West Side Highway would be underwater"	Climate scientists are trustworthy in how they do climate research.	Climate scientists are not trustworthy in how they do climate research.
"IPCC graph showing accelerating trends is misleading", "IPCC were wrong about Amazon rainforests", "IPCC human-caused global warming attribution confidence is unfounded", "IPCC were wrong about Himalayan glaciers", "IPCC disappeared the Medieval Warm Period", "IPCC edited out natural causes of climate change", "Skeptics were kept out of the IPCC?", "IPCC overestimate temperature rise", "IPCC global warming projections were wrong", "Ben Santer rewrote the 1995 IPCC report", "IPCC is alarmist"	The Intergovernmental Panel on Climate Change (IPCC) is trustworthy in how they treat climate research.	The Intergovernmental Panel on Climate Change (IPCC) is not trustworthy in how they treat climate research.

A2 Handbooks

The Debunking Handbook

Skeptical Science also provides downloadable materials such as handbooks devoted to various aspects of misinformation research. The **Debunking Handbook** is a consensus document written by 19 co-authors invited by the three lead authors Stephan Lewandowsky, John Cook and Ullrich Ecker based on their scientific status in the field. The Handbook explains what mis- and disinformation is, why it can cause substantial harm for individuals and societies, why it is often sticky and therefore hard to dislodge, why pre-bunking can be more effective than debunking and how to go about the latter best. As of July 2025, this handbook has been translated into 20 languages.

Cite: Lewandowsky, S., Cook, J., Ecker, U. K. H., Albarracín, D., Amazeen, M. A., Kendeou, P., Lombardi, D., Newman, E. J., Pennycook, G., Porter, E. Rand, D. G., Rapp, D. N., Reifler, J., Roozenbeek, J., Schmid, P., Seifert, C. M., Sinatra, G. M., Swire-Thompson, B., van der Linden, S., Vraga, E. K., Wood, T. J., Zaragoza, M. S. (2020). The Debunking Handbook 2020. Available at https://sks.to/db2020. DOI:10.17910/b7.1182

The Conspiracy Theory Handbook

Conspiracy theories attempt to explain events as the secretive plots of powerful people. While conspiracy theories are not typically supported by evidence, this doesn't stop them from blossoming. Conspiracy theories damage society in a number of ways. To help minimize these harmful effects, **The Conspiracy Theory Handbook** written by Stephan Lewandowsky and John Cook explains why conspiracy theories are so popular, how to identify the traits of conspiratorial thinking, and what effective response strategies are. As of July 2025, this handbook has been translated into 20 languages. The Handbook distills the most important research findings and expert advice on dealing with conspiracy theories. It also introduces the abbreviation CONSPIR which serves as a mnemonic to more easily remember the seven traits of conspiratorial thinking: They are contradictory, contain overriding suspicion, have nefarious intent, something must be wrong, peddlers of conspiracy theories see themselves as persecuted victims, they are immune to evidence and are re-interpreting randomness.

Cite: Lewandowsky, S., & Cook, J. (2020). The Conspiracy Theory Handbook. Available at https://sks.to/conspiracy

A3 Massive Open Online Course: Denial101x

In 2015, the Skeptical Science team in collaboration with the University of Queensland produced a Massive Open Online Course (MOOC) titled Denial101x: Making Sense of Climate Science Denial (Cook et al., 2017b; Winkler & Cook, 2021), which ran from April 2015 to February 2024. Included the fact-myth-fallacy resource (published at sks.to/fmf).

A4 Translations

In 2009, translation capabilities for rebuttals were added to the website and since then, 1086 translations have been published in 25 languages by volunteer translators. For some languages there are less than 5 translations while others have up to 213. Table A2 shows the top 15 languages by number of published translations.

Table A2. Number of Translations into each Language.

Language	Translations
German	213
Italian	136
Russian	108
Portuguese	99
Indonesian	60
Slovenian	60
Hebrew	58
Finnish	52
Polish	46
Czech	37
Spanish	35

Hungarian	27
Japanese	25
Dutch	23
Icelandic	17

A5 Conference presentations

Winkler, B., Cook, J. (2020). The story of Skeptical Science: How citizen science helped to turn a website into a go-to resource for climate science. EGU 2020.

Winkler, B. and Cook, J.: Using an interdisciplinary MOOC to teach climate science and science communication to a global classroom, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-8576, https://doi.org/10.5194/egusphere-egu21-8576, 2021. PDF

A6 Links to Skeptical Science Content and Resources

A6.1 Skeptical Science content

Website - https://skepticalsicence.com

Evolution from 2007 to 2017 - https://skepticalscience.com/SkepticalScience-10-Birthday.html

Activities 2017 - https://skepticalscience.com/2017-SkS-Review.html

Activities 2018 - https://skepticalscience.com/2018-SkS-Review.html

Activities 2019 - https://skepticalscience.com/2019-SkS-Review.html

Activities 2020 - https://skepticalscience.com/2020-SkS-Review.html

Activities 2021 - https://skepticalscience.com/2021-SkS-Review.html

Activities 2022 - https://skepticalscience.com/2022-SkS-Review.html

Activities 2023 - https://skepticalscience.com/2023-SkS-Review.html

Activities 2024 - https://skepticalscience.com/2024-SkS-Review.html

List of arguments - https://skepticalscience.com/argument.php

Taxonomy of arguments - https://skepticalscience.com/argument.php?f=taxonomy

With fixed numbers - https://skepticalscience.com/fixednum.php

Announcing the 3 rebuttal levels - https://skepticalscience.com/Plain-English-climate-science-now-live-at-Skeptical-Science.html

Rebuttal updates project - https://skepticalscience.com/rebuttal-update-project.html

Collaboration with the Sabin Center for Climate Change Law - https://skepticalscience.com/rebutting-33-false-claims-about-solar-wind-ev-introduction.html

FLICC-techniques of science denial - https://skepticalscience.com/history-FLICC-5-techniques-science-denial.html

A6.2 Myths and Rebuttals Referenced

It's not happening - https://skepticalscience.com/evidence-for-global-warming.htm

It's not us - https://skepticalscience.com/its-not-us.htm

It's not bad - https://skepticalscience.com/global-warming-positives-negatives.htm

It's too hard - https://skepticalscience.com/global-warming-too-hard.htm

CO2 was higher in the past - basic - https://skepticalscience.com/co2-higher-in-past-basic.htm

CO2 was higher in the past - intermediate - https://skepticalscience.com/co2-higher-in-past-intermediate.htm

Water vapor is the most powerful greenhouse gas - https://skepticalscience.com/water-vapor-greenhouse-gas.htm

It's albedo - https://skepticalscience.com/earth-albedo-effect.htm

CO2-effect is saturated - https://skepticalscience.com/saturated-co2-effect.htm

It's cooling - https://skepticalscience.com/global-cooling.htm

There is no consensus - https://skepticalscience.com/global-warming-scientific-consensus.htm

A7 Reading time/speed distributions

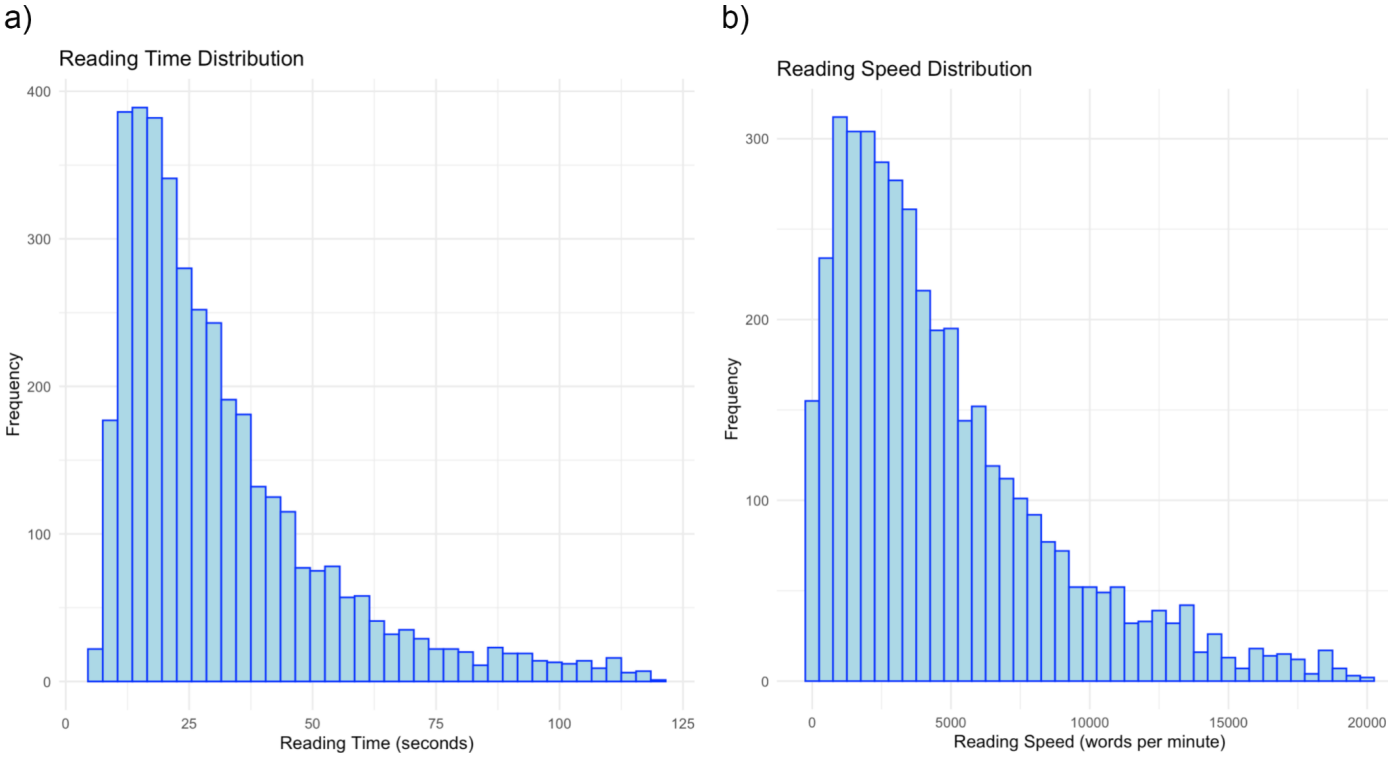

Figure A1. a) Reading time distribution (seconds). b) Reading speed distribution (words per minute).

Data Availability

Anonymised data has been uploaded to https://osf.io/jnce4/

Author Contributions

JC and BW contributed data analysis and writing of results. CM, TL, DB contributed descriptions of experimental implementation. DN contributed writing of manuscript.

Competing interests

The authors declare that they have no conflict of interest.

Ethical statement

This study was conducted with ethics approval obtained from the George Mason University Institutional Review Board (IRBNet number: 1379945-1).

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References

Bedford, D., & Cook, J. (2013). Agnotology, scientific consensus, and the teaching and learning of climate change: A response to Legates, Soon and Briggs. *Science & Education*, *22*(8), 2019-2030.

Bentley, A. P., Petcovic, H. L., Cassidy, D. P., & Eklund, P. R. (2016, December). The Relationship between Anthropogenic Climate Change Acceptance and Agreement with Authentic Dissenter Messages. In AGU Fall Meeting Abstracts (Vol. 2016, pp. ED33D-0909).

Cook, B. R., & Overpeck, J. T. (2019). Relationship-building between climate scientists and publics as an alternative to information transfer. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(2), e570.

Coan, T. G., Boussalis, C., Cook, J., & Nanko, M. O. (2021). Computer-assisted classification of contrarian claims about climate change. *Scientific Reports*, *11*(1), 22320.

Cook, J., Ellerton, P., & Kinkead, D. (2018). Deconstructing climate misinformation to identify reasoning errors. *Environmental Research Letters*, *11*(2).

Cook, J., Lewandowsky, S., & Ecker, U. (2017a). Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLOS ONE*, *12*(5): e0175799.

Cook, J., Nuccitelli, D., Green, S.A., Richardson, M., Winkler, B., Painting, R., Way, R., Jacobs, P., & Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*(2), 024024+.

Cook, J., Oreskes, N., Doran, P. T., Anderegg, W. R. L., Verheggen, B., Maibach, E. W., Carlton, J.S., Lewandowsky, S., Green, S. A., Skuce, A. G., Nuccitelli, D., Jacobs, P., Richardson, M., Winkler, B., Painting, R., Rice, K. (2016). Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters*, *11*(4), 048002.

Cook, J., Schuennemann, K., Nuccitelli, D., Jacobs, P., Cowtan, K., Green, S., Way, R., Richardson, M., Cawley, G., Mandia, S., Skuce, A. & Bedford, D. (2015). Denial101x: Making sense of climate science denial. *edX*. Retrieved from http://edx.org/understanding-climate-denial.

Cook, J., Winkler, B., Finn, C., & Dodgen, T. (2017b, January). Challenges and learning opportunities in a controversial MOOC forum on climate science denial. In *10th International Conference of Education, Research and Innovation (Iceri2017)* (pp. 3460-3468). IATED Academy.

Ecker, U. K., Lewandowsky, S., & Tang, D. T. (2010). Explicit warnings reduce but do not eliminate the continued influence of misinformation. *Memory & Cognition*, *38*(8), 1087-1100.

Eisenson, M., Elkin, J., Fitch, A., Ard, M., Sittinger, K., Lavine, S. (2023). Rebutting 33 false claims about solar, wind, and electric vehicles. *Sabin Center for Climate Change Law*. https://climate.law.columbia.edu/news/sabin-center-releases-new-report-rebutting-33-false-claims-about-solar-wind-and-electric .

Elsasser, S. W., & Dunlap, R. E. (2013). Leading voices in the denier choir: Conservative columnists' dismissal of global warming and denigration of climate science. *American Behavioral Scientist*, *57*(6), 754-776.

Flack, R., Cook, J., Ellerton, P., Kinkead, D., Coan, T., Boussalis, C., Nanko, M. O., Gallant, A., Dargaville, R. (2024). Identifying Flawed Reasoning in Contrarian Claims about Climate Change. *Online at https://osf.io/preprints/psyarxiv/tk76c*

Geiger, N., & Swim, J. K. (2016). Climate of silence: Pluralistic ignorance as a barrier to climate change discussion. *Journal of Environmental Psychology*, *47*, 79-90.

Goldberg, M. H., van der Linden, S., Maibach, E., & Leiserowitz, A. (2019). Discussing global warming leads to greater acceptance of climate science. Proceedings of the National Academy of Sciences, 116(30), 14804-14805.

Hansson, S. O. (2017). Science denial as a form of pseudoscience. *Studies in History and Philosophy of Science Part A*, *63*, 39-47.

Jolley, D., & Douglas, K. M. (2014). The social consequences of conspiracism: Exposure to conspiracy theories decreases intentions to engage in politics and to reduce one's carbon footprint. *British Journal of Psychology*, *105*(1), 35-56.

Lamb, W. F., Mattioli, G., Levi, S., Roberts, J. T., Capstick, S., Creutzig, F., Minx, J. C., Müller-Hansen,. F., Culhane, T., & Steinberger, J. K. (2020). Discourses of climate delay. *Global Sustainability*, 3, e17.

Leiserowitz, A., Smith, N., & Marlon, J. R. (2011). American teens' knowledge of climate change. Yale University. New Haven, CT: Yale Project on Climate Change Communication, 5.

Lewandowsky, S., Cook, J., Ecker, U. K. H., Albarracín, D., Amazeen, M. A., Kendeou, P., Lombardi, D., Newman, E. J., Pennycook, G., Porter, E. Rand, D. G., Rapp, D. N., Reifler, J., Roozenbeek, J., Schmid, P., Seifert, C. M., Sinatra, G. M., Swire-Thompson, B., van der Linden, S., Vraga, E. K., Wood, T. J., Zaragoza, M. S. (2020). *The Debunking Handbook 2020*. https://doi.org/10.17910/b7.1182

Lewandowsky, S., Oreskes, N., Risbey, J. S., Newell, B. R., & Smithson, M. (2015). Seepage: Climate change denial and its effect on the scientific community. *Global Environmental Change*, *33*, 1-13.

Lieu, R., Hayes, O. R., Cook, J. (in press). Testing the impact of fallacies and contrarian claims in climate change misinformation. *British Journal of Psychology*.

Ling, M., Head, A., & Clarke, E. J. R. (2019). Validation of a Novel Climate Change Denial Measure Using Item Response Theory. https://doi.org/10.31234/osf.io/57nbk

Maibach, E, Leiserowitz, A, Rosenthal, S, Roser-Renouf, C & Cutler, M 2016, *Is There a Climate "Spiral of Silence" in America: March, 2016*, Yale Program on Climate Change Communication, New Haven, CT.

Maertens, R., Roozenbeek, J., Simons, J. S., Lewandowsky, S., Maturo, V., Goldberg, B., ... & van der Linden, S. (2025). Psychological booster shots targeting memory increase long-term resistance against misinformation. *Nature Communications*, *16*(1), 2062.

McCright, A. M., Charters, M., Dentzman, K., & Dietz, T. (2016). Examining the effectiveness of climate change frames in the face of a climate change denial counter-frame. *Topics in cognitive science*, *8*(1), 76-97.

McCuin, J. L., Hayhoe, K., & Hayhoe, D. (2014). Comparing the Effects of Traditional vs. Misconceptions-Based Instruction on Student Understanding of the Greenhouse Effect. *Journal of Geoscience Education*, *62*(3), 445-459.

Metcalfe, J. (2020). Chanting to the choir: the dialogical failure of antithetical climate change blogs. *Journal of Science Communication*, *19*(2), A04.

Modirrousta-Galian, A., & Higham, P. A. (2023). Gamified inoculation interventions do not improve discrimination between true and fake news: Reanalyzing existing research with receiver operating characteristic analysis. *Journal of Experimental Psychology: General*, *152*(9), 2411.

Pearce, W., Brown, B., Nerlich, B., & Koteyko, N. (2015). Communicating climate change: Conduits, content, and consensus. *Wiley Interdisciplinary Reviews: Climate Change*, *6*(6), 613-626.

Pennycook, G., Cannon, T. D., & Rand, D. G. (2018). Prior exposure increases perceived accuracy of fake news. *Journal of Experimental Psychology: General*, *147*(12), 1865.

Ranney, M.A. & Clark, D. (2016). Climate Change Conceptual Change: Scientific Information Can Transform Attitudes. *Topics in Cognitive Science*, *8*(1), 49-75.

Rowan, K. E., Engblom, A., Hathaway, J., Lloyd, R., Vorster, I., Anderson, E. Z., & Akerlof, K. L. (2021). Overcome the deficit model by applying the CAUSE model to climate change communication. *The Handbook of Strategic Communication*, 225-261.

Schwarz, N., Newman, E., & Leach, W. (2016). Making the truth stick & the myths fade: Lessons from cognitive psychology. *Behavioral Science & Policy*, *2*(1), 85-95.

Seifert, C. M. (2002). The continued influence of misinformation in memory: What makes a correction effective? In *Psychology of learning and motivation* (Vol. 41, pp. 265-292). Academic Press.

Simchon, A., Zipori, T., Teitelbaum, L., Lewandowsky, S., & van der Linden, S. (2025). A Signal Detection Theory Meta-Analysis of Psychological Inoculation Against Misinformation. *Current Opinion in Psychology*, 102194.

Suldovsky, B. (2017). The information deficit model and climate change communication. In *Oxford Research Encyclopedia of Climate Science*. Oxford University Press.

Swim, J. K., Fraser, J., & Geiger, N. (2014). Teaching the choir to sing: Use of social science information to promote public discourse on climate change. *Journal of Land Use & Environmental Law*, 91-117.

van der Linden, S. (2015). The conspiracy-effect: Exposure to conspiracy theories (about global warming) decreases pro-social behavior and science acceptance. *Personality and Individual Differences*, *87*, 171-173.

van der Linden, S., Leiserowitz, A., Rosenthal, S., & Maibach, E. (2017). Inoculating the Public against Misinformation about Climate Change. *Global Challenges*, *1*(2), 1600008.

Vraga, E. K., Kim, S. C., Cook, J., & Bode, L. (2020). Testing the effectiveness of correction placement and type on Instagram. *The International Journal of Press/Politics*, *25*(4), 632-652.

Winkler, B. and Cook, J. (2021). Using an interdisciplinary MOOC to teach climate science and science communication to a global classroom, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-8576, https://doi.org/10.5194/egusphere-egu21-8576. PDF

Zainurrahman, Z., Yusuf, F. N., & Sukyadi, D. (2024). Text readability: its impact on reading comprehension and reading time. *Journal of Education and Learning (EduLearn)*, *18*(4), 1422-1432.

Zanartu, F., Cook, J., Frermann, L., Otmakhova, Y. (2024). Generative Debunking of Climate Misinformation. *ClimateNLP 2024 Workshop*. https://arxiv.org/abs/2407.05599