

Research Article

Motivated Reasoning Leads Climate Change Deniers to Access Unreliable Online Sources of Information: Automated Text Analyses of Multiple Reddit Communities

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Motivated reasoning suggests that climate change deniers are more likely to access and comment on unreliable online sources of information that support their existing views and political ideologies, whereas climate change believers are more likely to access more objective sources of information not necessarily related to their political viewpoints. To test this hypothesis, an R program in RStudio scraped over 68,000 user-generated comments from multiple Reddit communities (i.e., subreddits) with opposing perspectives on climate change. Leximancer identified the internet domains associated with the URL links in user comments. Consistent with a motivated reasoning explanation, comments from climate change denial subreddits tended to include URL links to content from blogs and social media pages advocating similar ideological positions, whereas comments associated with subreddits based on belief in climate change tended to include URL links to content from news media and academic journals.

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Short Abstract

Consistent with a motivated reasoning explanation, climate change deniers tend to post and comment on content from unreliable online sources like social media sites and blogs advocating similar ideological positions, whereas believers in climate change are more likely to post and comment on content from news media and academic journals.

Keywords: Climate change denial, motivated reasoning, biased information sources, online behavior, Reddit, automated text analysis, internet domains.

Climate change denial persists in the face of an ever-growing body of evidence supporting anthropogenic climate change (Wong-Parodi & Feygina, 2020). The research reported below applies *motivated reasoning* to understand the persistence and resistance of climate change skepticism (Carpenter, 2019; Kunda, 1990). Motivated reasoning suggests two online behaviors more likely to be adopted by climate change deniers compared to believers: (a) seeking out and interacting with like-minded people, and (b) relying on questionable sources of evidence. Prior research examining communication networks on social media suggests that this kind of bias occurs online (Bloomfield & Tillery, 2018)

The research reported below examines the motivated reasoning of climate change deniers on Reddit. Reddit is particularly relevant to this research question because, unlike social media platforms that fulfill a variety of communication and entertainment motives (Luchman, Bergstrom, & Krulikowski, 2014), Reddit is an online news community specifically intended for discussing newsworthy topics in user groups called subreddits. Submitted posts and comments tend to include URL links to original information sources. Hence, not only is it possible to examine the beliefs and opinions expressed in user comments, but also the types of information sources accessed by members of different subreddit groups with opposing views on climate change.

An R program written in RStudio was used to scrape over 68,000 user-generated comments from multiple Reddit communities with opposing perspectives on climate change. Leximancer identified the internet domains associated with the URL links in user comments. Consistent with a motivated reasoning interpretation, climate change deniers tended to comment on content from blogs with similar ideological positions and social media posts on Twitter and YouTube, whereas believers in climate change were more likely to comment on articles from scientific journals and news media.

Motivated Reasoning, Climate Change and Online Behavior

Motivated reasoning offers a theoretical basis for understanding how members of online forums behave when beliefs and attitudes associated with self-identity are threatened by mounting evidence. Motivated reasoning identifies two basic motives for accessing online content: (a) wanting to be rational and hold accurate positions about the world and (b) wanting to maintain beliefs and attitudes related to self-identity (Kunda 1990). Importantly, if one holds an identity-related viewpoint at odds with a growing body of publicly available evidence, these two motives come into conflict; the desire to maintain beliefs central to self-identity requires the rejection of evidence, which compromises the rationality and accuracy of one's position (Carpenter, 2019).

Identity-preservation in the face of mounting evidence tends to be associated with multiple types of bias. For example, people who want to maintain identity-relevant viewpoints tend to avoid belief-discrepant information and derogate the sources of counter-attitudinal information (Johnson & Eagly, 1989). However, while these behaviors facilitate the preservation of self-identity, they involve ignoring information, which may conflict with the desire to hold accurate positions. On the other hand, actively seeking out online information sources that overtly support an identity-relevant viewpoint allows people to discuss information with like-minded people, which fulfills their need to hold accurate positions but also allows them to maintain their self-identity (Kunda, 1990). Previous research suggests that search engines and social media algorithms tend to facilitate this kind of intellectual insularity when users seek identity-relevant information online (Allison & Bussey, 2020).

In the context of climate change, the need to preserve self-identity is likely to be more pronounced for deniers given mounting scientific evidence supporting anthropogenic climate change. Climate change denial tends to be linked to other beliefs that shape overall political ideology and self-identity (Jylhä & Hellmer, 2020), triggering motivated reasoning (Druckman & McGrath, 2019). Motivated reasoning suggests that online activity related to searching for and discussing climate change information will depend on a person's views regarding anthropogenic climate change. Climate change deniers should be more likely to access and discuss low credibility sources like blogs and social media, especially when these websites can be identified as supporting ideological positions similar to their own. By contrast, climate change believers do not experience as much of a conflict between their desire to hold accurate views and their desire to maintain identity-affirming beliefs, so they should be

more likely to access credible, unbiased sources like news media and academic journals. The predictions derived from motivated reasoning are summarized in the following research hypotheses:

- **H₁**: Compared to climate change believers, climate change deniers comment on information sourced from blogs advocating political ideologies similar to their own more frequently.
- **H₂**: Compared to climate change believers, climate change deniers comment on information sourced from social media pages advocating political ideologies similar to their own more frequently.
- **H₃**: Compared to climate change deniers, climate change believers comment on information sourced from news media more frequently.
- **H₄**: Compared to climate change deniers, climate change believers comment on information sourced from academic journals more frequently.

Method

Numerous social media pages and online forums were considered as possible data sources for testing Hypotheses 1 – 4, with the purpose being to find multiple online communities, some that attract climate change deniers and others that target believers. Three subreddit communities – *Climate Change*, *Climate Action Plan* and *Climate Skeptics* – seemed particularly well-suited for this purpose. At the time of the data extraction, the *Climate Change* subreddit had more than 31,000 members and was described as “a place for the rational discussion of the science of climate change”. The *Climate Action Plan* subreddit had more than 68,000 members and was described as “showing action being taken against climate change”. *Climate Skeptics* had over 30,000 members and was described as “questioning climate related environmentalism”. An R program was used in conjunction with RStudio software to extract user comments from the period May 2nd – August 16th, 2020. During this period, 68,061 comments were posted on the *Climate Change* (21,572), *Climate Action Plan* (6,303), and *Climate Skeptics* (40,186) subreddits.

Given Hypotheses 1 – 4, the essential step was to examine associations between the three subreddits and the types of information sources linked to user posts. Leximancer identified the internet domains associated with the URL links in user posts and comments and provided a rank order list of domains in terms of the frequency with each domain appeared. The number of online domains was large, but there was a substantial drop in frequency of associated comments between the 17th and

18th domain, with the latter falling below 500 comments. Given that over 68,000 comments were included in the database, only the top 17 domains were included in the analyses below. The top 17 internet domains are presented in Table 1 below, which includes the domain name, the number of associated comments, a brief description, and whether the domain pertains to a subreddit, a blog, social media, news media, or an academic journal.

The distinction between the news media and blog categories was based on (a) whether the website had a verifiable affiliation with a company that produces and/or distributes news content via some other channel besides the website, and whether the website presented a political ideology as a guiding theme for the information content. News media domains were associated with multiple channels for distributing news besides the website (i.e., branded broadcast and print media), but had no stated political ideology, whereas blogs had clearly stated political ideologies on their landing page and were the only medium for distributing content (i.e., no associated broadcast or print media).

Domain Name	Number of Comments	Domain Description	Classification
self.climateskeptics	13211	ClimateSkeptics subreddit	subreddit
self.climatechange	11234	ClimateChange subreddit	subreddit
i.redd.it	6171	Other subreddits	subreddit
electroverse.net	2036	Electroverse is a news and opinion website that “has been set up to wade against the mainstream propaganda and accurately document earth changes.”	Blog
wattsupwiththat.com	1877	Watts Up With That? Is a blog promoting beliefs that are in opposition to the scientific consensus on climate change.	Blog
self.climateactionplan	1553	ClimateActionPlan subreddit	subreddit
youtube.com youtu.be	1293	YouTube is an American online video-sharing platform.	Social media
notrickszone.com	1223	NoTricksZone is a blog that is skeptical of human-influenced climate change.	Blog
nature.com	985	Nature is a weekly international journal publishing peer-reviewed research in all fields of science and technology.	Academic journal
forbes.com	774	Forbes is an American business magazine featuring original articles on finance, industry, investing, and marketing topics.	News media
twitter.com	726	Twitter is an American microblogging and social networking service on which users post and interact with messages known as “tweets”.	Social media
thedailyfodder.com	693	The Daily Fodder promotes several ideological positions, and generally publishes articles questioning anthropogenic climate change.	Blog
reuters.com	667	Reuters is an international news organisation.	News media

Domain Name	Number of Comments	Domain Description	Classification
bbc.co.uk	604	BBC Online is the BBC's online service.	News media
thegwpf.com	561	The Global Warming Policy Foundation stated aims are to challenge "extremely damaging and harmful policies" envisaged by governments to mitigate anthropogenic global warming.	Blog
theguardian.com	539	TheGuardian.com is a British news and media website owned by the Guardian Media Group.	News media
climateréalism.com	533	The Heartland Institute is an American conservative and libertarian public policy think tank and a leading promoter of climate change denial.	Blog

Table 1. Top 17 internet domains based on frequency

Results

Leximancer performed a lexicon-based analysis, identifying the 100 most frequently used common nouns, proper nouns, verbs, adjectives, adverbs and numerals in user comments in an inductive, bottom-up analysis (Humphreys & Wang, 2018). After word variants (e.g., different spellings, capitalizations, fonts, verb tenses, and singular-plural versions of the same words), and highly co-occurring words were merged (see Areni, Momeni & Reynolds, 2022), Leximancer created the graphic representation of the underlying co-occurrence matrix in Figure 1. Figure 1 depicts three types of variables: words that frequently co-occur in user comments, the type of internet domain associated with the URL links in user comments, and the three subreddit communities from which the comments were scraped. Terms in proximity to one another tend to occur together in user comments; the shorter the distance the higher the co-occurrence. The direct visual connection between two words reflects the highest co-occurrence frequency for the outer term. So, in the lower right of Figure 1 the direct connection between *record* and *data* indicates that if a comment contained the word *record*, the word *news* had the highest co-occurrence frequency among the other terms in the figure (Leximancer, 2021).

Most relevant to Hypotheses 1 – 4 are direct connections and proximity of the subreddit communities and the internet domain types, which indicate what types of information sources were represented in the URL links in posts and comments scraped from each subreddit. The bottom of Figure 1 depicts direct connections between internet domains associated with blogs and social media sites and the Climate Skeptics subreddit. Consistent with Hypothesis 1, if a comment contained a URL link associated with a blog, then the subreddit community from which it was scraped tended to be Climate Skeptics. Likewise, if a comment contained a URL link associated with a social media site, then the subreddit community from which it was scraped tended to be Climate Skeptics, which is consistent with Hypothesis 2. At the top of Figure 1, there is a direct connection between comments associated with URL links to news media sources and the Climate Action Plan subreddit, as posited by Hypothesis 3; and comments associated with URL links to academic journals are connected with the Climate Change subreddit, which is consistent with Hypothesis 4.

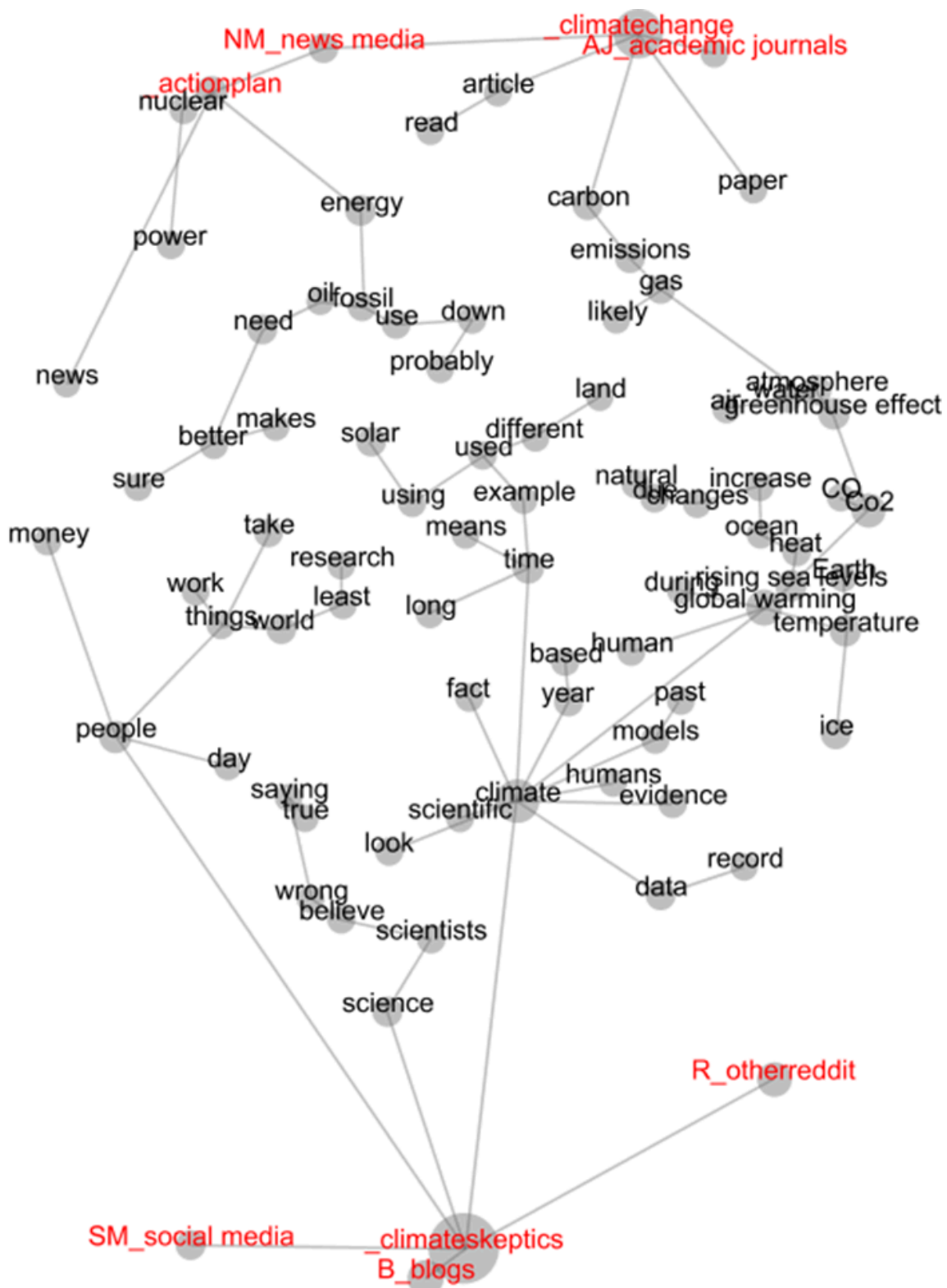


Figure 1. Associations between co-occurring words, subreddit communities, and domain types

As shown in Table 2 below, difference in proportion tests based on the underlying co-occurrence matrix confirmed the interpretation of Figure 1. Regarding Hypothesis 1, the proportion of comments related to content from blogs was higher for the Climate Skeptics subreddit (45.37%) than for the Climate Change subreddit (4.59%) ($z = 44.48, p < .00001$), which was a higher proportion than for the Climate Action Plan subreddit (.00%) ($z = 7.21, p < .00001$). Consistent with Hypothesis 1, climate change deniers accessed and discussed content from blogs with stated political ideologies similar to their own more frequently than did subreddit communities who believe in climate change. With respect to Hypothesis 2, the proportion of comments related to content from social media sites was higher for the Climate Skeptics subreddit (17.52%) than for the Climate Change subreddit (0%) ($z = 26.52, p < .00001$); but there was little or no difference between the Climate Skeptics and Climate Action Plan (15.46%) subreddits ($z = 1.74, p > .05$). However, when Climate Change and Climate Action Plan were combined to reflect belief in climate change, Climate Skeptics had a higher proportion of comments featuring links to social media sites than the two subreddits that believe in climate change (3.73%) ($z = 23.23, p < .00001$), which is consistent with Hypothesis 2.

Regarding Hypothesis 3, the proportion of comments related to news media content was higher for the Climate Action Plan subreddit (58.74%) than for the Climate Change subreddit (26.18%) ($z = 19.79, p < .00001$), which was a higher proportion than for the Climate Skeptics subreddit (6.98%) ($z = 33.01, p < .00001$). Consistent with Hypothesis 3, climate change believers accessed and discussed content from news media sources more frequently than did climate change deniers. Finally, with respect to Hypothesis 4, the proportion of comments related to content from academic journals was higher for the Climate Change subreddit (25.55%) than for the Climate Skeptics subreddit (.72%) ($z = 58.18, p < .00001$). However, the proportion of comments related to academic journal articles was higher for Climate Skeptics than for Climate Action Plan (.00%) ($z = 2.81, p < .005$); but when Climate Change and Climate Action Plan were combined the total proportion of comments related to academic journals was higher (19.36%) than that for Climate Skeptics ($z = 51.26, p < .00001$), supporting Hypothesis 4. Climate change believers tended to access and discuss information obtained from academic journals more frequently than climate change deniers.

Climate Change Ideology	Subreddit	Academic Journals ⁴	Blogs ¹	News Media ³	Reddit	Social Media ²	Total
Believers	Action Plan	0 (.00%)*	0 (.00%)	642 (58.74%)	282 (25.80%)	169 (15.46%)	1093
	Climate Change	878 (25.55%)	158 (4.59%)	901 (26.18%)	1504 (43.71%)	0 (.00%)	3441
Deniers	Climate Skeptics	107 (.72%)	6765 (45.37%)	1041 (6.98%)	4385 (29.41%)	2613 (17.52%)	14911
Total	985	6923	2584	6171	2782	19445	

Table 2. Frequencies of various online sources by climate subreddit

* Percentages are row percentages relevant for testing Hypotheses 1 – 4.

¹ CC > AP ($z = 7.21, p < .00001$); CS > CC ($z = -44.48, p < .00001$). Hypothesis 1 is supported.

² AP > CC ($z = -23.5085, p < .00001$); CC = CS ($z = 1.74, p > .05$); CS > CC+AP ($z = 23.24, p < .00001$). Hypothesis 2 partially supported.

³ CC > CS ($z = -33.01, p < .00001$); AP > CC ($z = 19.79, p < .00001$). Hypothesis 3 supported.

⁴ CC > CS ($z = -58.18, p < .00001$); CS > AP ($z = -2.81, p < .05$); CC+AP > CS ($z = -51.26, p < .00001$). Hypothesis 4 partially supported.

Discussion

Consistent with a motivated reasoning explanation, the results reported above indicate that, compared to subreddit users who believe in anthropogenic climate change, climate change deniers are more likely to access and discuss information obtained from unreliable sources with the stated purpose of expressing views similar to their own (i.e., blogs and social media). Climate change believers are more likely to access and discuss more credible sources of information obtained from academic journals and news media. Social media and other online forums allow climate deniers to

search for and interact with others who hold similar view, accessing unreliable content to support their positions, thus creating a kind of insulation from opposing views backed by stronger evidence.

Comparing the posts and comments in multiple subreddits as opposed to social media sites like Facebook and Twitter is particularly relevant to this issue since Reddit encourages online discussions based on comments containing URL links to original sources of news content. Leximancer analyzed these links and identified associated internet domains, which could be examined and classified as blogs, social media sites, news media, or academic journals. This made it possible to associate different subreddits with opposing views on climate change with the types of sources cited in user comments. Another strength of the method is its ecological validity – its reliance on ‘real-world’ data that emerges independently of researchers’ objectives, theories, and hypotheses. Unlike research findings based on experiments, surveys, and other methods where specifically recruited participants know they are part of a study, the data trails left by online behavior reflect the activities of people in naturalistic settings (Sterling, Jost & Bonneau, 2020).

However, one of the limitations of the method is the inability to directly examine users’ motives for joining a subreddit and leaving comments. An implicit assumption of this research is that users who leave comments on a given subreddit have an identity-related interest in the topic. They have joined the online community and interacted with others because the stated purpose of the subreddit is related to self-identity. Yet this cannot be directly verified by scraping comments and examining their content.

In terms of implications of the key findings, given the ‘intellectual cocoon’ often created by online communities, the motivated reasoning of climate deniers seems likely to continue in the face of an ever-expanding body of research verifying anthropogenic climate change. Climate deniers can avoid and resist new scientific findings confirming human-generated global warming, and online communities offer a convenient ‘hiding place’ for those wishing to maintain beliefs that run increasingly counter to available evidence. Hence, it is not clear that simply increasing the amount of online scientific evidence supporting climate change will penetrate these cocoons and change the views of deniers. According to motivated reasoning, the ever-growing amount of scientific evidence supporting anthropogenic climate change will simply increase self-identity threat, leading deniers to avoid this online content (Johnson & Eagly, 1989; Kunda, 1990).

Instead of *increasing* self-identity threat by continuing to present the latest scientific discoveries, another approach to changing the views of deniers would be to *reduce* the self-identity threat posed by

adhering to inaccurate beliefs (Kunda, 1990). One tactic would be to create content that agrees with certain views of climate deniers (e.g., advocating nuclear power as an alternative source of energy), but nevertheless emphasizes the climate change threat. Another approach would involve creating video content wherein a celebrity who resonates with deniers is shown engaging in environmentally-friendly behaviors as part of their everyday life (e.g., recycling plastic containers, putting food scraps in a compost bin). A variation of this tactic would involve the creation of content by people who climate skeptics identify with (i.e., politically conservative, older, less educated, lower income, white and male) who nonetheless discuss the climate change threat. Still another tactic would entail assembling a forum of multiple authors with very different political ideologies and personal values, who nevertheless, agree on the existence of anthropogenic climate change (Carpenter, 2019; Kunda, 1990).

Of course, for any of these approaches to be effective in an online setting, climate deniers must access and read these kinds of communications. Fortunately, research suggests that the terminology used in news stories, social media posts, and other online sources can be tailored for this very purpose. For example, something as subtle as labelling something a “tax” rather than an “offset” has been shown to influence audience reactions based on political ideology (Hardisty, Johnson, and Weber, 2010). So, the search terms that climate change deniers are likely to use to access online content can be incorporated into content designed to change their views as a way of penetrating their ‘intellectual cocoons’.

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