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Cognitive and Emotional Impact of Politically-polarized Internet Memes About Climate Change

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Abstract

Public opinion polls have shown that beliefs about climate change have become increasingly polarized in the United States. A popular contemporary form of communication relevant to beliefs about climate change involves digital artifacts known as *memes*. The present study investigated whether memes can influence the assessment of scientific data about climate change, and whether their impact differs between political liberals and conservatives in the United States. In Study 1, we considered three hypotheses about the potential impact of memes on strongly-held politicized beliefs: 1) memes fundamentally serve social functions, and do not actually impact cognitive assessments of objective information; 2) politically incongruent memes will have a "backfire" effect; and 3) memes can indeed change assessments of scientific data about climate change, even for people with strong entering beliefs. We found evidence in support of the hypothesis that memes have the potential to change assessments of scientific information about climate change. Study 2 explored whether different partisan pages that post climate change memes elicit different emotions from their audiences, as well as how climate change is discussed in different ways by those at opposite ends of the political spectrum.

Keywords: climate change, memes, metaphor, politics, beliefs, topic models

Introduction

Public opinion polls have shown that beliefs about climate change have become increasingly polarized in the United States. Websites discrediting the relevant science convey misinformation to an audience predisposed to believe the attacks and electronically spread them further (Hamilton, 2011), resulting in an ongoing struggle between climate scientists and various forms of popular media (Ladle, Jepson, & Whittaker, 2005).

Beyond blogs and opinion columns, one form of communication relevant to beliefs about climate change involves the digital artifacts known as *memes* that now pervade the internet (Davidson, 2012). Memes can communicate social and political beliefs (Hakoköngäs, Halmesvaara, & Sakki, 2020), thereby playing a role in formation of collective identity and in promoting cultural cohesion (Gal, Shifman, & Kampf, 2016; Leach & Allen, 2017), and influencing political movements (Milner, 2013; Ross & Rivers, 2017). Huntington (2020) demonstrated that motivated reasoning impacts the appraisal of political memes, such that greater agreement with the message is associated with less scrutiny and greater perceived message effectiveness. Wong and Holyoak (2021) found that the political congruity of a meme impacts people's judgments of the meme's aptness, ultimately affecting their willingness to share it with their social network.

Though there is general agreement that memes serve social functions, it is unclear whether they can influence beliefs for those who have strong preexisting positions, as is likely to be the case for climate change. . The possibility of such influence is consistent with the view that memes constitute a form of visual metaphor (Milner, 2016; Piata, 2016; Shifman, 2013). Verbal metaphors have been shown to be effective in promoting conceptual change and development, perhaps because they elicit emotional responses (Pollio, Smith, & Pollio, 1990). Lakoff and his colleagues (1995, 1996, 2002; Lakoff & Johnson, 1980) have argued that metaphor is a useful tool that people use to understand abstract topics, including political issues, by relating them to more concrete and familiar experiences.

Empirical research has provided some support for the persuasive power of metaphors. For example, framing a hypothetical crime scenario in terms of either a virus or beast metaphor differentially impacts people's proposed solutions to the crime problem (Thibodeau & Boroditsky, 2011, 2013). Verbal metaphors have also been shown to impact people's

beliefs about climate change (Flushberg, Matlock, & Thibodeau, 2017; Thibodeau, Frantz, & Berretta, 2017). Recent work has shown that memes, which perhaps act as visual metaphors, are effective in changing beliefs about the morality of eating meat (Horne, Rottman, & Lawrence, 2021).

In this paper, we explore two approaches to investigating how memes achieve their functions. Study 1 investigated whether memes can influence the assessment of scientific data about climate change, and whether their impact differs between political liberals in the United States (who generally believe in anthropogenic climate change) and political conservatives (who are generally very skeptical that the phenomenon exists). We considered three plausible hypotheses about the potential impact of memes on strongly-held politicized beliefs. One hypothesis is that memes fundamentally serve social functions such as enhancing group identity, and do not actually impact cognitive assessments of objective information. A second is that incongruent memes (e.g., a liberal meme viewed by a political conservative) will have a "backfire" effect, reinforcing (rather than countering) the person's preexisting beliefs and attitudes (Nyhan & Reifler, 2010). There is some evidence that efforts to correct misconceptions about climate change can result in backfiring (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Sanna, Schwarz, & Stocker, 2002). The third hypothesis is that memes can indeed change assessments of scientific data about climate change, even for people with strong entering beliefs. This possibility is consistent with findings regarding the persuasive power of metaphors (Thibodeau & Boroditsky, 2011, 2013) and memes (Horne et al., 2021) for other politically-charged issues.

Study 2 focused specifically on the emotional component of memes that circulate on the internet. Memes surveyed in the second study were not necessarily metaphorical, but served to elicit different emotions as measured by Facebook reactions. It has been suggested that attitudes based in emotions are more stable over time (Rocklage & Luttrell, 2021), which seems particularly relevant to climate change beliefs. Attitudes based on emotions may be more stable because emotions make attitudes more accessible (Rocklage & Fazio, 2018). Study 2 investigated the naturalistic functions of memes, by taking advantage of the large amounts of data on climate change memes, and modeling the different emotional reactions elicited by memes posted to political liberal and conservative Facebook pages, as well as how climate change is discussed across divergent political positions.

Study 1

Method

Study 1 was preregistered on the Open Science Framework on September 8, 2020 https://osf.io/w8qau/). The design was a 2 (political orientation: conservative, liberal) x 3 (meme: conservative, liberal, and neutral) between-subjects design.[1]

Participants Participants were 493 Amazon Mechanical Turk (MTurk) workers located in the United States (55% male) who were between 19 and 74 years of age (M = 36.14, SD = 11.11). American conservatives (N = 229) and liberals (N = 264) were recruited using the MTurk filters for political orientation. Political orientation was determined by self-report in our survey; if a self-report was not provided, MTurk's classification was used instead. Libertarians and independents were not recruited for the study. The sample size was determined by an *a priori* power analysis. To detect an effect size of 0.2 between the two experimental conditions of interest (politically congruent vs. incongruent memes) for conservatives and liberals separately, at 80% power, and with a 5% false alarm rate, we required a minimum of 63 participants of each political orientation in each of the three conditions (with the third condition being the neutral-meme control).

A total of 240 liberals and 280 conservatives were recruited from MTurk; more conservatives were recruited because the MTurk filter tends to be less accurate for that political grouping. A total of 547 responses were recorded on Qualtrics, 10 of which were bots, and 44 of which were missing data for the main dependent measure. The 10 bots and 44 missing responses were excluded, leaving 493 usable responses. Participants received a $3 compensation for participation in the study, which took about 20 minutes to complete. The study was approved by the Institutional Review Board for the University of California, Los Angeles.

Materials and Procedure Five conservative-leaning memes were collected from the Imgflip page

[1] The executed study did not include an additional variable (presence versus absence of climate-related data) that had been part of the preregistered design. Only conditions that included presentation of data were actually run. Two information-evaluation questions were added in the executed study. All else remained the same as in the preregistered description.

@politics (on August 18, 2020), five liberal-leaning memes were collected from the Instagram page @climemechange (on August 19, 2020), and five neutral memes were collected from the Instagram page @memes (on August 19, 2020).[2] Memes were chosen based on popularity (number of likes for Instagram, and number of views for Imgflip). We selected memes that had an image with corresponding text; the top five most recent memes that met these criteria were selected. Figure 1 depicts an example meme from each of the three sets.

Each participant was randomly assigned to view one of the three sets of five memes (either the conservative, liberal, or neutral set), and provided Likert-scale ratings for each meme in response to eight questions used previously by Wong and Holyoak (2021, Study 2). These questions assessed perceived humor, familiarity with the meme, relatability of the meme, aptness, comprehension, surprisingness of the captions, agreement with the message, and willingness to share. Exact questions are registered on OSF https://osf.io/jpwhx/)

Figure 1: Examples of conservative (left), liberal (middle), and neutral (right) memes used in Study 1.

After viewing and rating the set of memes, participants were presented with an excerpt from NASA's climate change website. This excerpt described the impact of excess levels of carbon dioxide on Earth's climate, accompanied by a graph of the increasing levels of carbon dioxide from 800,000 years ago to 1950 (materials pre-registered on OSF: (https://osf.io/w8qau/). Participants were then asked four questions with respect to the presented climate-change materials. To avoid potential demand characteristics, ratings were only obtained after the intervention. The questions were:

(1) In order to gauge a participant's judgment of how **objective** the information was, they were asked, "How objective is the information above?" Response options ranged from 1 (Not at all objective) to 4 (Entirely objective).

(2) In order to gauge a participant's **trust in the information**, they were asked, "How much do you trust the information above?" Response options ranged from 1 (Do not trust at all) to 4 (Entirely trust).

(3) In order to gauge a participant's **belief** in the information, they were asked, "How much do you believe the information above?" Response options ranged from 1 (Do not believe at all) to 4 (Entirely believe).

(4) In order to gauge a participant's **trust in the source** of the information above (i.e., NASA), they were asked, "How much do you trust the source (NASA) of the information above?" Response options ranged from 1 (Do not trust at all) to 4 (Entirely trust).

Finally, participants were asked to complete the 12-item Social and Economics Conservatism Scale (SECS) (Everett, 2013). Participants were also asked to provide their self-described political orientation, with the following response options: Extremely Conservative, Moderately Conservative, Moderately Liberal, and Extremely Liberal.

Results

Political conservatives scored higher (M = 65.96) on the SECS than political liberals (M = 49.88), $t(490)$ = 10.28, d = 0.93, p < .001. Table 1 provides the correlations among ratings for the four questions.

Because the results were qualitatively the same for each of the four information-evaluation items, the primary dependent measure was the average of the ratings from the four information-evaluation questions. Figure 2 depicts participants' average information-evaluation scores across political orientations and meme conditions. A two-way ANOVA revealed an overall main effect of political orientation, $F(1, 487)$ = 96.86, η_P^2 = 0.17, p < .001, with mean ratings lower for conservative than for liberal participants (2.94 vs. 3.46). The differences among meme conditions were also reliable, $F(2, 487)$ = 5.15, η_P^2 = 0.02, p = .006, and the two variables did not interact, $F(2, 547)$ = 0.57, η_P^2 = 0.002, p = .57. Planned contrasts showed that for conservatives, viewing a set of conservative memes led to lower overall ratings on the information-evaluation questions than did viewing a set of liberal memes, b = -0.319, $t(487)$ = 3.21, d = 0.53, p = .001.

For liberals as well, viewing conservative memes led to lower overall ratings than did viewing liberal memes, b = -0.18, $t(487)$ = 2.01, d = 0.30, p = 0.045. The size of the difference between information ratings after viewing conservative versus liberal memes did not differ reliably between conservative and liberal participants, $F(2, 487)$ = 0.57, η_P^2 = 0.002, p = .57. Thus regardless of political orientation, viewing

[2] Conservative memes were taken from Imgflip because no politically conservative pages were found on Instagram.

conservative memes, relative to liberal memes, negatively impacted information-evaluation ratings. Collapsing across conservative and liberal memes, information ratings did not differ between political and neutral memes either for conservatives, b = -0.03, $t(489) = 0.34$, $d = 0.05$, $p = .73$, or for liberals, b = -0.04, $t(489) = 0.528$, $d = 0.07$, $p = .60$.

Table 1: Pearson's Correlations Among Ratings of the Four Information-evaluation Items. All correlations were significant, *p's* < .001.

	Objective	Trust Info.	Believe
Trust Info.	.467		
Believe	.545	.682	
Trust Source	.394	.661	.612

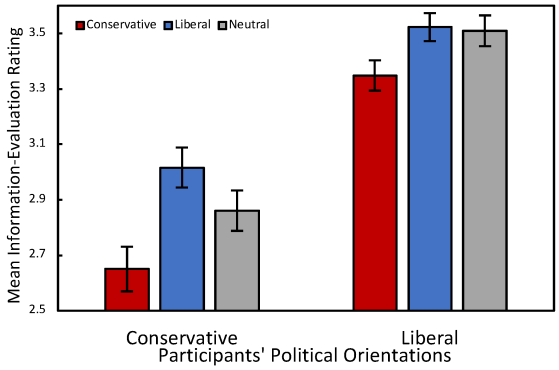

Figure 2: Mean information-evaluation ratings across political orientations (conservative and liberal) and meme type (conservative, liberal, and neutral) in Study 1. Error bars indicate +/- 1 standard error.

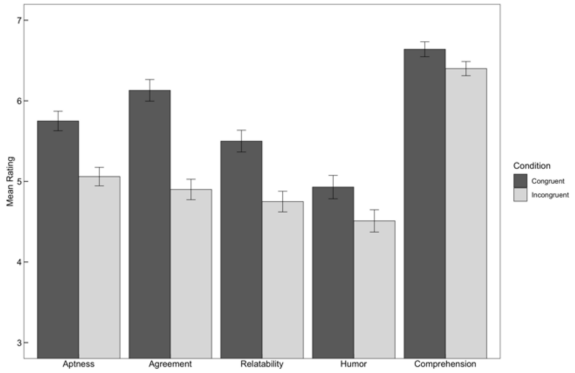

Figure 3: Average ratings of aptness, agreement, relatability, humor, and comprehension across five memes, between politically congruent and incongruent conditions in Study 1. Error bars represent +/- 1 standard error.

Relationships Among Ratings of Memes For the political memes, we assessed the impact of political congruity on core evaluations of the memes. For these analyses, conservative memes viewed by conservative participants, and liberal memes viewed by liberal participants, were coded as congruent; cases where memes conflicted with participants' political views were coded as incongruent. A multivariate analysis of variance (MANOVA) was conducted, in which the outcome variable was the sum of participants' average ratings on scales for aptness, agreement, relatability, humor and comprehensibility across the five memes. Figure 3 displays the average ratings across different levels of congruity. For each scale, ratings were higher for congruent than incongruent memes. Political congruence significantly predicted this composite outcome, $F(5, 323) = 12.42$, $\eta_P^2 = 0.16$, $p < .001$. In addition, individual ANOVAs showed that political congruence predicted average rated aptness, $F(1, 327) = 16.73$, $\eta_P^2 = 0.05$, $p < .001$, average rated agreement with the message, $F(1, 327) = 44.38$, $\eta_P^2 = 0.12$, $p < .001$, average rated relatability, $F(1, 327) = 15.98$, $\eta_P^2 = 0.05$, $p < .001$, and average rated humor, $F(1, 327) = 4.42$, $\eta_P^2 = 0.01$, $p = .036$. The effect on average rated comprehension fell short of statistical reliability, $\eta_P^2 = 0.01$, $p = .067$.

Study 2

Method

Study 2 was a naturalistic study of the impact of political position on the use of memes, based on analyzes of data concerning Facebook memes. Study 2 included memes that did not appear metaphorical (unlike those used in Study 1), but simply consisted of an image with text (see Figure 4 for an example). The primary aim was to explore the different emotions elicited by memes from liberal and conservative webpages, and to compare the nature of discussions of a shared topic (climate change) in liberal and conservative pages.

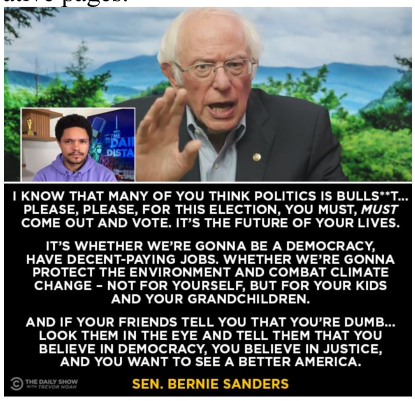

Figure 4: An example of a post that constitutes a meme for the purposes of Study 2.

Data The data were obtained through the Facebook API CrowdTangle, which includes information on over 20,000 memes on the topic of climate change posted to Facebook. From that large data set, we utilized the following variables in our models: the **name of the page** that posted the meme, number of **likes**, number of **comments**, number of **shares**, number of other **reactions** from a menu of choices (love, wow, laugh, sad, angry and care), **text** within the meme, and the **total number of interactions** (sum of the number of reactions, comments, and shares). For the **political-leaning** variable, an undergraduate research assistant hand-coded the political leaning of the posting page. Study 2 study analyzed data from the top 1,000 memes with the greatest number of total interactions. Because we were interested in partisan differences, only pages that strictly fell under the conservative or liberal label for the political-leaning variable were included in the analyses (i.e., memes from political ambiguous sources were excluded). In total, 955 memes were included.

Elicited Emotions

Linear mixed effect models were fit for every emotional reaction: love, wow, laugh, sad, angry, and care. All models were fit in R using the "lme4" package, and evaluated using the "lmerTest" package. Degrees of freedom were estimated using the Satterthwaite approximation for all models.

Figure 5 displays the distribution of emotional reactions between memes coming from conservative and liberal pages. Memes from conservative pages elicited more angry and laughing reactions relative to memes from liberal pages, p's < .001. Memes form liberal pages elicited more care and love reactions than memes from conservative pages, p's < .001. There were no significant differences between the two political camps for the sad and wow reactions.

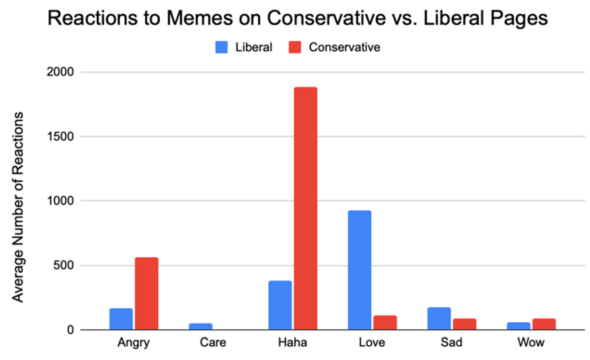

Figure 5: Distribution of emotional reactions across conservative and liberal pages analyzed in Study 2.

Structural Topic Models

A structural topic model (prevalence) was fit to the same data using the "stm" package in R. The model was fit with political leaning as the covariate.

Prevalence Model To explore the prevalence of different topics discussed in memes posted from conservative and liberal pages, a structural topic model was run with political leaning of the posting page as a covariate. From preliminary results based on two separate Latent Dirichlet Allocation (LDA) models for liberals and conservatives, we determined that there were likely at least 20 distinct topics. The final prevalence model that converged was one that contained $K = 40$ topics.

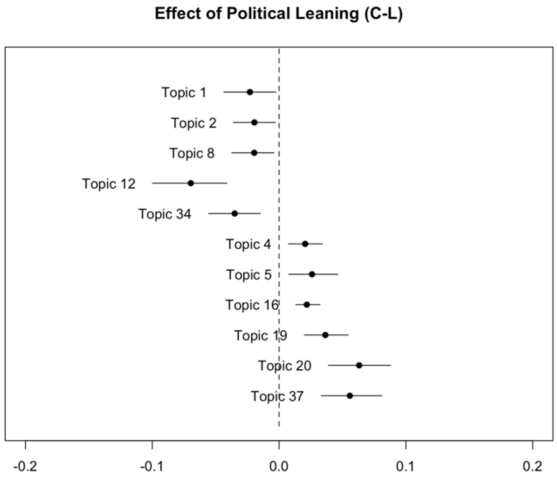

Figure 6: Prevalence of different topics discussed in memes posted in liberal versus conservative groups (Study 2). Values to the left of the dashed line indicate higher prevalence in liberal posts; values to the right indicate higher prevalence in the conservative posts.

Table 2: Statistically significant differences in prevalence of topic between liberals and conservatives. (L) and (C) respectively indicate a topic with greater prevalence in liberal vs. conservative memes.

Topic	Label	*p*
1	Believe science (L)	.024
2	Believe women (L)	.022
8	Bernie-Trump (L)	.020
12	Political corrupt. -pollution (L)	< .001
34	Climate change denial (L)	< .001
4	Economic crisis (C)	.003
5	Fear on political left (C)	.011
16	Ill kid (C)	< .001
19	Science education-vaccines (C)	< .001
20	Social media (C)	< .001
37	Liberal hypocrisy (C)	< .001

Figure 6 summarizes the prevalence of major topics discussed by liberals and conservatives, and Table 2 gives the general nature of each topic. Results from the prevalence model suggest that memes from conservative pages discussed more frequently the hypocrisy of climate activists, poked fun at prominent activists (e.g., Greta Thunberg, Alexandria Ocaso-Cortez), and likened the urgency of climate change to fear-mongering. In contrast, liberals were more likely to discuss racial and economic disparities related to climate crisis, and the need for America to lead mitigation efforts.

General Discussion

The present studies demonstrate that viewing politically-oriented internet memes can influence evaluation of scientific data related to climate change, and that the content of how political pages discuss the issue of climate change align with the emotional responses they elicit from their viewers. Study 1 provided evidence that memes can operate much like metaphorical frames (Thibodeau & Boroditsky, 2011, 2013), affecting participants' judgments of the objectivity of the data, its trustworthiness, trust in its source (NASA), and belief in the information. Relative to viewing liberal memes, brief exposure to a set of conservative memes related to climate change led not only conservatives but also liberals to provide less favorable evaluations of the NASA information.

We also replicated previous findings (Wong & Holyoak, 2021) demonstrating that political congruity impacted participants' appraisals of aptness, agreement, relatability, and humor. The present findings provide evidence that memes do not solely serve social functions, nor do they generate backfire effects. Rather, they can serve to influence evaluations of scientific data, even when the memes run counter to the viewer's entering beliefs. These findings have potential ethical implications for how current social-media algorithms are designed to show users attitudinally-consistent content (Bozdag, 2013; Gates, 2017, Pariser, 2011), even when that content may be misleading or misinformed.

Study 2 broadened the analyses of how memes may function to influence people's beliefs. More specifically, the second study explored how the way in which climate change is discussed may differ between political ideologies. We analyzed a naturalistic set of memes that were posted on Facebook. This analysis revealed that memes posted on pages from different political positions elicited different emotions. In particular, memes from conservative pages elicited more angry and laughing reactions, while memes from liberal pages elicited more care and love reactions. Results from the prevalence model suggest that memes from conservative pages more frequently belittled climate activists and denied the urgency of climate issues, while liberals were more likely to discuss the seriousness of the problem and the need for immediate action.

Future research should assess whether the impact of memes on the evaluation of scientific data is transient, or whether memes can have more long-lasting effects on the acceptance of data and the conclusions they support. In addition, individual differences may influence the impact of memes. For example, individual differences in crystallized and fluid intelligence affect the ability to comprehend metaphors (Stamenković, Ichien, & Holyoak, 2019, 2020), and comprehension influences willingness to share a meme (Wong & Holyoak, 2021).

Finally, future research should further explore the different ways in which memes may influence beliefs. For example, it may be insightful to compare the word embeddings from a structural topic model between conservative and liberal pages, and to compute their similarity to emotion words such as "angry" and "love". More generally, understanding the impact of memes on acceptance of scientific data will be important in addressing social problems that require cooperation among citizens.

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