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Internet Memes in Political Reasoning

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy
in Psychology

by

Emily Frances Wong

2023

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ABSTRACT OF THE DISSERTATION

Internet Memes in Political Reasoning

by

Emily Frances Wong

Doctor of Philosophy in Psychology

University of California, Los Angeles, 2023

Professor Keith Holyoak, Chair

The studies presented in this dissertation explore several covert processes that underlie political attitude formation and development: relational reasoning and emotions evoked by internet memes. Studies 1A and 1B quantitatively demonstrate that some memes on the internet may constitute a form of metaphor. Structural equation modeling was used to demonstrate the structural interrelationships among cognitive and motivational factors that might impact appraisals of the comprehensibility and humor of non-political internet memes. Study 2 extended the initial work to include political content and assessed participants' propensity to share memes with others. Study 3A demonstrated that some memes on the issue of climate change can serve as conceptual frames that shape judgments of objective data. Study 3B showed that liberal memes on climate change elicited more positive emotions (love and care), relative to conservative memes which elicited more negative emotions (anger and laughing). Structural topic modeling results from study 3B suggested 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.

The dissertation of Emily Frances Wong is approved.

Patricia Cheng

Han Du

David O. Sears

Keith Holyoak, Committee Chair

University of California, Los Angeles

2023

DEDICATION

To my grandpa, Joseph Wong, who made the bold decision to leave everything in Hong Kong to give us a better life and access to education. He was laid to rest on December 8, 2021.

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BIOGRAPHICAL SKETCH

Emily Frances Wong is currently in her fifth year of study at the University of California, Los Angeles. She graduated from Chaparral High School in 2014. She then earned her Bachelor's in Psychology and Social Behavior at the University of California, Irvine in 2018. There, she also obtained a minor in Statistics and was a member of several academic organizations (Psi Chi and Phi Beta Kappa).

Internet Memes in Political Reasoning

Political beliefs, attitudes, and decisions have been investigated across many fields, including anthropology, sociology, history, international relations, political science, economics, and psychology. Within psychology, political thinking and behavior have been studied across multiple different subfields, including developmental, social, and cognitive psychology. The bulk of psychological work on this topic has been done in social psychology, which has identified many important phenomena related to political behavior, such as motivated reasoning, stereotyping, and confirmation biases. However, cognitive and computational psychology may offer a useful additional avenue to explore the cognitive processes underlying political beliefs, judgments, and decisions. Political beliefs and judgments are closely linked to moral reasoning, a well-studied area in cognitive psychology. It appears that basic relational and causal reasoning underlie judgment and decision making (JDM) processes, including moral reasoning (Brooks-Walsh & Sullivan, 1973; Rai & Holyoak, 2010; Phillips & Shaw, 2015). This suggests that many of the same cognitive processes are likely to underlie political beliefs, judgments, and reasoning (Lakoff, 1995). While reasoners may tend to view long-held beliefs as based more on rational analysis (Rocklage & Luttrell, 2021), the present experiments explore the more covert processes that underlie political attitude formation and development. In particular, the initial studies will dissect the role of relational thinking in a contemporary form of political metaphor—internet memes. While some memes may constitute a form of metaphor (e.g., Piata, 2016), internet memes can be more broadly described as, “[...] a piece of culture, typically a joke, which gains influence through online transmission” (Davison, 2012). Regardless of their specific form, all viral memes tend to evoke at least some emotion, which has implications for emotional contagion, social influence, and online behavior (Guadagno, Rempala, Murphy, & Okdie, 2013). The later studies will consider

memes more broadly (beyond metaphor), and explore the various emotions elicited by memes posted to politically liberal or conservative web pages. A combination of experimental and naturalistic methodologies will be used.

Metaphors have been shown to play an integral role in how we perceive and understand the world, suggesting our conceptual systems are metaphorical in nature (Lakoff & Johnson, 1980). Beyond cognition, metaphors also shape actions. Verbal metaphors can serve as conceptual frames in areas such as politics (Lakoff, 1996; 2002), and can evoke emotions that potentially make their effects on conceptual development and change more salient (Pollio, Smith, & Pollio, 1990). The effects of metaphorical frames on reasoning seem to operate rather covertly, such that reasoners may remain unaware of the impact of a metaphor on their judgments (Thibodeau & Boroditsky, 2013). Therefore, “[p]art of the dangerous power of a strong metaphor is its control over one’s thinking at a level beneath that of deliberation or volition” (Moran, 1989). Comprehension and interpretation of a strong, or apt, metaphor are seemingly automatic (Camp, 2017). The emotions evoked by such metaphors may also play a role in attitude stability over time, although their influence on our reasoning systems may also go unnoticed by reasoners (Rocklage & Luttrell, 2021).

Cognitive Components

The ability to reason about relations between things is what sets humans apart from other species (Penn, Holyoak, & Povinelli, 2008). Our ability to infer and generalize relations from sparse data—a form of inductive reasoning—is much more flexible than that of current artificial intelligence systems (Lu, Wu, & Holyoak, 2019). This basic cognitive ability to reason about relations and learn from relational reasoning also contributes to people’s political beliefs (e.g.,

Holyoak & Thagard, 1989; Blanchette & Dunbar, 2000; Thibodeau & Boroditsky, 2011, 2013), by making it possible to discuss and comprehend issues discussed figuratively, as in metaphors.

Analogical Reasoning. The ability to comprehend metaphors may partly rely on analogical reasoning (Holyoak & Stamenković, 2018). Analogical reasoning is the ability to reason about the similarity of relations between two, typically disparate domains that share little feature similarity. We use this ability in various daily tasks, including explanation (Thagard, 1992), learning (Richland, Zur, & Holyoak, 2007), scientific discovery (Holyoak & Thagard, 1995), problem solving (Gick & Holyoak, 1983), and social and political cognition (Blanchette & Dunbar, 2000). Across these different domains, a reasoner with the goal to persuade or teach will draw analogies between target concepts and learners' known experiences.

According to Gentner and Maravilla (2018), the analogical process is carried out in three stages: mapping, inference, and evaluation. The mapping process has been a central topic of investigation in both psychology and computer science (Gentner & Forbus, 2011). It involves identifying corresponding objects in the source and target that share the same relational role, establishing a common relational structure (Gentner, 1983; Gentner & Markman, 1997). For example, in the four-term analogy, “Nucleus is to atom as sun is to solar system”—alternatively expressed as *sun : solar system :: nucleus : atom* ($A:B::C:D$)—nucleus and atom constitute the target, whereas sun and solar system constitute the source. The nucleus corresponds to the sun as they share a common relational role, being the center of mass. The atom corresponds to the solar system as they share the relational role of representing an entire orbital system. The relational structure shared between source and target is roughly, “the center of mass that holds all together.”

Effective analogies are based on a source that the learner understands better than the target, which is to be learned, enabling useful inferences about the target. A reasoner can use her prior

knowledge about the relations in the source domain to infer new properties about the target. However, these inferences are not guaranteed to be valid in the target and must be evaluated by the reasoner. There are at least two factors that influence the evaluation of candidate inferences: adaptability of the target, and goal relevance. Inferences that can be more easily adapted to fit the target are more readily accepted than those that are less so (Keane, 1996).

The goal of the reasoner also plays a role in how different candidate inferences are evaluated, a factor particularly relevant to motivated, political reasoning. Even when an inference is structurally consistent and valid, it may be disregarded if it does not achieve the goal of the reasoner. For example, Spellman and Holyoak (1996) gave participants structurally ambiguous analogs set in science-fictional worlds. In the first two experiments, participants were assigned to one of two goal conditions or a control. Participants' mappings between these structurally ambiguous analogs were constrained by, and thus consistent with, the goal condition to which they were assigned. To rule out the possibility that the manipulation in the first two studies could have operated on pre-mapping stages instead of the mapping process itself, their third experiment did not direct participants to the goal until the mapping task. The results from the third experiment suggested that goal-relevant information did in fact operate on the mapping process. Such findings can have implications for motivated reasoning in the political domain.

In the policy domain, there is evidence to suggest that policy decisions based on analogy are guided by the source analogs that reasoners have active in working memory. In Experiment 3 of Gilovich (1981), political science students were posed with a hypothetical foreign policy crisis and were asked to recommend a solution. In one experimental condition, participants were led to believe that the hypothetical crisis was analogous to the Vietnam War, where intervening was not favorable. Another condition led participants to believe that the crisis was analogous to WWII,

where intervening was favorable, while participants in the control condition were not led to believe that the hypothetical crisis was analogous to any previous event. As expected, participants in the WWII condition recommended more interventionist solutions than those in either Vietnam or control conditions.

Metaphor. A closely related concept to analogy is that of metaphor, which has been shown to be influential in political reasoning (Thibodeau & Boroditsky, 2011, 2013). The extent to which metaphor comprehension relies on analogical reasoning remains an open issue and is discussed in length by Holyoak and Stamenković (2018). Lakoff & Johnson (1980) argue that metaphor is a useful tool that people use to understand abstract topics (e.g., politics and society) by relating it to more concrete experiences. Lakoff (1996, 2002), for example, has posited that metaphors serve as important conceptual frames in areas like politics.

Experimental work has demonstrated this potential role of metaphor in reasoning about social policy (Thibodeau & Boroditsky, 2011, 2013). In one study, Thibodeau and Boroditsky (2011) randomly assigned participants to read about a hypothetical crime problem described using either a metaphorical virus frame or a metaphorical beast frame. They found evidence of a metaphorical framing effect such that the virus metaphor led participants to favor a reformative solution (e.g., address the root cause of crimes), whereas the beast metaphor led participants to favor a corrective solution (e.g., harsh punishments for committing a crime). In a series of follow-up studies, Thibodeau and Boroditsky (2013) presented participants with the same metaphors, with a few modifications. Participants performed a similar task, but instead 1) evaluated the two proposed solutions (reform vs. enforcement) in lieu of proposing their own solutions, and 2) were tested on their recall of the metaphors used. These results suggested that participants' evaluations

of the optimal solution were impacted by the metaphorical framing (even when they were able to compare two solutions). Moreover, the effect of the metaphorical framing was apparent even when participants could not explicitly recall the metaphor, suggesting that metaphors may operate covertly to influence our political thoughts.

However, across all studies, Republicans were on average more likely to endorse policies that emphasize enforcement and punishment and were less swayed by metaphorical framing than were Democrats or Independents (Thibodeau & Boroditsky, 2011, 2013). This difference may be due to the fact that metaphors commonly used to describe crime support policies that emphasize enforcement and punishment, an important issue on the Republican party's policy platform (Sulkin, Moriarty, & Hefner, 2007). These experimental results are consistent with observations of actual policy and its effects. For example, Reagan's "war on drugs" in the 1980s framed smugglers, dealers and users as an enemy to be defeated. This led to policies that implemented longer and harsher sentences for drug-related crime (Thibodeau & Boroditsky, 2011).

Emotional Component

Almost all recent work in moral psychology has acknowledged the role of emotion in the reasoning process, though the exact role played by affect remains opaque (Huebner, Dwyer, & Hauser, 2009; Waldmann et al., 2012). In the context of moral reasoning, it has been suggested that emotions contribute to fast thinking, while slow, deliberate thinking should lead to more "utilitarian" or "normative" judgments. In particular, it has been argued that cognitive inhibition supports deliberate thinking by inhibiting emotions (e.g., Greene et al., 2004, 2008; Greene, 2007; Haidt, 2001, 2008). For example, Greene et al. (2008) demonstrated that increasing cognitive load—thus reducing cognitive inhibition—affected utilitarian judgments but not non-utilitarian

ones. Participants were presented with various moral dilemmas for which a utilitarian choice exists; results showed that there was a significant effect of cognitive load on reaction time for when a participant responded with the utilitarian response, but no effect of increasing cognitive load on reaction time when a participant's judgment was non-utilitarian. As later shown in Experiment 1 of Rai and Holyoak (2010), more deliberate thinking does not necessarily lead participants to favor utilitarian judgments more; conversely, deliberate thinking may lead to less agreement with the utilitarian solution.

More recent work has shown that emotions predict more stable consumer attitudes throughout time (Rocklage & Luttrell, 2021). Moreover, people whose attitudes are based on emotion are more likely to rely on their attitude for making judgments and decisions (Lavine, Thomsen, Zanna, & Borgida, 1998; Rocklage & Fazio, 2020; Rocklage, Rucker, & Nordgren, 2018). It is possible that emotions make attitudes more accessible, consistent with dual-process accounts of the role of emotions in decision-making processes. These results are likely applicable to political cognition, as it has been suggested that political cognition is a kind of "hot cognition" (Sniderman, Hagen, Tetlock, & Brady, 1989).

Internet Memes as Metaphors

Digital artifacts known as *memes* now pervade the internet (Davidson, 2012). Memes, which often though not always focus on political themes, typically take the form of humorous images or video clips hybridized with text, which are copied and reposted with variations. They are usually based on a visual image, which functions as the *source* (to borrow a term from the literature on analogy and metaphor). The meaning of the image is shifted to a new *target* topic by the addition of verbal text, or sometimes other images. Often the source and target are drawn from disparate semantic domains, creating a sense of incongruity and surprise. Figure 1 depicts how a

meme may be decomposed into source and target components that are consistent with the structural arrangements of metaphors or analogies.



Figure 1. Decomposing a meme into its source and target components.

Patterns of virality among memes have been analyzed using big data available on open sources such as Google Trends (Bauckhage, 2011; Bauckhage, Kersting, & Hadiji, 2013). In part because of their often-contagious humor, memes can communicate social and political beliefs (Hakoköngäs, Halmesvaara, & Sakki, 2020), thereby playing a role in culture development and formation of collective identity (Gal, Shifman, & Kampf, 2016; Leach & Allen, 2017), and influencing political movements (Milner, 2013; Ross & Rivers, 2017). Hakoköngäs et al. (2020) have argued that memes serve as tools to “crystallize” arguments in a compact, easily shareable form, providing a powerful tool for persuasion, mobilization, and reaching new audiences. Memes and other media appear to have been used purposefully to share political opinions about the 2016 U.S. presidential election, even by those who were not extreme partisans (Huntington, 2020; Kim et al., 2018; Mihailidis & Viotty, 2017; Penney, 2017).

Overview of Dissertation Work

This dissertation will aim to quantitatively demonstrate that some memes on the internet may constitute a form of metaphor, thus potentially providing conceptual frames that shape our judgments on political issues; and that internet memes more broadly elicit emotions in the political

domain. Two survey studies addressed the first issue. Structural equation modeling was used to demonstrate the structural interrelationships among cognitive and motivational factors that might impact appraisals of the comprehensibility and humor of internet memes. Subsequent studies extended the initial work to include political content, and assessed participants' propensity to share the memes with others. A later experiment demonstrated that some memes on the issue of climate change can serve as conceptual frames that shape judgments of objective data. The final study utilized machine learning—specifically, structural topic modeling—to explore the different topics liberals and conservatives discuss in their memes on the issue of climate change, as well as the different emotions these memes elicit.

SECTION 1: MEMES AS METAPHORS

Studies 1A and 1B

Studies 1A and 1B explore the nature of the cognitive and motivational processes that guide the comprehension and perceived humor of memes, and that influence the propensity to share specific memes with friends and family. A guiding hypothesis is that internet memes constitute a variety of metaphor. The hypothesis has been considered in numerous fields, including communication, rhetoric, and linguistics (Huntington, 2013; Shifman, 2013; Milner, 2016; Piata, 2016). Metaphors, which are prevalent both in everyday language (Lakoff & Johnson, 1980) and in poetry (Lakoff & Turner, 1989; Holyoak, 2019), are typically verbal. Verbal metaphors have been shown to be effective in promoting conceptual change and development, perhaps because they elicit emotional responses (Pollio, Smith, & Pollio, 1990). The concept can be usefully extended to include visual metaphors, such as those expressed by some works of art (Kennedy, 2008). Internet memes in fact provide a readily-accessible source of naturally-occurring metaphors. Psychological studies of verbal metaphors have primarily involved artificial stimuli

(metaphors created by research psychologists), or less commonly literary metaphors (generally created by elite writers) (Jacobs & Kinder, 2018; Stamenković, Ichien, & Holyoak, 2019, 2020). Internet memes, in contrast, are typically created, modified, and transmitted colloquially, and hence may provide a window into the nature of everyday creativity. Because memes are often political in nature, they offer a source of stimuli for investigating the political impact of metaphors (Thibodeau, Fleming, & Lannen, 2019).

Metaphor is closely linked to analogy, although the extent to which metaphor comprehension depends on analogical reasoning remains an open issue (for a recent review see Holyoak & Stamenković, 2018). Like analogies, metaphors often involve relational parallels between the source and target. However, whereas analogies may be formal in nature, metaphors inevitably depend on semantic interpretation. Analogies focus on clarity of correspondences between the source and target; in contrast, good metaphors emphasize expressiveness (often including an emotional component) and semantic richness, as well as sensory detail (Gentner & Clement, 1988; Gentner, Falkenhainer, & Skorstad, 1988). These qualities of metaphors seem to match those of internet memes. Many theorists have argued that a critical dimension of variation among metaphors is *aptness*. A metaphor can be characterized as apt to the extent that the source is perceived as providing a unique and accurate description of the target—that is, salient properties of the source also apply to the target (Jones & Estes, 2006; Thibodeau & Durgin, 2011). Rated aptness is a strong predictor of the comprehensibility of metaphors, perhaps more potent than sheer familiarity or conventionality (Blasko & Connine, 1993; Chiappe, Kennedy, & Chiappe, 2003; Pierce & Chiappe, 2008). A structural alignment between source and target facilitates comprehension, and in addition also may affect how people think about policy issues (Thibodeau & Boroditsky, 2011).

An important property of internet memes that distinguishes them from many other metaphors is that memes are usually intended to be in some way humorous. It has been noted that humorous analogies (a closely related concept) can drive home a political argument (Gentner & Maravilla, 2018). The psychology of humor is a complex topic (for a review see Ruch, 2008; for neural evidence see Amir & Biederman, 2016), but a central hypothesis is that humor often depends on perception of incongruity (e.g., Deckers, 1993). Koestler (1964) introduced the term “bisociation” to refer to the juxtaposition of two normally disparate ideas, concepts, or situations in a surprising or unexpected manner. Of course, incongruity can be generated by purely random juxtapositions, which are seldom very funny. Humor seems to depend on satisfactory resolution of incongruity (Suls, 1972), which depends on achieving comprehension, and hence is likely to require some degree of aptness. It has also been argued that appreciating humor involves relating oneself to the situation, often yielding a sense of superiority within a social hierarchy (Gruner, 2000). Memes, like jokes in general, often act as “put downs” of whomever or whatever is the butt of the joke, and may be shared within in-groups to disparage out-group members (Guadagno, Rempala, Murphy & Okdie, 2013). Similarly, political bloggers may share politically incongruent content if it serves the purpose in disparaging rivals (Wallsten, 2010).

Previous research has emphasized the emotional component of memes (Guadagno, Rempala, Murphy, & Okdie, 2013; Huntington, 2015; Leach & Allen, 2017; Rieger & Klimmt, 2019; Akram et al., 2020). Huntington (2020) has demonstrated that motivational reasoning impacts the appraisal of political memes, such that greater agreement with the message is associated with less scrutiny and greater perceived message effectiveness. The appraisal of a meme is therefore likely to depend on the degree to which the viewer relates to the attitude expressed by the meme (Akram et al., 2020). The impact of relatability is likely to be particularly evident in

political memes (e.g., a meme expressing liberal superiority may be less funny to a conservative). An important question is whether the perceived aptness of a meme is itself influenced by its relatability—is aptness a basic property of a meme, or is “aptness in the eye of the beholder”, varying with the viewer’s point of view?

The current study focuses on the structural interrelationships among cognitive and motivational factors that might impact appraisals of the comprehensibility and humor of internet memes. Studies 1A and 1B examined apolitical internet memes. Study 2 examined political memes expressing liberal or conservative attitudes, and compared appraisals made by participants who identified as either politically liberal or conservative. In addition to comprehension and humor, Study 2 also assessed propensity to share a meme with others.

These initial studies each examined several variants of two basic internet memes, with Study 1B serving as a replication and extension of Study 1A using two different basic memes. Because the pattern of results proved to be extremely similar across the two studies, we report them together, focusing on analyses of the combined data.

Method

Participants. Participants were 200 (100 each in Study 1A and 1B) Amazon Mechanical Turk workers located in the United States (62% male) who were between 18 and 72 years old ($M = 36.51$, $SD = 10.83$). The sample size was comparable to that used in previous studies of metaphor comprehension (e.g., Blasko & Connine, 1993; Chiappe et al., 2003; Jones & Estes, 2006). Participants received \$2 compensation for participation in a study, which took about five minutes to complete. All studies were approved by the Institutional Review Board for the University of California, Los Angeles.

Materials. Each study included two *basic* memes that each served as a meme template (i.e. a meme without text). In Study 1A the two basic memes were Distracted Boyfriend and Evil Kermit (see Figure 1, top). Given the current study's emphasis on the analogical and metaphorical framework, these basic memes were selected for their explicit text-to-image mappings (comparable to analogical mappings between source and target). The content of the memes was also vetted to avoid profanity. Based on these constraints, a set of 12 total variations of each basic meme were collected (for a total of 24 variations) from a variety of sources including Google Images, Twitter and Reddit. To control for variations in text size, image rendering, and other image qualities, all variations were standardized in text and size. All text was in Arial, 14-point font to ensure readability. Memes for Study 1A were collected in October 2018, and the study was conducted in November 2019. Memes for Study 1B were collected in January 2020, and the study was conducted in January 2020.

In Study 1B the two basic memes were Epic Handshake and Baby Yoda (see Figure 2, bottom). As in Study 1A, twelve specific variants of each basic meme were collected from various internet sources. The display size for all variants of the Epic Handshake meme was standardized to 1096 x 616 pixels, and that for the Baby Yoda meme was standardized to 616 x 1096 pixels.

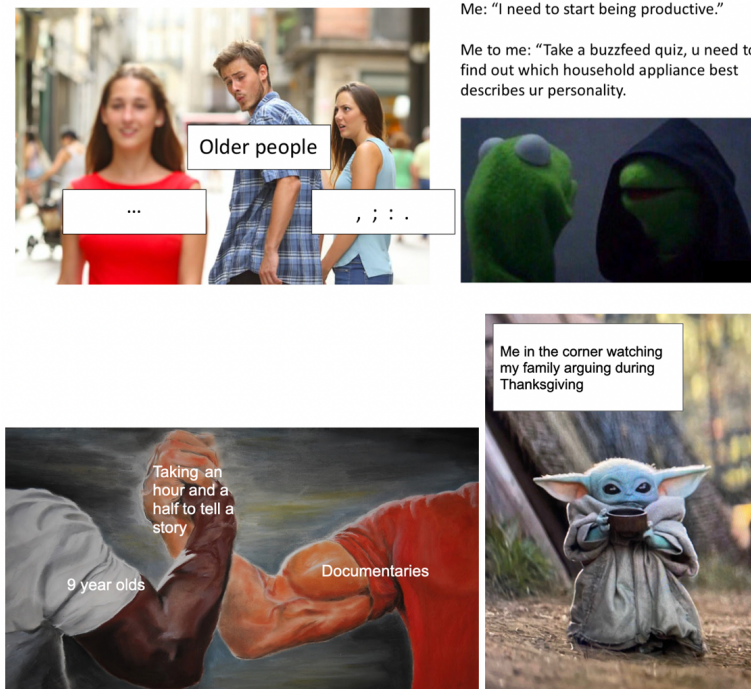


Figure 2. Variations of the two basic memes used in Study 1A (top row: Distracted Boyfriend and Evil Kermit) and Study 1B (bottom row: Epic Handshake and Baby Yoda). Basic memes here refer to the meme template (i.e. the meme without text).

Measures. Each participant was presented with two memes, and provided Likert-scale ratings for each in response to six questions, presented in the following order:

- (1) To gauge how humorous a meme appeared to be, participants were asked to rate, “On a scale from 1 (not funny at all) to 8 (very funny), how funny did you find this?”
- (2) To measure prior exposure to the meme, participants were asked, “On a scale from 1 (not at all familiar) to 8 (very familiar) how familiar are you with this meme?”
- (3) To assess how well participants were able to personally identify with the meme, participants were asked, “On a scale from 1 (not relatable at all) to 8 (very relatable), how relatable did you find this?”
- (4) To assess the goodness of metaphorical fit between the image and its topic, participants were asked, “On a scale from 1 (not apt at all) to 8 (very apt), how aptly does this meme fit its topic?”

(5) To measure comprehension, participants were asked, “On a scale from 1 (not at all) to 8 (very well), how well did you understand this?”

(6) To measure the extent to which the meme had an unexpected quality, participants were asked, “On a scale from 1 (not surprising at all) to 8 (very surprising), how surprising were the captions?”

Because we did not wish to bias participants by providing theoretical definitions of terms, we simply asked the questions without providing elaboration. Pilot data indicated that participants found the questions clear. The measure of aptness was similar to that introduced by Tourangeau and Sternberg (1981), who also did not define the term to participants (also Blasko & Connine, 1993; Chiappe et al., 2003; Jones & Estes, 2006; Pierce & Chiappe, 2008).

Procedure. Both studies were administered through Qualtrics. Each participant was shown one specific instance of each of the two basic memes (i.e., a total of two images). The instances were randomly sampled for each participant from among the twelve in each of the two sets, with a restriction to ensure that an approximately equal number of participants rated each of the 12 instances of each meme. The presentation order of the two memes was counterbalanced across participants.

Prior to the six main questions for each meme, participants were presented with the basic meme (i.e., the bare template of the image without any text), and asked if they had ever seen the image before (to be answered “yes” or “no”). The same question was then asked for the specific meme (with text). Participants then answered the six rating questions for the specific meme. The same procedure was then repeated for the second meme.

Results

Because Study 1A and 1B had identical designs and very similar patterns of results, all analyses reported here combined data from both ($N = 200$). Table 1 summarizes the Pearson

correlations among all measured variables. The pattern of correlations reveals a strong association between humor and comprehension, as well as strong correlations of each of these variables with aptness and relatability. Both humor and comprehension had weaker but reliable correlations with familiarity; humor only had a small but reliable correlation with surprise. Basic regression analyses revealed that whether a participant had seen either the basic meme template or the specific meme did not reliably predict participants' ratings of comprehension or humor; hence these two variables were omitted in subsequent analyses.

As there were no meaningful zero points for any of the ratings, all variables were mean-centered to improve interpretability of regression results. Structural equation modeling was conducted in R Studio (version 1.2.5) using the R package 'lavaan', and regressions were conducted using the package "lme4". Data were clustered by participant to account for the repeated-measures nature of the data (equivalent to random intercept model); because of the repeated-measures nature of the data, 95% confidence intervals were percentile bootstrapped. Guided by a priori hypotheses and exploratory regression analyses, we sought to construct a moderated mediation model that could provide a satisfactory overall fit to the rating data. Previous research suggests that the aptness of a metaphor influences its comprehensibility, rather than the other way around (Chiappe et al., 2003). Relatability was constrained to precede aptness, based on the hypothesis that aptness is in part subjective. Humor was always treated as a final dependent measure. Given the hypothesis that humor depends on the resolution of initial perceived incongruity (Suls, 1972), the model also includes an interaction between surprise and aptness as a moderator variable for humor only. Initial regression analyses indicated that familiarity was not a reliable independent predictor of humor, and only a weak predictor of comprehension. We were unable to find a satisfactory overall model that included familiarity, so this variable was excluded.

Table 1. Pearson correlations among all measured variables (combined data from Study 1A and 1B).

	1	2	3	4	5	6
1. Humor	1	.517***	.723***	.701***	.346***	.195***
2. Comprehension		1	.649***	.581***	.456***	-.131**
3. Aptness			1	.690***	.452***	.023
4. Relatability				1	.413***	.059
5. Familiarity					1	-.057
6. Surprise						1

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

The resulting model, depicted in Figure 3, hypothesizes that relatability of a meme influences its perceived aptness, which in turn influences both comprehension and humor. Model fit was evaluated by the following fit indices: chi-squared test (null hypothesis being that the model fits perfectly), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). All indices (CFI, TLI, RMSEA, and SRMR) range between 0 and 1 (though TLI values can be slightly out of

these bounds). Larger values of CFI and TLI, and lower values of RMSEA and SRMR, are indicative of better fit.

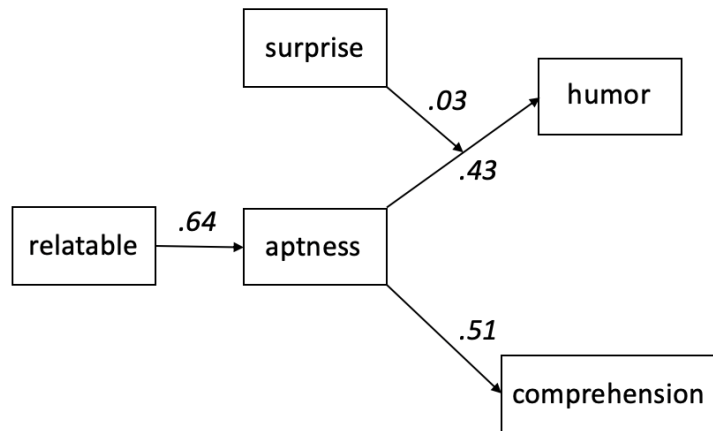


Figure 3. Best-fitting path model for Study 1A and Study 1B (apolitical memes). All regression coefficients shown are statistically significant.

All links shown in Figure 3 were reliable, $p < .001$ in all cases except the moderating link, for which $p = .03$ (0.03, 95% CI: [0.003, 0.054]). Overall, the model’s fit was good, $X^2(2) = 5.343$, $p = .065$, CFI = .996, TLI = 0.983, RMSEA = 0.065 (90% CI: [0.000, 0.134]), SRMR = .025. The indirect effect of relatability on humor, through aptness, was strongest when the captions were rated as more surprising; this interaction was statistically significant (0.03, 95% CI: [0.003, 0.054]). The indirect effect of relatability on comprehension was also significant (0.327, 95% CI: [0.241, 0.413]). At all levels of surprise as a moderator, the total indirect effect was significant, p ’s $< .001$. Partial mediation was achieved, as the direct effect of relatability on humor remained statistically significant (0.349, 95% CI: [0.258, 0.441], $p < .001$) after accounting for the indirect effects, as was also the case for comprehension (0.253, 95% CI: [0.146, 0.360], $p < .001$).

Section 1 Discussion

In two studies, each using different memes, we investigated cognitive factors that predict the comprehensibility and humor of internet memes. Overall, our findings support the hypothesis that

memes are best viewed as a variety of metaphor (Piata, 2016). Unlike verbal metaphors examined in previous studies of metaphor, which have generally been produced by either psycholinguists or elite writers, memes more clearly constitute creative products of ordinary people. Structural equation modeling established that the most potent and robust direct predictor of both comprehensibility and humor was the rated aptness of the meme—the participant’s sense of how well the source image matched and informed the target topic cued by the verbal caption. Although aptness was correlated with familiarity of the meme, the latter factor had little predictive power after accounting for aptness. These findings parallel evidence from studies of metaphor comprehension, which have also identified aptness as a particularly central predictor of metaphor appreciation (Chiappe et al., 2003; Jones & Estes, 2006). A plausible hypothesis is that apt memes, like apt metaphors, are more likely to be propagated and hence become familiar.

The present findings go beyond previous studies of metaphor comprehension in linking aptness not only to comprehension of memes, but also to their perceived humor. Consistent with theoretical analyses of humor, which have often emphasized the importance of surprise or incongruity (Koestler, 1964; Ruch, 2008; Suls, 1972), the impact of aptness was to some extent moderated by the degree to which the meme was viewed as surprising. Moreover, aptness and its consequences were subject to the influence of pragmatic and motivational factors. In work on metaphor, aptness is often treated as an objective characteristic of a metaphor; but at least for memes, perceived aptness clearly has a subjective component. In particular, structural equation modeling revealed that rated relatability—the degree to which the participant personally identified with the message conveyed by the meme—influenced its perceived aptness. To some extent, aptness is indeed in the eye of the beholder.

SECTION 2: EVALUATION OF POLITICAL MEMES

Study 2

Study 2 extended the project to memes that were explicitly political in their focus, with participants selected as self-identified American conservatives or liberals. In addition to the appraisals obtained in Study 1A and 1B, we also assessed participants' propensity to share the memes with others. Propensity to share is directly relevant to the social impact of memes. Pre-registration of Study 2 through the Open Science Framework was initiated on 14 April 2020 and was approved on 16 April 2020 (<https://osf.io/jpwhx/>).

Method

Participants. Participants were 281 (61% male) Amazon Mechanical Turk workers located in the United States, between the ages of 18 and 76 ($M = 37.26$, $SD = 11.40$). American conservatives ($N = 133$) and liberals ($N = 148$) were recruited using the MTurk filters for political orientation. Libertarians and independents were not included in this study.

Materials. A set of 12 memes were collected from a conservative subreddit (<https://www.reddit.com/r/Conservative/top/?t=all>), and another set of 12 memes were collected from a liberal subreddit (<https://www.reddit.com/r/PoliticalHumor/top/?t=all>). These served as the “conservative” and “liberal” memes, respectively. Memes were selected from each site's most popular posts of all time. Memes were collected in April 2020, and the study was conducted the same month. Figure 4 provides examples. Whereas the memes used in Studies 1A and 1B were selected to be variants of two basic memes, the memes in each set of 12 used in Study 2 were all unique, thus providing increased variety. Consistent with the view that humor typically functions as some sort of “put down” (Gruner, 2000), the majority of these popular memes attacked an opposing view, rather than supporting the favored view. Among the 12 conservative-oriented

memes, ten attacked liberal views, one attacked China, and only one directly supported the conservative cause. Among the 12 liberal-oriented memes, eight attacked conservative views and four criticized the U.S. government.

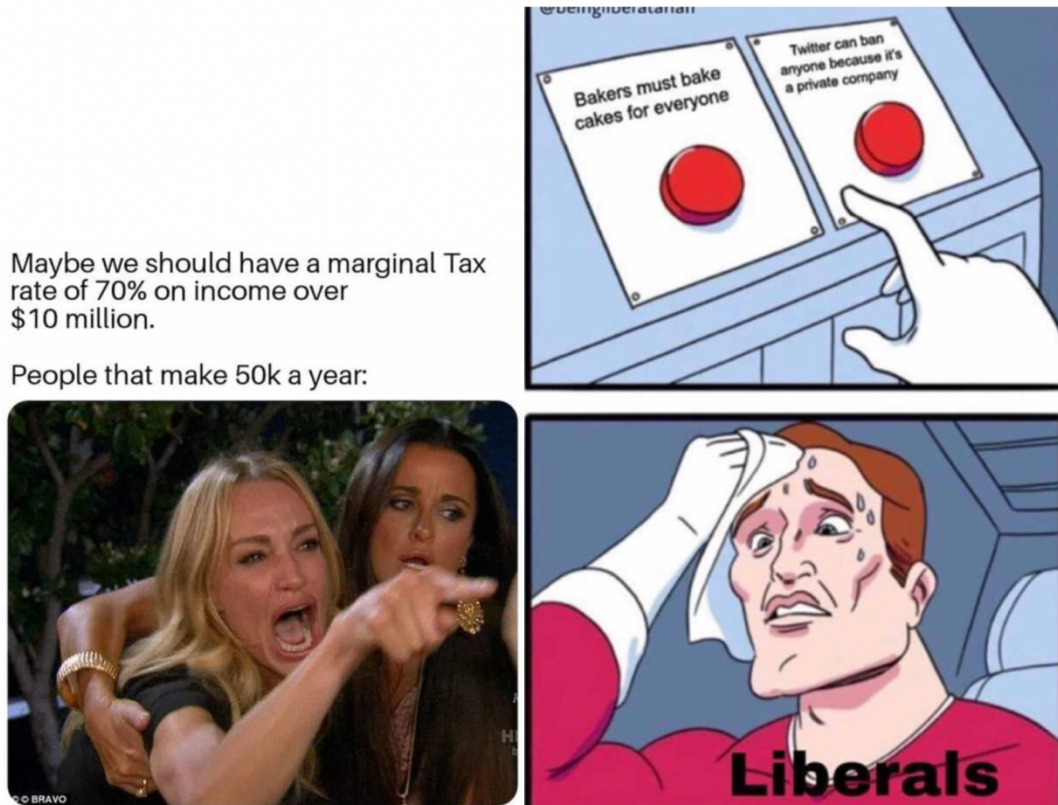


Figure 4. An example of a liberal-oriented meme (left) and conservative-oriented meme (right).

Measures. Each participant was presented with two randomly selected memes, one from each set (conservative and liberal). Participants provided Likert-scale ratings for each meme in response to the same six questions used in Study 1A and 1B. In Study 2, participants were asked two additional questions after the initial six questions, in the following order:

- (1) To gauge a participant's (dis)agreement with the meme, they were asked to rate, "On a scale from 1 (strongly disagree) to 8 (strongly agree), how much do you agree with the message?"

(2) To gauge a participant's willingness to share the meme, they were asked, "Is this [meme] something you would share with friends and family (e.g., via social media, text messaging, etc.)?"

This question was to be answered yes or no.

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.

Procedure. Each participant was shown one specific instance of each of the two sets of political memes (i.e., a total of two images). The instances were randomly sampled for each participant from among the twelve in each of the two sets, with a restriction to ensure that an approximately equal number of participants rated each of the 12 instances of each meme set. The presentation order of the two memes was counterbalanced across participants.

Participants then answered the six core questions for the first meme followed by the two additional questions. The same procedure was then repeated for the second meme. Lastly, participants responded to the 12-item SECS (Everett, 2013).

Results

All participants were coded as either politically conservative or liberal (binary variable). Mean score on the SECS scale (range 0-100) was 74.13 for conservatives and 43.52 for liberals. The political congruity of each meme was also coded as a binary variable ("1" for conservatively-oriented memes viewed by conservatives, and liberal-oriented memes viewed by liberals; "0" otherwise).

Table 2 summarizes the Pearson correlations among all measured variables. The pattern of correlations reveals strong associations among propensity to share memes and rated humor and

comprehension, as well as strong correlations of each of these variables with aptness and relatability, and weaker but reliable correlations with familiarity. Sharing and humor, but not comprehension, also had a small but reliable correlation with surprise.

Table 2. Pearson correlations among all measured variables (Study 2).

	1	2	3	4	5	6	7	8	9
1. Share	1	.669***	.379***	.642***	.162***	.577***	.642***	.376***	.231***
2. Humor		1	.469***	.724***	.173***	.730***	.753***	.359***	.220***
3. Comprehension			1	.481***	.052	.590***	.530***	.355***	-.041
4. Agreement				1	.222***	.750***	.769***	.358***	.118**
5. Congruity					1	.141***	.187***	.085*	-.037
6. Aptness						1	.773***	.409***	.087*
7. Relatability							1	.464***	.170***
8. Familiarity								1	.197***
9. Surprise									1

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

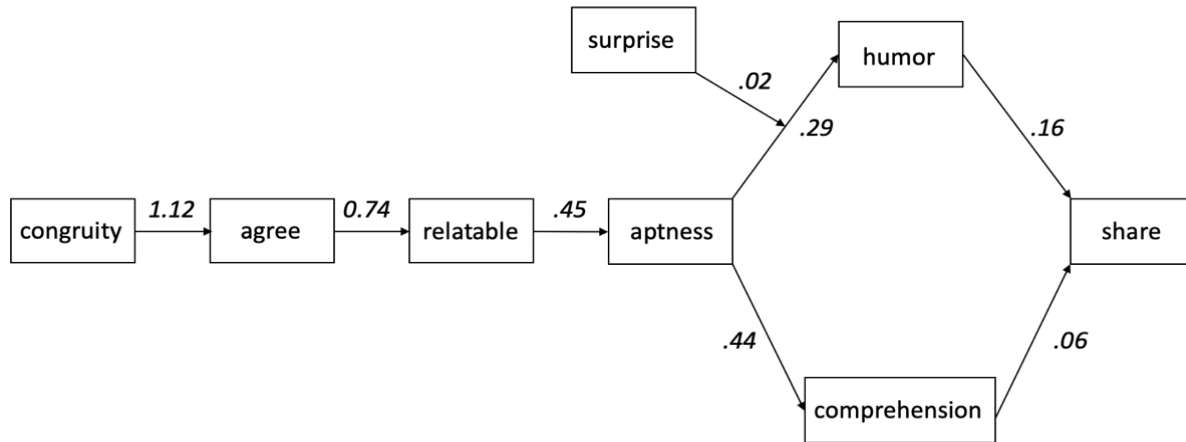


Figure 5. Best-fitting path model for Study 2 (political memes). All regression coefficients shown are statistically significant, except for the moderating link from surprise.

Using the same methods as in Study 1, we sought to construct a moderated mediation model that could provide a satisfactory overall fit to the rating data. The most successful model is depicted in Figure 5. This model was constrained to incorporate all pathways from the comparable model for Study 1 (Figure 3), augmented by additional pathways to incorporate the new variables examined in Study 2. We hypothesized that individuals would agree more with congruent memes than incongruent ones, leading to greater relatability, which in turn influences perceived aptness. The model also reflects the hypotheses that memes that are viewed as comprehensible and humorous will be most likely to be shared with others.

Overall, the fit of the model presented in Figure 5 was good, $X^2(5) = 5.31, p = .379, CFI = 1.00, TLI = 0.999, RMSEA = 0.011$ (90% CI: [0.000, 0.060]), $SRMR = .001$. The indirect effect of congruity on sharing propensity, through humor, was statistically significant (0.017, 95% CI: [0.008, 0.026]), conditioning on the average value of surprise as a moderator. Qualitatively, this indirect effect became stronger as captions were rated as more surprising. However, the coefficient for the moderating effect of surprise on humor (via aptness) was slightly smaller than that estimated for Study 1, and fell short of statistical significance (0.021, 95% CI: [-0.007, 0.049]).

The second indirect effect of congruity on sharing propensity, through comprehension, was statistically significant (0.009, 95% CI: [0.001, 0.017]). The total indirect effects at each level of the moderator were significant, p 's < .001. Complete mediation was achieved, as the direct effect of congruity on sharing propensity was not significant after accounting for the indirect effects (0.098, 95% CI: [-0.060, 0.255]).

Guided by the path model depicted in Figure 5, we can trace the indirect influences of meme congruity on propensity to share in greater detail. Although a larger proportion of congruent than incongruent memes were shared (.45 of congruent memes versus .29 of incongruent memes, odds ratio = 2.48, p < .001), the proportion shared was nontrivial even for incongruent memes (for both liberal and conservative participants). Each participant saw one congruent and one incongruent meme and could elect to share both, either, or neither; hence the proportion of participants who elected to share the incongruent meme was also .29. Rated aptness, the main immediate driver of comprehension and humor, was higher for congruent than incongruent memes (means of 5.24 versus 4.60, $t(280) = 4.11$, p < .001). Congruent memes were also rated as more humorous (4.72 versus 3.90, $t(280) = 5.19$, p < .001). However, ratings of comprehensibility did not reliably differ between congruent and incongruent memes (6.23 versus 5.99, $t(280) = 1.39$, $p = .164$). Thus, people could generally understand memes incongruent with their political position, but found them less funny than congruent memes.

We also examined the differences in humor and comprehensibility between shared and unshared memes. Memes selected to share were rated as much more humorous than those not selected (6.37 versus 3.10, $t(280) = 20.68$, p < .001), and also more comprehensible (7.27 versus 5.44, $t(280) = 9.61$, p < .001). This pattern was not reliably different for congruent versus incongruent memes. Thus, while people generally found congruent memes more humorous than

incongruent ones, they were willing to share an incongruent meme that struck them as especially humorous as well as comprehensible.

A number of alternative models that varied the structure of the new variables added in Study 2, while maintaining the structure of the variables established for Study 1 (Figure 3), were also examined. These alternative models included: (1) linking comprehension to humor, (2) removing the node for agreement, and (3) dropping the link from comprehension to share. These models either produced significant chi-square test results, worse comparative fit (CFI and TLI), or greater error (RMSEA and SRMR) relative to the model in Figure 5.

Section 2 Discussion

The impact of pragmatic and motivational factors was particularly salient when we examined how political memes were perceived by self-identified conservative and liberal participants (Study 2). The perception of polarized memes was heavily influenced by their congruity with the political views of the participant (where conservative-oriented memes viewed by conservatives and liberal-oriented memes viewed by liberals were considered congruent, and memes supporting the opposing view were considered incongruent). The most successful structural equation model for Study 2 (Figure 4) included all the same paths as those identified in Study 1 for apolitical memes (Figure 2). In addition, for political memes we found that congruity of the meme operates via a link to agreement with its message, to its relatability, to its aptness, thereby influencing both comprehension and humor, which in turn influence propensity to share the meme with friends and family.

Not surprisingly, people were more likely to elect to share congruent than incongruent memes; however, the impact of congruity on sharing was nuanced and indirect. For both

conservatives and liberals, only about half of the congruent memes were selected for sharing, whereas about a quarter of incongruent memes were also selected. The major factors differentiating shared from unshared memes were their rated humor and comprehensibility; complete mediation was achieved, in that the direct effect of congruity on sharing propensity was not significant after accounting for its indirect effects. Unlike metaphors or analogies intended to persuade, memes seem to be devices for building social coherence (Gal et al., 2016). They are intended to generate humor shared by those who already agree with the view being expressed, often at the expense of those who would disagree (Gruner, 2000). Particularly in this era of political polarization, it is perhaps comforting that congruity is not the sole or direct determinant of the propensity to share memes and thus promote their virality. We found that a substantial proportion of both liberals and conservatives appeared able to appreciate an incongruent meme that successfully pokes fun at their own political beliefs. If a meme is funny enough (even at one's own expense), it may be worth passing along to others.

SECTION 3: SHAPING CLIMATE CHANGE ATTITUDES

Study 3A

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 it and to electronically spread it 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 memes. Though there is general agreement that memes serve social functions, it is unclear whether they can influence

beliefs for those who have strong pre-existing 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 (Huntington, 2013; Milner, 2016; Piata, 2016; Shifman, 2013). 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 impacted reasoners' proposed solutions to the crime problem (Thibodeau & Boroditsky, 2011, 2013). Verbal metaphors have also been shown to impact our beliefs about climate change (Flushberg, Matlock, & Thibodeau, 2017; Thibodeau, Frantz, & Berretta, 2017). Recent work has shown that memes, which likely operate as visual metaphors, are effective in changing beliefs about the morality of eating meat (Horne, Rottman, & Lawrence, 2021).

The present study 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, actually 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.

Method

The study 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 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; 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 participants' 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 participants who provided usable data. Participants received \$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 @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 6 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 6. Examples of conservative (left), liberal (middle), and neutral (right) memes.

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:

(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) as in the previously conducted studies. Participants were also asked to provide their self-described political orientation, with the following response options: Extremely (Moderately) Conservative, and Extremely (Moderately) 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 3 provides the correlations among ratings for the four questions.

Table 3. Pearson's Correlations Among Ratings of the Four Information-evaluation Items

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

Note: All correlation coefficients are statistically significant, p 's < .001.

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 7 depicts participants' average information-evaluation scores across political orientations and meme conditions. A two-way ANOVA revealed an overall main effect of political orientation, $F(1, 487) = 96.86$, $\eta_p^2 = 0.17$, $p < .001$, with mean ratings lower for conservative than for liberal participants (2.94 vs. 3.46). The differences among meme conditions were also reliable, $F(2, 487) = 5.15$, $\eta_p^2 = 0.02$, $p = .006$, and the two variables did not interact, $F(2, 547) = 0.57$, $\eta_p^2 = 0.002$, $p = .57$. 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, $b = -0.18$, $t(487) = 2.01$, $d = 0.30$, $p = 0.045$. There was no significant interaction between meme condition and political orientation, $F(2, 487) = 0.57$, $\eta_p^2 = 0.002$, $p = .57$. The size of the difference between information ratings after viewing conservative versus liberal memes did not differ reliably between conservative and liberal participants, $F(1, 489) = 0.02$, $\eta_p^2 = 3.32e-5$, $p = .90$. Thus,

regardless of political orientation, viewing conservative memes, relative to liberal memes, negatively impacted information-evaluation ratings.

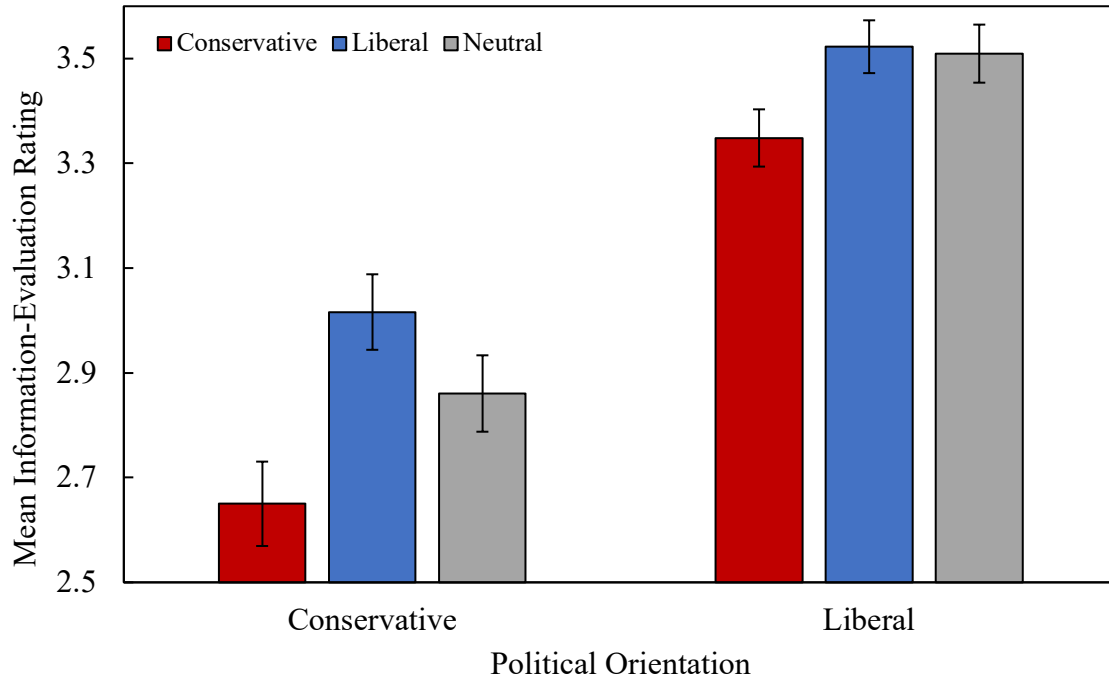


Figure 7. Mean information-evaluation ratings across political orientations (conservative and liberal) and meme type (conservative, liberal, and neutral). Error bars indicate +/- 1 standard error. Collapsing across conservative and liberal memes, information ratings did not differ between political and neutral memes either for conservatives, $b = -0.03$, $t(489) = 0.34$, $d = 0.05$, $p = .73$, or for liberals, $b = -0.04$, $t(489) = 0.528$, $d = 0.07$, $p = .60$.

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, reliability, humor and comprehensibility across the five 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 reliability, $F(1, 327) = 15.98$, $\eta_p^2 = 0.05$, $p < .001$, 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, $\eta_p^2 = 0.01$, $p = .067$. Figure 8 depicts the estimated marginal means of rated aptness, agreement, reliability, humor, and comprehension across five memes, between politically congruent and incongruent conditions.

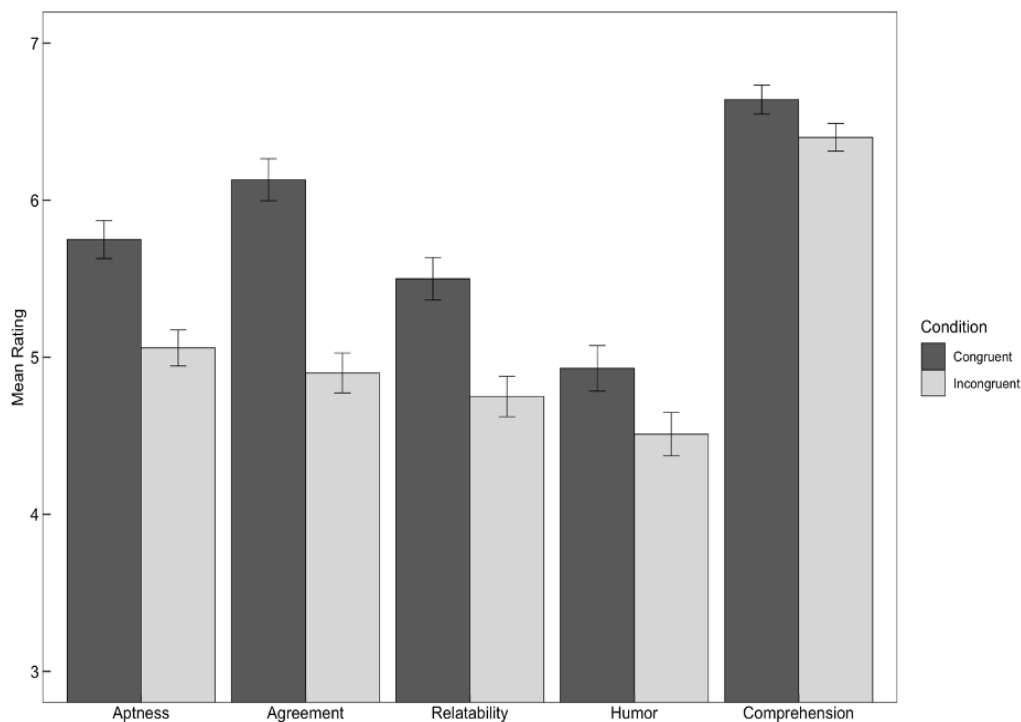


Figure 8. Average ratings of aptness, agreement, reliability, humor, and comprehension across five memes, between politically congruent and incongruent conditions. Error bars represent +/- 1 standard error.

Study 3B

In the final study, I analyzed naturalistic data from Facebook to explore the different emotions elicited by liberal and conservative memes on the topic of climate change. Emotionality is a strong predictor of the longevity of an attitude (Rocklage & Luttrell 2021). These different elicited emotions may be contributing to polarized beliefs about climate change among people in the U.S. As observed in Study 3A, political memes on the topic of climate change—which likely elicited emotions—were able to momentarily affect participants’ judgments of objective information. It may be possible that the way in which we discuss issues such as climate change elicit specific emotions that in turn crystallize our beliefs in the long-run, especially when similar content is presented regularly. The final study of this dissertation explored the relationship between the topics discussed earlier and emotions elicited from climate change memes on conservative and liberal pages.

What constitutes a meme is broadened in this study. In particular, a meme no longer has to be a template image (e.g., the Evil Kermit template) with corresponding text. Instead, a meme is simply an image with text. Figure 9 depicts an example of a post that will be considered a meme for the purposes of the current study. It is important to note that not all memes in this dataset will be metaphors. The primary study objective will be to explore differential emotional reactions to liberal and conservative content. In addition to exploring the different emotions elicited by memes from liberal and conservative pages, this study will also explore differential discussion of a common topic (climate change) in liberal and conservative pages.

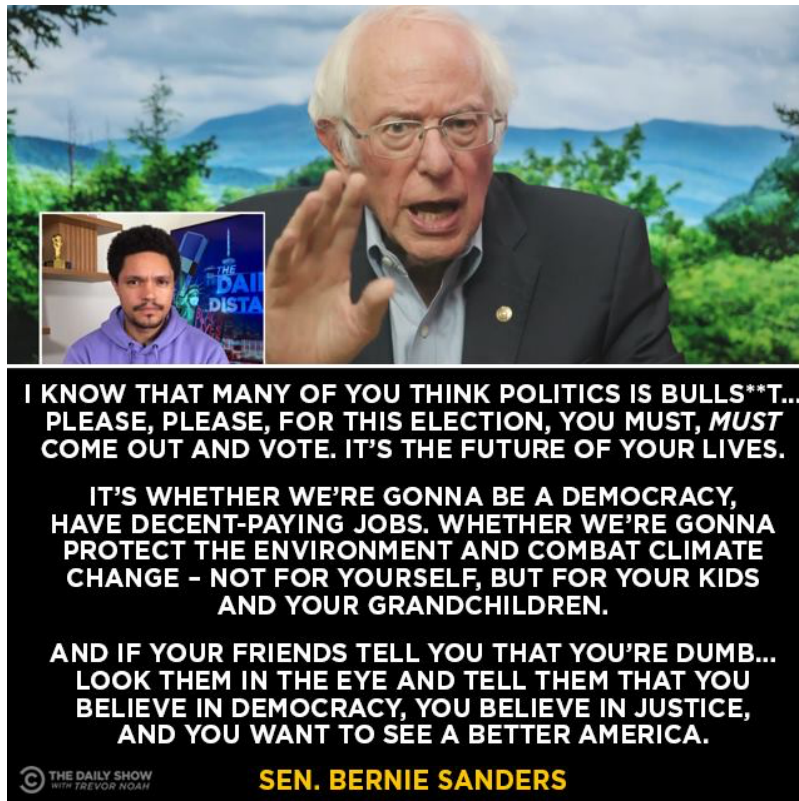


Figure 9. An example of a post that constitutes a meme for the purposes of Study 3B.

Methods

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 3B 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 politically ambiguous sources were excluded). In total, 955 memes were included. Each page was coded as either liberal or conservative by an undergraduate research assistant. See Table 4 for the rubric for coding pages’ political orientations.

Table 4. Political Orientation Coding Scheme

Classification	Description
Liberal	<ul style="list-style-type: none"> ● “Image Text”: attacks climate change deniers ● “Image Text”: non-ironically promotes pro-climate actions ● “Image Text”: attacks politician for inaction in the face of climate change ● “Image Text”: non ironically supports a politician or climate activist in addressing climate change ● “Image Text”: criticizes environmentally unfriendly actions (e.g., pipelines) ● “Image Text”: refers to climate change as a real crisis ● “Message”: is in agreement with “Image Text” ● “Page Name”: belongs to a source with a well-known liberal leaning (e.g., MSNBC and CNN both lean liberal) ● Use Allsides.com rating for source evaluations: https://www.allsides.com/media-bias/media-bias-ratings ● Give a 1 if at least one of the “Image Text” statements applies to the meme, the “Message” is in agreement” with “Image Text”; “Page Name” is not a source with a well-known conservative leaning. ● Give a 0 otherwise
Conservative	<ul style="list-style-type: none"> ● “Image Text”: calls out hypocrisy in politicians and climate activists (e.g., they fly in private planes/jets) ● “Image Text”: Ironically promotes climate actions ● “Image Text”: Ironically supports politician or climate activist in addressing climate change ● “Image Text”: mocks politician or climate activist who support climate change efforts ● “Image Text”: undermines the idea or denies that climate change that a real crisis ● “Message” mocks a pro-climate meme; support climate skeptic meme ● “Page Name”: belongs to a source with a well-known conservative leaning (e.g., FOX News and OAN both lean conservative) ● Use Allsides.com rating for source evaluations: https://www.allsides.com/media-bias/media-bias-ratings ● Give a 1 if at least one of the “Image Text” statements applies to the meme; “Page Name” is not a source with a well-known liberal leaning OR if “Message” mocks a pro-climate meme (i.e., “Message” and “Image Text” are contradictory). ● Give a 0 otherwise
Unsure	<ul style="list-style-type: none"> ● Give a 1 if both Liberal and Conservative are 0

To evaluate the different emotional reactions elicited by each of the liberal and conservative memes, a linear mixed effect model was used to predict each emotional reaction (e.g., Angry, Sad, Love), with a random fit for each page. To evaluate the ways in which the topic of climate change is discussed between liberal and conservative pages, a structural topic model (prevalence) was used to analyze the text within each of the memes.

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 10 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 from 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.

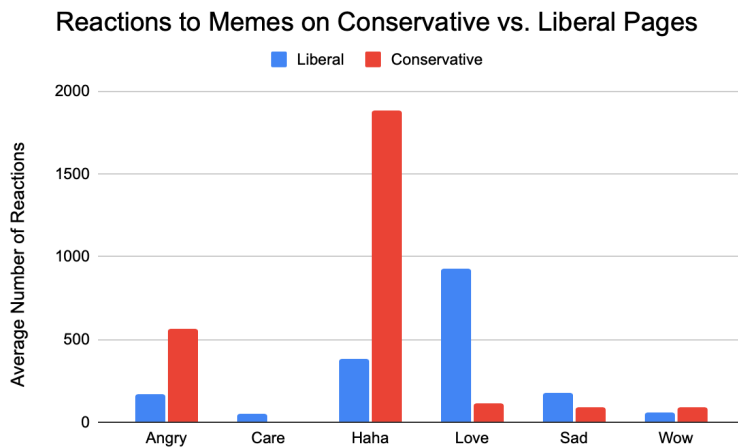


Figure 10. Average number of Angry, Care, Haha, Love, Sad, and Wow reactions across memes from liberal and conservative pages.

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 LDA models for liberals and conservatives, we determined that there were likely at least 20 distinct topics. The “textmineR” package in R was used to fit the LDA model to the text data within the meme. A window size of 1:2 was used, and the maximum number of topics was set to 20. The data were split into two separate datasets for liberals versus conservatives. The model reached maximum coherence with 16 topics for the liberal set, and 19 topics for the conservative set. Figure 11 depicts the 16 topics from the liberal set, and Figure 12 depicts the 19 topics from the conservative set. As shown in the model results, topics discussed in memes from liberal pages differ significantly from topics discussed in memes from conservative pages. Analyzing the data together, the final prevalence model contained 25 topics; considering the results from the LDA models, the number of topics was determined using the searchK function in the ‘stm’ package which computes diagnostic values for models with different values of K; Figure 13 shows the diagnostic results. Figure 14 summarizes the prevalence of major topics discussed by liberals and conservatives, and Table 5 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., 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 the climate crisis, and the need for America to lead mitigation efforts.

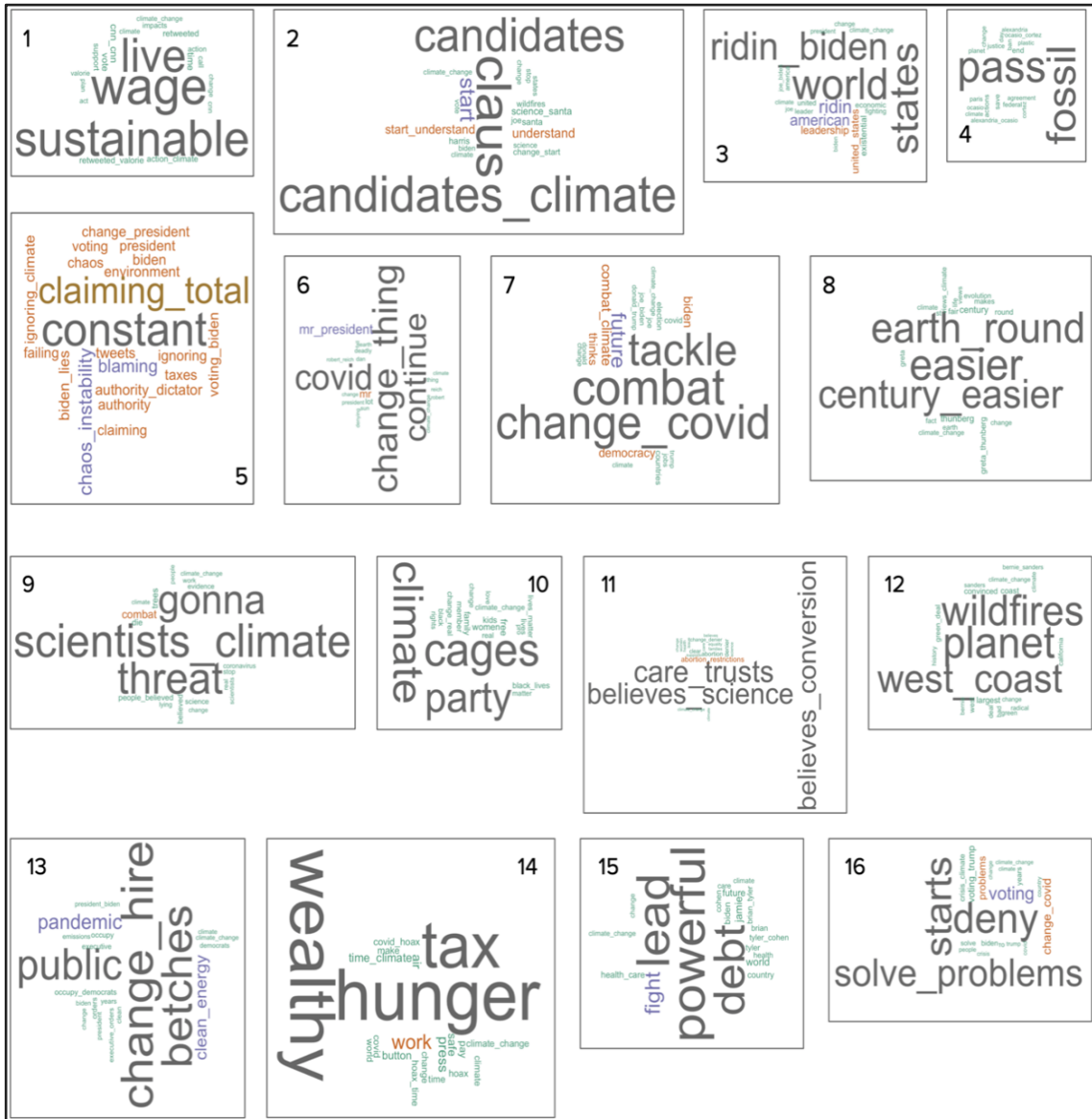


Figure 11. Word clouds for each of the 16 topics discussed in memes from liberal pages.

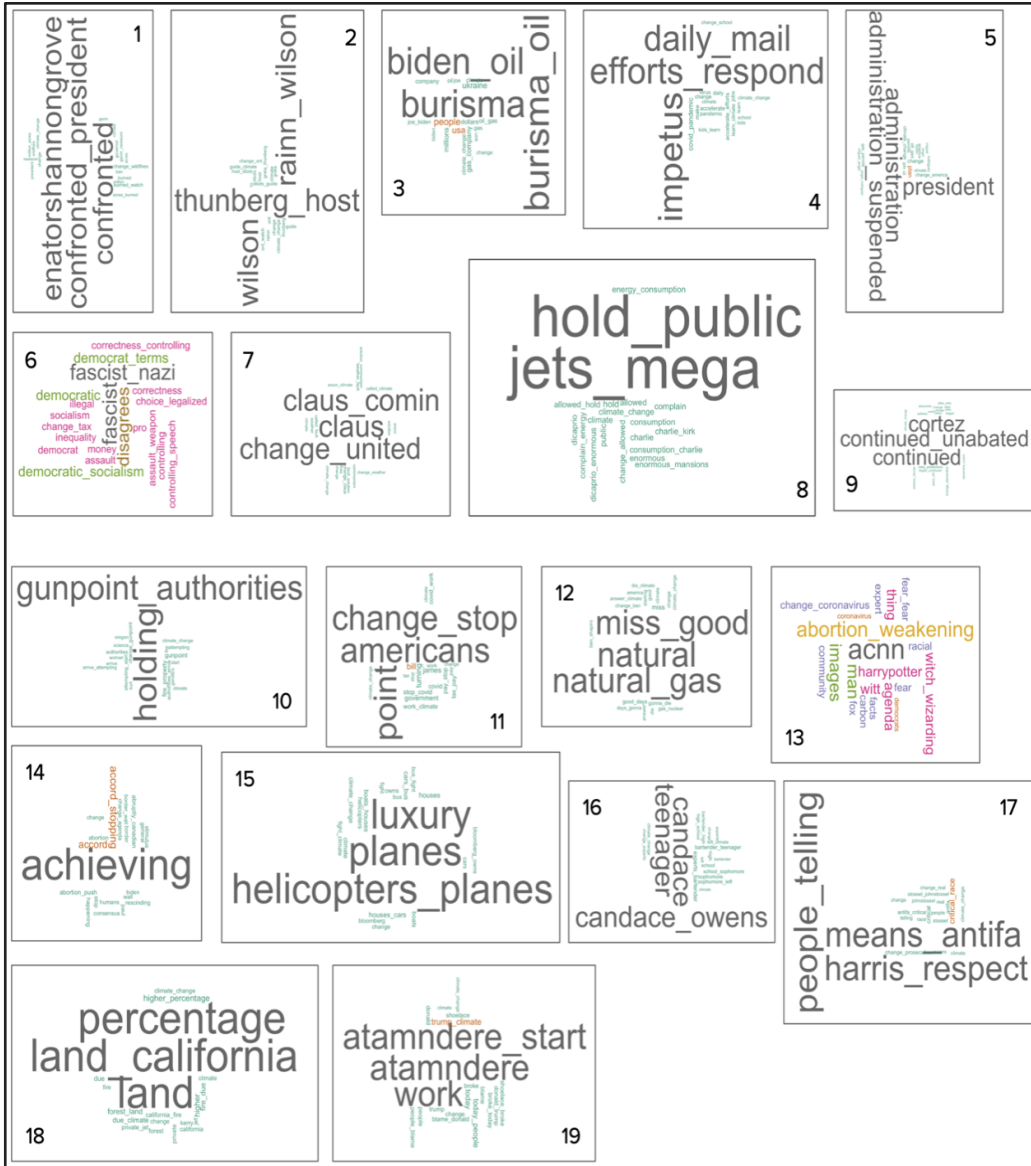


Figure 12. Word clouds for each of the 19 topics discussed in memes from conservative pages.

Diagnostic Values by Number of Topics

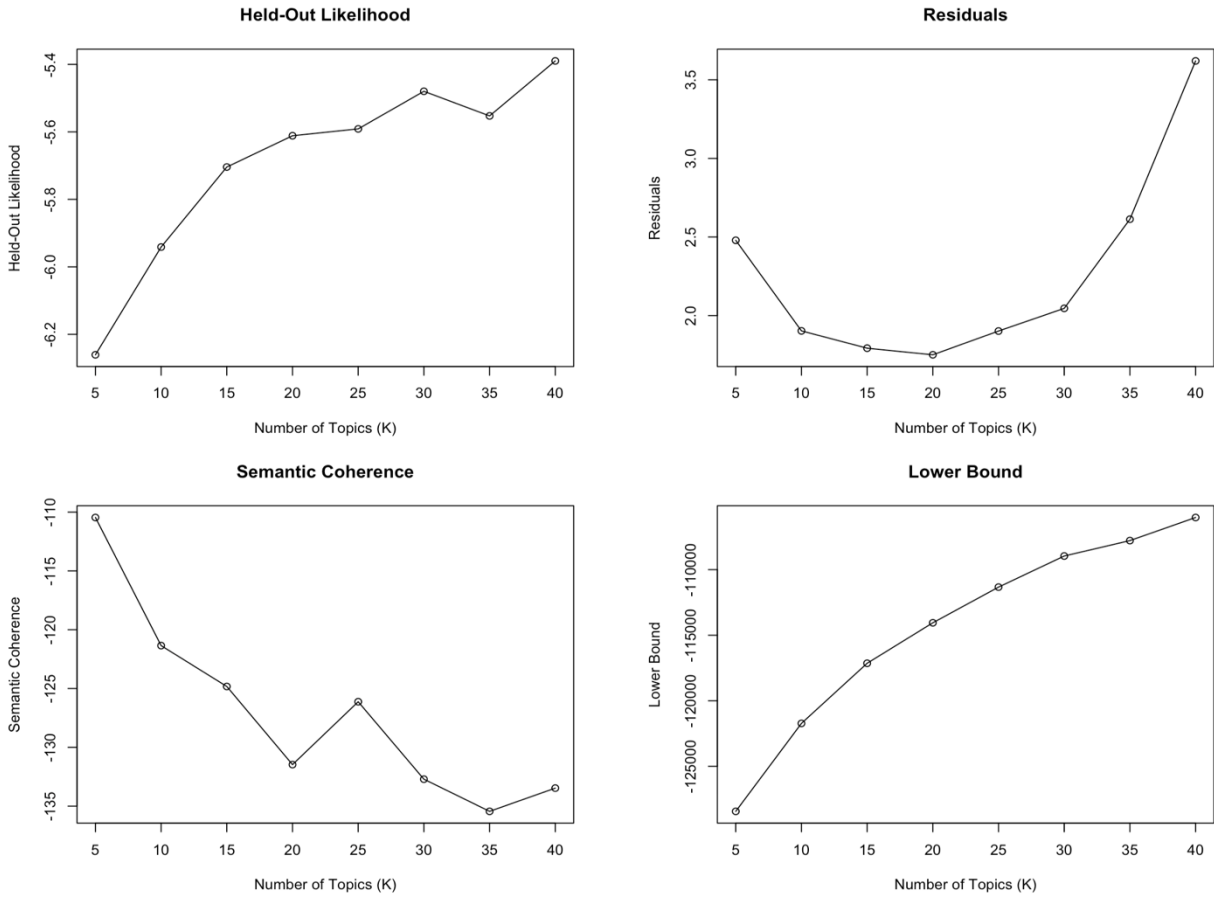


Figure 13. Diagnostic results from the searchK function via the ‘stm’ package. Results indicate that a model with 25 topics has a relatively high held-out likelihood (i.e., generalization capability), low residuals, and high semantic coherence.

Effect of Political Leaning (L-C)

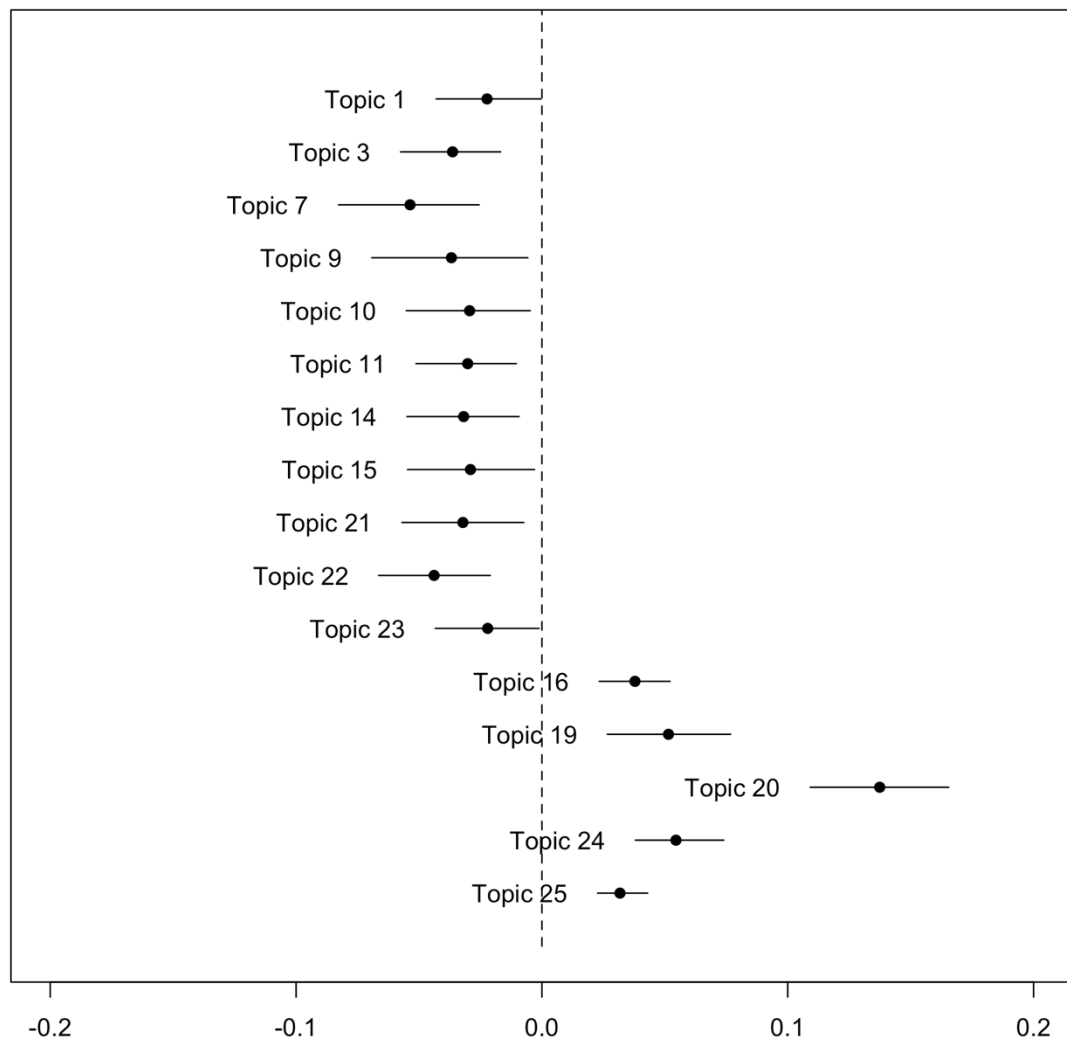


Figure 14. Prevalence of different topics discussed in memes posted in liberal versus conservative groups (Study 2). Values to the left of the dashed line indicate higher prevalence in liberal posts; values to the right indicate higher prevalence in the conservative posts.

Table 5: Statistically significant differences in prevalence of topic between liberals and conservatives.

Topic	Label	<i>p</i>
1	Santa Clause Analogy (L)	.048
3	Republican Denial (L)	< .001
7	Joe Biden - Progressive (L)	< .001
9	Political Corrupt. -Pollution (L)	.017
10	Fossil Fuel (L)	.020
11	Climate-COVID Denial (L)	.005
14	Healthcare - LGBTQ (L)	.005
15	Greta Thunberg (L)	.022
21	Abortion – BLM (L)	.009
22	Joe Biden (L)	< .001
23	Robert Christian (L)	.038
16	Science Education (C)	< .001
19	AOC-Bartending (C)	< .001
20	Twitter – Social Media (C)	< .001
24	Liberal Hypocrisy (C)	< .001
25	Climate – COVID (C)	< .001

Section 3 Discussion

Studies 3A and 3B 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 3A 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 (Bozdog, 2013; Gates, 2017, Pariser, 2011), even when the content may be misleading or misinformed.

Study 3B broadened the analyses of how memes may function to influence people's beliefs. More specifically, the final 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, many of which were not metaphorical. 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.

GENERAL DISCUSSION

The five presented studies explored and found evidence for the covert cognitive and emotional processes that underlie political attitude formation and development. Studies 1A through 2 dissected the role of relational thinking in a contemporary form of political metaphor—internet memes. Using structural equation modeling, the aforementioned studies gave quantitative evidence of some memes functioning as metaphors. In the best fitting models, we observed that more relatable memes were judged as more apt, a core property of effective metaphors. Studies

1A and 1B went beyond previous studies of metaphor comprehension in linking aptness not only to comprehension of memes, but also to their perceived humor. We found that greater aptness was associated with greater ratings of comprehension. Consistent with theoretical analyses of humor, which have often emphasized the importance of surprise or incongruity (Koestler, 1964; Ruch, 2008; Suls, 1972), the impact of aptness was to some extent moderated by the degree to which the meme was viewed as surprising such that the effect of aptness on rated humor was greater when the stimuli was surprising. Studies 1A and 1B also went beyond previous work on metaphor, where aptness is often treated as an objective characteristic of a metaphor, showing that at least for memes, perceived aptness clearly has a subjective component. In particular, structural equation modeling revealed that rated relatability—the degree to which the participant personally identified with the message conveyed by the meme—influenced its perceived aptness. Study 2 built on the first two studies by extending the study paradigm to include political memes; structural equation modeling suggested that political congruity was associated with greater relatability, and that ultimately, greater comprehension and rated humor was associated with a greater propensity to share.

Study 3A then explored and found evidence for the potential of memes to serve as metaphorical frames. In particular, presenting participants with a set of conservative memes subsequently led to more skeptical judgments of climate change data from NASA relative to presenting participants with a set of liberal memes. Study 3B extended the dissertation's focus to internet memes more broadly; it leveraged statistical and structural topic modeling to explore the various emotions elicited by memes posted to politically liberal or conservative web pages. Particularly, liberal memes on climate change elicited more positive emotions (love and care), relative to conservative memes which elicited more negative emotions (anger and laughing).

Subsequent structural topic modeling revealed topics consistent with the elicited emotions. Results from the prevalence model suggested 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 work should explore potential differential impacts of metaphorical vs non-metaphorical memes. Given that metaphors are known to provide conceptual frames and elicit emotions, they may be more effective in communicating and *revising* deeply-held beliefs compared to purely emotive memes. Future studies may also consider how the degree of emotiveness in memes actually predicts future attitudes.

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