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Influencing environmental attitudes: An experimental and meta-analytic examination of interventions

DISSERTATION

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for the degree of

DOCTOR OF PHILOSOPHY

in Psychology and Social Behavior

by

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ABSTRACT OF THE DISSERTATION

Influencing environmental attitudes: An experimental and meta-analytic examination of interventions

by

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Doctor of Philosophy in Psychology and Social Behavior

University of California, Irvine, 2020

Professor Peter H. Ditto, Chair

Despite increasing scientific evidence about climate change, the topic often fails to be prioritized in mainstream American politics. Yet the most impactful tools that the citizens of the U.S. have to mitigate the negative effects of climate change involve policies applied at both a nationwide and multinational level. Through three distinct empirical investigations, this dissertation examines ways to influence environmental and climate change attitudes, using both original experiments and meta-analysis.

The first set of studies focused on perceptions of fracking through three experiments. Participants were given a pro-fracking (conservative position) or anti-fracking (liberal position) article from Fox News (conservative source) or MSNBC (liberal source). Overall, participants who read an anti-fracking article tended to be less supportive of fracking than those who read a pro-fracking article. Contrary to hypotheses, the source of the article did not impact participants' attitudes about the methods of the study or about fracking.

The next set of experiments investigated climate change attitudes specifically. Past research finds that providing people with the statement that 97% of climate scientists agree that climate change is human-caused is an effective way to convince people about climate change. To

extend this research, the current studies provided participants with a news article about climate change and embedded a consensus statement at the end of some of the articles. Compared to those in a control condition, participants who read an article with consensus information had significantly higher perceptions of the scientific consensus, although there were mixed results for other climate change attitudes across the three studies. The studies provide evidence that consensus statements can still be effective even if they are embedded at the end of a news article.

The dissertation ends with a meta-analysis of experimental interventions on climate change attitudes. The meta-analysis located experimental studies with a control condition and examined the difference between treatment and control as a measure of effect size. The results show that interventions had a small, statistically significant positive effect on attitudes. Furthermore, interventions were less effective for policy attitudes than for belief in climate change. Unexpectedly, the type of intervention used was not a significant moderator of effect size. The findings indicate that attitudes towards policy are more resistant to change than other climate change attitudes, but also point to the limited effectiveness of interventions. The meta-analysis ends with a discussion of the implications and future directions.

INTRODUCTION

Climate change—increasing global mean surface temperature primarily due to human greenhouse gas emissions—presents a threat to both ecosystems and human society due to changes in Earth's ecological system on a global scale (IPCC, 2018).[1] Mitigating the worst effects of climate change will require action at the individual, organizational (e.g., industry), and governmental levels of society. The level of warming predicted due to existing greenhouse gas emissions presents much less of a threat than the warming that is predicted to happen if emissions are not substantially reduced in the next two to three decades (IPCC, 2018). Therefore, climate change is a threat that can be addressed to lessen its risks.

Action towards addressing climate change has been steady but not occurring quickly enough. For example, the United States withdrew from the Paris Agreement, an international agreement where countries set greenhouse gas emissions reduction targets and report their progress on those goals (Hersher, 2019). This withdrawal stems from a political divide in the U.S., where liberals tend to be more supportive of environmental action than conservatives (McCright et al., 2014; McCright & Dunlap, 2011). For instance, although people in the U.S. are taking climate change more seriously in recent years and placing it higher as a political priority, most of this increase is from liberals (Kennedy & Hefferon, 2019; Pew, 2020). Any attempt to stir action towards climate change mitigation needs to identify the role of politics in influencing attitudes.

This dissertation examines experimental approaches to influencing attitudes about climate change and other environmental topics. Chapter 1 presents a paper published in the journal *Environmental Studies and Sciences*. The series of experiments in this paper investigate

[1] Climate change and global warming will be used interchangeably throughout this dissertation.

attitudes about fracking, specifically how political partisans respond to information about fracking in the media. Research in motivated reasoning finds that people are overly critical of information that is counter to their prior beliefs, and overly accepting of information that confirms their prior beliefs (Ditto et al., 2019; Lord et al., 1979; Taber & Lodge, 2006). Other research finds similar effects with sources of information, such that people are more likely to accept information from a source aligned with their political beliefs than one they disagree with (Cohen, 2003; Ehret et al., 2018; Fielding et al., 2019). Typically, sources present information that is aligned with their political leanings. However, what happens when a source presents information that is counter to its politics? Specifically, would conservatives be more accepting of environmental information if it were presented by a conservative source, like Fox News? To answer this question, I conducted three experimental studies. Participants were presented with descriptive results of a study with either a pro- or anti-fracking conclusion. Furthermore, the results of the study were presented and described by either a conservative news outlet (Fox News) or a liberal one (MSNBC). Surprisingly, I found that both liberals and conservatives were more supporting of fracking after reading pro-fracking articles than anti-fracking articles, regardless of the source. There was some evidence that liberals were particularly responsive to information from MSNBC, although the results were inconsistent across studies. The experiments point to the malleability of fracking attitudes, but fail to find evidence that presenting environmental information from a conservative source is a particularly promising intervention for a conservative audience. The chapter concludes by situating the findings in the larger body of research and examines some of the reasons why attitudes towards fracking may be qualitatively different than climate change attitudes.

Turning more specifically to climate change, Chapter 2 examines the impact of another intervention for attitudes. Previous research finds that providing people with information about the agreement among climate scientists about global warming—specifically that the overwhelming majority of climate scientists agree that human-caused climate change is happening—can increase people's perception about the consensus among climate scientists (e.g., van der Linden et al., 2019; van der Linden et al., 2015). Some studies using this manipulation find that it also increases belief in climate change, worry about climate change, and support for policy (e.g., Goldberg et al., 2019; van der Linden et al., 2019), whereas other studies provide more mixed evidence (e.g., Cook et al., 2017; Cook & Lewandowsky, 2016; Ma et al., 2019). In addition, most of the studies using a consensus manipulation provide participants with an overt message (often short) that strongly highlights the consensus information. Across three experiments, I replicated and extended this work by inserting a consensus message at the end of a news article, testing whether a more subtle and ecologically valid medium could still effectively convey the same information. In all three studies, participants who read an article with the consensus manipulation had significantly higher perceptions of the consensus (i.e., 97% of climate scientists who agree) than those in a control condition. Furthermore, the news article with consensus information embedded at the end was just as effective as a commonly used overt message. However, other effects were less robust. For example, participants in Study 1 had more belief in climate change after reading the consensus article compared to a control group, but this effect was not found in Studies 2 or 3. In Study 2, the consensus article was particularly effective for conservatives (more so than for liberals), but this effect was not found in Studies 1 or 3. Overall, the series of studies provides evidence that a news article with consensus information can effectively increase people's perception about the scientific consensus on climate change,

but little evidence for the intervention's ability to influence climate change attitudes like belief or support for action.

A few results in Chapters 1 and 2 are promising—fracking attitudes can be influenced, and news articles are effective for changing perceptions of scientific consensus—but evidence for overall intervention effectiveness is lacking in each chapter. Given that many other researchers have attempted to influence attitudes through experimental studies, Chapter 3 steps away from individual experiments and instead investigates climate change attitudes through meta-analysis. The chapter begins with an overview of the various types of interventions that have been used for climate change attitudes and a discussion of various moderators. After collecting studies through a large literature search, I quantitatively combined experimental studies that measured climate change attitudes between experimental conditions and a control condition. Overall, interventions had a small but statistically significant effect on attitudes. Intervention type was not a significant moderator of effect size, although most categories had too few studies to make meaningful comparisons between them. Importantly, attitude type was a significant moderator such that interventions were more effective for influencing belief in climate change than policy support. This finding suggests that, while policy may be the best way to implement large scale solutions to climate change, attitudes towards policy are the most resistant to change among climate change attitudes. The chapter concludes with a discussion of the overall takeaways, as well as the implications the meta-analysis has for future research on climate change attitudes.

Taken together, this dissertation presents various examples of ways to influence environmental attitudes, finding that these attitudes are generally resistant to change, although they can be swayed in certain contexts.

References

Cohen, G. L. (2003). Party over policy: The dominating impact of group influence on political beliefs. *Journal of Personality and Social Psychology*, *85*(5), 808–822. https://doi.org/10.1037/0022-3514.85.5.808

Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using bayesian networks. *Topics in Cognitive Science*, *8*(1), 160–179. https://doi.org/10.1111/tops.12186

Cook, J., Lewandowsky, S., & Ecker, U. K. H. (2017). Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLoS ONE*, *12*(5), e0175799. https://doi.org/10.1371/journal.pone.0175799

Ditto, P. H., Liu, B. S., Clark, C. J., Wojcik, S. P., Chen, E. E., Grady, R. H., Celniker, J. B., & Zinger, J. F. (2019). At least bias is bipartisan: A meta-analytic comparison of partisan bias in liberals and conservatives. *Perspectives on Psychological Science*, *14*(2), 273–291. https://doi.org/10.1177/1745691617746796

Ehret, P. J., Van Boven, L., & Sherman, D. K. (2018). Partisan barriers to bipartisanship: Understanding climate policy polarization. *Social Psychological and Personality Science*, *9*(3), 308–318. https://doi.org/10.1177/1948550618758709

Fielding, K. S., Hornsey, M. J., Thai, H. A., & Toh, L. L. (2019). Using ingroup messengers and ingroup values to promote climate change policy. *Climatic Change*. https://doi.org/10.1007/s10584-019-02561-z

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). The role of anchoring in judgments about expert consensus. *Journal of Applied Social Psychology*, *49*(3), 192–200. https://doi.org/10.1111/jasp.12576

Hersher, R. (2019, November 4). U.S. formally begins to leave the Paris climate agreement. *NPR*. https://www.npr.org/2019/11/04/773474657/u-s-formally-begins-to-leave-the-paris-climate-agreement

IPCC. (2018). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*. World Meteorological Organization.

Kennedy, B., & Hefferon, M. (2019, August 28). U.S. concern about climate change is rising, but mainly among Democrats. *Pew Research Center*. https://www.pewresearch.org/fact-tank/2019/08/28/u-s-concern-about-climate-change-is-rising-but-mainly-among-democrats/

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37*(11), 2098–2109. https://doi.org/10.1037/0022-3514.37.11.2098

Ma, Y., Dixon, G., & Hmielowski, J. D. (2019). Psychological reactance from reading basic facts on climate change: The role of prior views and political identification. *Environmental Communication, 13*(1), 71–86. https://doi.org/10.1080/17524032.2018.1548369

McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly, 52*(2), 155–194. https://doi.org/10.1111/j.1533-8525.2011.01198.x

McCright, A. M., Xiao, C., & Dunlap, R. E. (2014). Political polarization on support for government spending on environmental protection in the USA , 1974 – 2012. *Social Science Research*, *48*, 251–260. https://doi.org/10.1016/j.ssresearch.2014.06.008

Pew. (2020, February 13). As economic concerns recede, environmental protection rises on the public's policy agenda. *Pew Research Center*. https://www.people-press.org/2020/02/13/as-economic-concerns-recede-environmental-protection-rises-on-the-publics-policy-agenda/

Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science*, *50*(3), 755–769. https://doi.org/10.1111/j.1540-5907.2006.00214.x

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS ONE*, *10*(2), e0118489. https://doi.org/10.1371/journal.pone.0118489

van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology*, *62*, 49–58. https://doi.org/10.1016/j.jenvp.2019.01.009

CHAPTER 1

Abstract

The present research examines the combined role of the message and source of a news article in persuading political partisans about an environmental policy. In a series of three experiments, we presented participants (Total N = 3,457) with a realistic news article summarizing scientific evidence concerning the environmental and economic costs and benefits of hydraulic fracturing (fracking). The article's message was manipulated to support either a conservative (pro-fracking) or liberal (anti-fracking) policy and was attributed to either a conservative news source (Fox News) or a liberal one (MSNBC). Participants who read pro-fracking articles were generally more supportive of fracking than those who read anti-fracking articles, regardless of whether articles were from an ideologically friendly or unfriendly source. Consistent with previous research, however, participants perceived articles with ideologically unfriendly messages to have worse methods than articles with ideologically friendly messages. Finally, liberal participants showed some reduction in resistance to ideologically unfriendly messages coming from an ideologically friendly source, but conservative participants did not. Implications for politicization of environmental policy and future research are discussed.

Keywords: fracking, motivated reasoning, biased assimilation, environmental attitudes

Comparing the Effects of a News Article's Message and Source on Fracking Attitudes in an Experimental Study

The natural gas extraction method of hydraulic fracturing, or fracking, has been met with both scientific and political debate surrounding its costs and benefits. Some research indicates that fracking has more greenhouse gas emissions than renewable energy sources, but is cleaner than traditional sources like coal (Alvarez et al., 2012), especially when paired with the right energy policies (Newell & Raimi, 2014). Other studies reach stronger conclusions, arguing that fracking has a bigger negative impact on climate change—specifically through methane emissions—than even traditional sources of oil and gas production (Howarth et al., 2011). A recent review on fracking research found that the main benefits are economic in nature, while the costs tend to be environmental (Sovacool, 2014). Furthermore, the costs of fracking have been both potentially underestimated (e.g., Brandt et al., 2014) and inequitable—those receiving the benefits of fracking are not always the same ones incurring the costs (Fry et al., 2015).

Given the scientific debate surrounding the value of fracking, it is a prime topic for political polarization. Environmental politics in the U.S. have become politicized over the last few decades (e.g., Andrews, 2012; Dunlap et al., 2001; McCright & Dunlap, 2003; McCright & Dunlap, 2011; McCright et al., 2014), and fracking is not immune to this ideological divide: a 2016 poll found that 70% of conservative Republicans supported expanding fracking, while only 17% of liberal Democrats supported it (Funk & Kennedy, 2016). Although liberals tend to oppose fracking and conservatives tend to support it, it seems that the public generally does not know much about the issue (e.g., Boudet et al., 2014; Davis & Fisk, 2014). The mixed findings of a recent report on fracking (EPA, 2016) led partisans to claim evidence for their policy positions: one website stated that "EPA declares no 'widespread' harm to drinking water from

fracking, boosting industry" (Fox News, 2015), whereas another website used the same evidence to claim that, "EPA confirms that fracking poses a risk to drinking water" (Berman, 2015). This example shows how political partisans tend to interpret scientific evidence in favor of their pre-existing beliefs, especially for hotly contested topics like fracking.

Researchers in various fields have studied people's attitudes about fracking and the political polarization of those attitudes. For example, sociology researchers have examined social media coverage of fracking in response to a documentary (Vasi et al., 2015), energy policy researchers have investigated the influence of political identity on attitudes towards energy (Karlstrøm & Ryghaug, 2014), and researchers in the fields of political science (e.g. Bullock, 2011; Guisinger & Saunders, 2017), social psychology (e.g., Cohen, 2003; Ehret et al., 2018), energy policy (e.g., Christenson et al., 2017; Stokes & Warshaw, 2017), and communication (e.g., Bergan, 2012; Bolsen et al., 2019) have all investigated different experimental manipulations of environmental information to better understand the causes and outcomes of political attitudes.

The current research builds on these studies by adding to the experimental research on environmental attitudes and politics, specifically fracking. Typically, political media sources produce message content aligned with their politics. But what happens when source and message are crossed, such that a political source produces information that is not aligned with its politics? More specifically, would people be more receptive to pro-environmental information if it came from an ideologically friendly source (i.e., one that aligns with their politics)? To examine this question, we provided participants with an edited news article that summarized a recent study on fracking. We manipulated whether the conclusions drawn from the article were anti-fracking or pro-fracking as well as whether the article came from a liberal or a conservative media source.

Through three studies, we evaluate how people respond to news articles when the typical source-message link is broken, with a particular focus on whether a pro-environmental message is more persuasive to conservative participants when it comes from a conservative rather than a liberal news source. Before describing the current set of studies and results, we first review research on independent effects of message content and message source of political persuasion.

Message Content: Motivated Reasoning

In the political domain, people are often motivated to defend their political identity and engage in partisan motivated reasoning, or "directional goals aimed at protecting one's partisan identification" (Bolsen et al., 2014, p. 237). When people process information with directional rather than accuracy goals, they tend to become more polarized in defending their pre-existing beliefs (Lord et al., 1979; Taber & Lodge, 2006) and find ways to reject information that does not fit with their desired conclusions and accept at face value information that does fit (Ditto & Lopez, 1992; Ditto et al., 1998). Recent research has examined hot political topics under the lens of motivated reasoning, showing that people across the political spectrum are more likely to deny a scientific message when it reaches a conclusion that disagrees with their political views than one that agrees with them (Ditto et al., 2019; Kraft et al., 2015; McCright et al., 2013; Washburn & Skitka, 2018).

Research on fracking specifically, however, paints a more nuanced picture. Experimental studies on fracking attitudes have found little evidence of partisan motivated reasoning: Bayer and Ovodenko (2019) found that all partisans were less supportive after reading messages about fracking's costs, while Christenson et al. (2017) found that both Democrats and Republicans were no different than a control condition when reading about fracking's costs or costs plus benefits. Finding similar results, Ciuk and Yost (2016) suggested that partisans rely on the

information within a message (rather than source) when dealing with a highly salient issue like fracking. Perhaps people have less knowledge about fracking than other issues (Boudet et al., 2014) and this enables them to be responsive to various messages (see Choma et al., 2016 for evidence of a nuanced relation between fracking knowledge and polarization). Although the mechanism is unclear, these studies suggests that the context of fracking may lead to partisans being relatively open to an ideologically unfriendly message.

Message Source: Partisan Framing

Numerous experimental studies have manipulated the source of a message and measured how it affects people's perceptions of the message. This research documents a robust effect such that people tend to support the identical policy proposal more strongly when it is said to be supported by their own political party than by the opposite political party (Cohen, 2003; Ditto et al., 2019). This effect has been shown with various environmental policies, including cap-and-trade, carbon tax, and renewable portfolio standards (Stokes & Warshaw, 2017; Van Boven et al., 2018). Mullinix (2016) refers to these source manipulations as a partisan frame, and argues that individuals tend to rely on partisan frames when there is more political polarization, when the partisan frame is made salient, and when the specific issue at hand is not as important to the individual as partisan identity. Furthermore, partisan frames can increase motivated reasoning (Petersen et al., 2013) and political polarization (Unsworth & Fielding, 2014).

Uncoupling Message and Source

Motivated reasoning research suggests that information consistent with one's political attitudes will be accepted more readily than information inconsistent with those attitudes. Partisan framing research suggests that information from a politically friendly source will be accepted more readily than information from a politically unfriendly source. Typically, these two

effects reinforce one another. People tend to get political information from sources with a preferred political slant (Mitchell et al., 2014), and political partisans engage in selective exposure to ideologically friendly information (Hart et al., 2009; Iyengar & Hahn, 2009; for recent trends, see Rodriguez et al., 2017). This phenomenon has been consistently found in online political media and communication (e.g., Adamic & Glance, 2005; Bakshy et al., 2015; Barberá et al., 2015).

But what happens when message and source contrast, such that a message challenging your political attitudes comes from a politically friendly source? Orthogonal manipulations of message and source break the natural link between ideologically aligned sources and information and this misalignment of source and message is a potential way to make politically unfriendly information more palatable.

Research on persuasion, for example, suggests that communicators are perceived as particularly credible when they argue against their own self-interest (Eagly et al., 1978). Similarly, there is evidence that politicians espousing so-called "maverick" stands (policy positions that are opposed by their political party) often evoke more positive evaluations than politicians who more closely tow the party line (Ditto & Mastronarde, 2009), perhaps because independence and authenticity are generally viewed as desirable personality traits (Peterson & Seligman, 2004). This work suggests that messages that challenge an individual's political views might be more readily accepted if they come from a politically friendly media source. For example, the editor of the traditionally conservative publication *Christianity Today* recently called for the removal of President Donald Trump in an editorial titled, "Trump Should Be Removed from Office" (Galli, 2019). It seems possible that this ideologically unfriendly message might be more persuasive to a conservative audience than the identical message coming from a

more liberal, more ideologically unfriendly source. Alternatively, it is possible that the motivation to reject information that challenges one's preferred conclusions is strong enough to counteract the benefit of a politically friendly source, or that any effects of the source of information may be stronger on one side of the political spectrum than the other.

The present studies examine the combined effects of message and source on the persuasive effects of scientific information on fracking. We expect to replicate past findings showing that a) people are generally responsive to information about fracking, whether it supports or challenges the wisdom of fracking and regardless of media source, but b) people will accept scientific information about fracking more when it is consistent with their political views than when it is inconsistent with their political views (replicating Lord et al., 1979 and Taber & Lodge, 2006). Our key empirical question, however, is whether receiving politically unfriendly information about fracking from a politically friendly media source will mitigate resistance to the information, and particularly whether this effect might lead political conservatives to be more receptive to information challenging the effectiveness of fracking when it comes from a media source that is perceived to share their political orientation.

Study 1

Method

Materials

We found an article online from the California Independent Petroleum Association that discussed a recent economic study from Yale University about the benefits of fracking (CIPA, nd).[2] The article included data from an economic study that emphasized the financial benefits of

[2] Although the original source of this article is a proponent of fossil fuels, we chose this article because it presented the best source material to edit to be both pro- and anti-fracking. The article presented a cost-benefit analysis that relied heavily on numbers (rather than narrative, as in other articles), allowing us to manipulate the numbers and get different conclusions with as little editing as possible.

fracking and minimized the environmental costs. We created an alternative version of the article where the author argues against fracking, citing minimal economic benefits and large environmental costs. We manipulated the numbers in the article with little editing of the words, resulting in two nearly identical articles with opposite conclusions. We took the look and logos of Fox News and MSNBC online articles and paired them with both versions of the fracking article. In total, we had four versions: an anti-fracking article presented as coming from either Fox News or MSNBC, and a pro-fracking article presented as coming from either Fox News or MSNBC (see Figure 1.1). We used Fox News and MSNBC because they are widely understood by the U.S. public to be conservative and liberal news outlets, respectively (Mitchell et al., 2014).

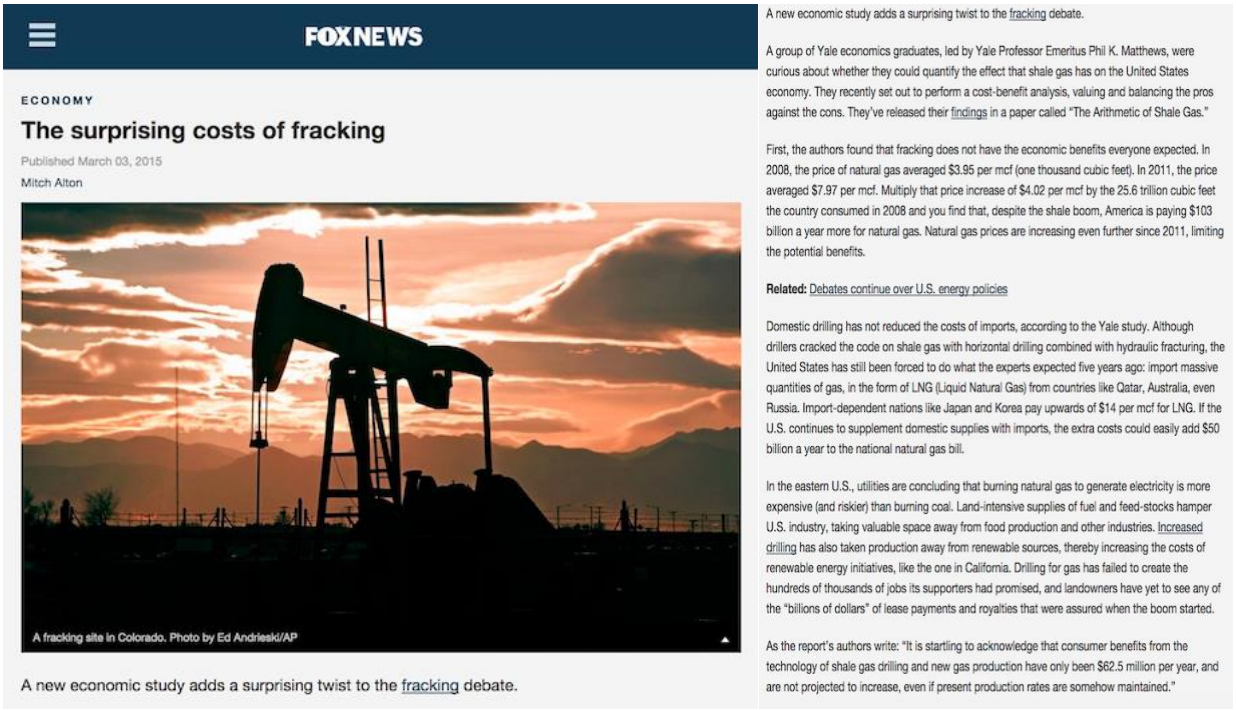
Participants

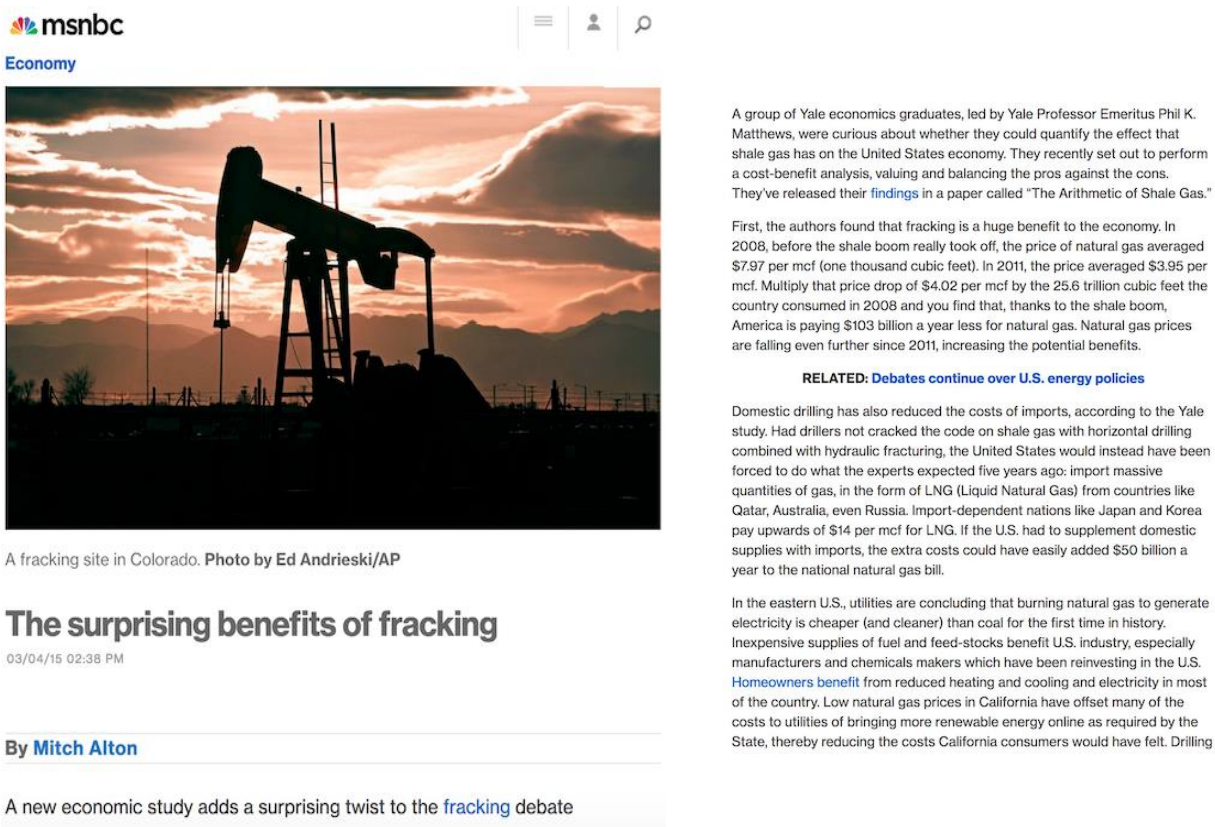
We recruited participants from the website *YourMorals.org*, a publicly available website where participants take surveys about their political attitudes and opinions in return for feedback about the studies. We collected data on 1,753 participants from January 2016 to May 2016, and from October 2016 to January 2017. We excluded any participants living outside of the U.S., resulting in a final sample of 1,278.[3] Sample demographics for Study 1 (and all three studies) can be found in Table 1.1, including demographics before and after excluding participants as outlined below.

[3] Because people can enter and leave the website freely, many click on a study to look at it and then leave. For example, out of the total 1,753 participants in our dataset, only 1,220 participants answered at least one question on the first page of our study. Likewise, out of the 1,278 U.S. participants, only 927 answered at least one question on the first page.

Figure 1.1

Screenshots of the Stimulus Materials





Procedure and Measures

After reading the university approved IRB statement (all three studies part of an ongoing IRB for the research lab started in 2007, HS #2007-5740) and consenting to participate, participants were taken to the next page where they were shown the article and instructed to read it carefully. Afterward, participants answered a few questions about its content, and a number of questions evaluating the article, the media, and their attitudes on fracking. At the end of the survey, participants were debriefed and informed that the article had been edited.

To maintain our cover story of evaluating science in the media, we included a range of questions designed to make participants believe we were mostly interested in their evaluation of the article. All questions asked in the studies can be found in the online supplementary materials (see published article listed in the acknowledgements). Here we outline our measures of primary interest.

Participants reported their level of political conservatism at registration for the website on a 7-point scale from 1 (*Very liberal*) to 7 (*Very conservative*), where the midpoint was "Moderate/middle-of-the-road" (three other options were listed: "Don't know/Not political"; "Libertarian"; or "Other"). We grouped participants scoring between 1 and 3 on conservatism as liberal participants and those scoring between 5 and 7 as conservative participants. As seen in Table 1.1, nearly 75% of the sample was liberal, making it difficult to draw conclusions about conservative participants.

To determine whether participants understood the main purpose of the article, we excluded any participants who incorrectly identified the main argument of the article they read (n = 55; see the online supplementary materials for exact question wording). All analyses exclude individuals who did not respond accurately to the manipulation check. Analyses with the full

sample (for all three studies) can be found in the online supplementary materials, but the overall pattern of results remained the same.

We gave participants a statement about the study methods, "The methods used in the Yale study were scientifically flawed". Participants answered on a 5-point Likert scale from 1 (*Strongly agree*) to 5 (*Strongly disagree*). We reverse coded the scores so higher scores indicated more agreement that the methods were flawed.

Finally**,** we included two questions to assess attitudes about fracking. The first question asked, "Which of the following best describes your beliefs about whether fracking should be legal in the U.S.?" (Raimi & Leary, 2014). Participants chose one of five responses that decreased in support for fracking, from "Fracking should be legal without any restrictions" to "Fracking should never be legal". Because of the non-equivalent distances between response options, we analyzed the item as an ordinal variable. We reverse coded the item such that higher scores indicated more support for fracking. Our second question on fracking attitudes was a general measure of support, "In general, I support fracking in the U.S." Participants chose between three response options: "Yes," "No," and "I do not have an opinion on fracking".

Statistical Analysis

We used the same statistical analyses for all three studies.[4] We dummy coded each experimental condition with the Fox News anti-fracking article as the reference group. For each dependent variable, we conducted a regression with the dependent variable predicted by the set of experimental dummy variables for liberal and conservative participants separately. We ran linear regressions for continuous outcome variables, ordered logistic regressions for ordinal

[4] This way of analyzing the results is different from our Study 3 preregistration and was changed based on reviewer suggestions. The online supplementary materials for the published study include the results for Study 3 analyzed as specified in preregistration.

variables, and logistic regressions for binary variables. To conduct pairwise comparisons between experimental conditions, we calculated estimated marginal means using the *emmeans* package (Lenth, 2018) in R and used Tukey-corrected *p*-values to adjust for inflated Type I error across six comparisons.

Table 1.1

Sample Demographics from Each Study, Broken Down Before and After Any Exclusions

	Full sample		After exclusions	
	n (%)	*M* (*SD*)	*n* (%)	*M* (*SD*)
Study 1				
Age	1,277	37.43 (15.00)	872	37.82 (14.53)
Female	429 (33.57)		275 (31.54)	
Conservative	131 (13.06)		91 (13.17)	
Moderate	121 (12.06)		82 (11.87)	
Liberal	751 (74.88)		518 (74.96)	
Study 2				
Age	780	21.66 (3.19)	554	21.76 (3.50)
Female	635 (81.20)		454 (81.51)	
Conservative	82 (12.41)		55 (11.55)	
Moderate	138 (20.88)		97 (20.38)	
Liberal	441 (66.72)		324 (68.07)	
Study 3				
Age	1,003	41.79 (13.36)	869	42.36 (13.46)
Female	567 (56.59)		496 (57.14)	
Conservative	469 (46.76)		394 (45.34)	
Moderate	*NA*		*NA*	
Liberal	534 (53.24)		475 (54.66)	

Note. For age, *n* represents the number of people who reported their age. "Female" is the number and percentage of people who identified as female. "Conservative" combines people who responded to the ideology scale as "Very conservative", "Conservative", or "Slightly conservative". "Moderate" is composed of people who responded to the ideology scale as "Moderate/middle-of-the-road". "Liberal" refers to people who responded to the ideology scale as "Very liberal", "Liberal", or "Slightly liberal". In Study 3, we only recruited participants who identified as conservatives or liberals. We removed participants who took less than one minute (for Studies 2 and 3), who failed a manipulation check, and who were suspicious of the experimental manipulation.

Results

Liberal Participants

Study Quality. As displayed in the overall regression results in Table 1.2, liberal participants engaged in partisan motivated reasoning with regard to the fracking message: despite each study having the exact same methods, pro-fracking studies were rated as having worse methods than anti-fracking studies. Liberals rated the study in both pro-fracking articles (MSNBC M = 3.20, Fox News M = 3.41) as having significantly more flawed methods than the study in the anti-fracking articles (MSNBC M = 2.74, Fox News M = 2.80): MSNBC pro-fracking vs. Fox News anti-fracking ($t(513) = 3.81$, $p < .001$, $d = 0.48$), MSNBC pro-fracking vs. MSNBC anti-fracking ($t(513) = 4.46$, $p < .001$, $d = 0.55$), Fox News pro-fracking vs. Fox News anti-fracking ($t(513) = 5.83$, $p < .001$, $d = 0.73$), Fox News pro-fracking vs. MSNBC anti-fracking ($t(513) = 6.50$, $p < .001$, $d = 0.80$).

Table 1.2

Effect of Experimental Condition on Perceptions of the Scientific Methods Used in the Study Reported in the Experimental Text (Study 1)

	Liberals	Conservatives
Intercept	2.80***	3.25***
Fox News pro-fracking	0.61***	-0.20
MSNBC anti-fracking	-0.06	-0.35
MSNBC pro-fracking	0.40***	-0.55*
N	517	91
R^2	0.10	0.05
Adjusted R^2	0.10	0.02
F Statistic	19.28***	1.55

Note. Unstandardized regression coefficients are reported. Since the Fox News anti-fracking condition is the reference group, the intercept represents the mean of this group and *b*s represent differences between each article condition and the Fox News anti-fracking group.
*$p < .05$. **$p < .01$. ***$p < .001$.

Interestingly, the source manipulation did not mitigate this tendency to derogate the quality of ideologically unfriendly information. Even from an ideologically friendly source, liberal participants found the study to have worse methods when its results were pro-fracking than when they were anti-fracking (see above MSNBC pro vs. anti comparison). Furthermore, although liberals found the Fox News pro-fracking study particularly flawed, they did not show significant differences in study quality between MSNBC and Fox News articles for pro- ($t(513) = 2.06$, $p = .17$, $d = 0.25$) or anti-fracking articles ($t(513) = 0.60$, $p = .93$, $d = 0.08$).

Fracking Attitudes. Visualized in Figure 1.2, liberal participants generally had low levels of support for fracking. However, the ideologically friendly article did show evidence of garnering fracking support. Pairwise comparisons between estimated marginal means from the ordered logistic model (Table 1.3 for the regression results) confirm the visual pattern: liberals who were told the pro-fracking message came from MSNBC reported significantly higher support for fracking after receiving the message ($Z = 2.75$, $p = .03$, Odds Ratio [OR] = 2.05) than liberals who received exactly the same message but believed it came from Fox News. Participants in the Fox News pro-fracking article condition reported the second highest level of fracking support, although it was not significantly different from either of the anti-fracking articles (ps > .24, ORs < 1.63). Liberal participants were more accepting of politically unfriendly information when it ostensibly came from an ideologically friendly source.

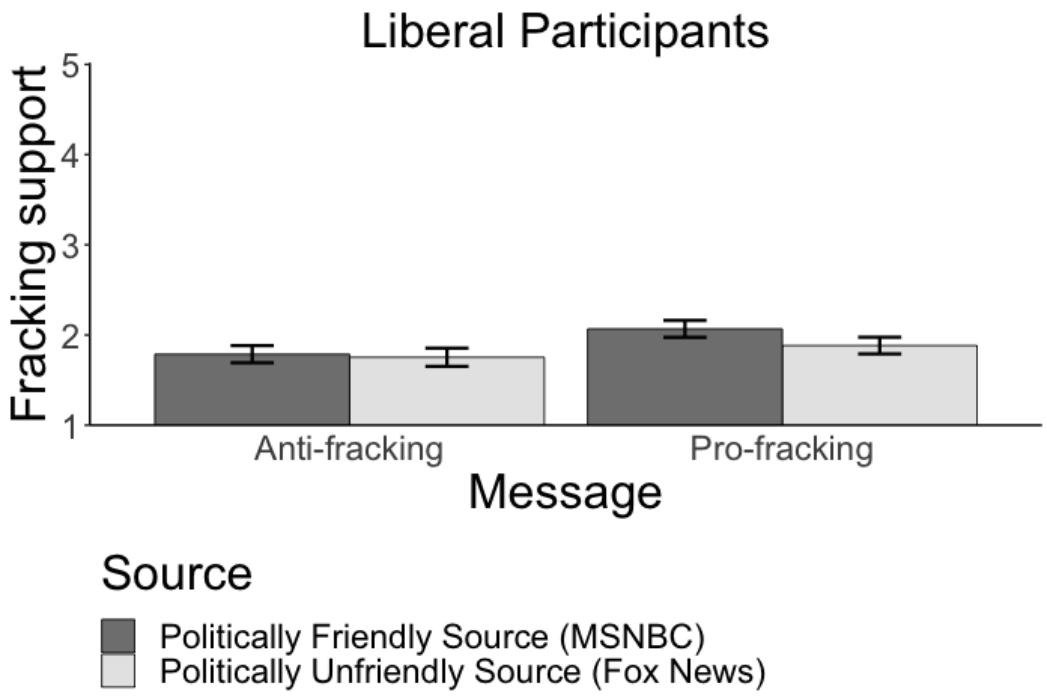
Conservative Participants

Conservative participants' evaluation of the methods of the study did not differ significantly by experimental condition (as displayed in Table 1.2), and there were no significant differences between any of the experimental conditions for conservative participants (all ps >

.17, |*ds*| < .64; highest mean: Fox News anti-fracking *M* = 3.25; lowest mean: MSNBC pro-fracking *M* = 2.70).

Figure 1.2

The Effect of Experimental Condition on Liberal Participants' Fracking Support in Study 1

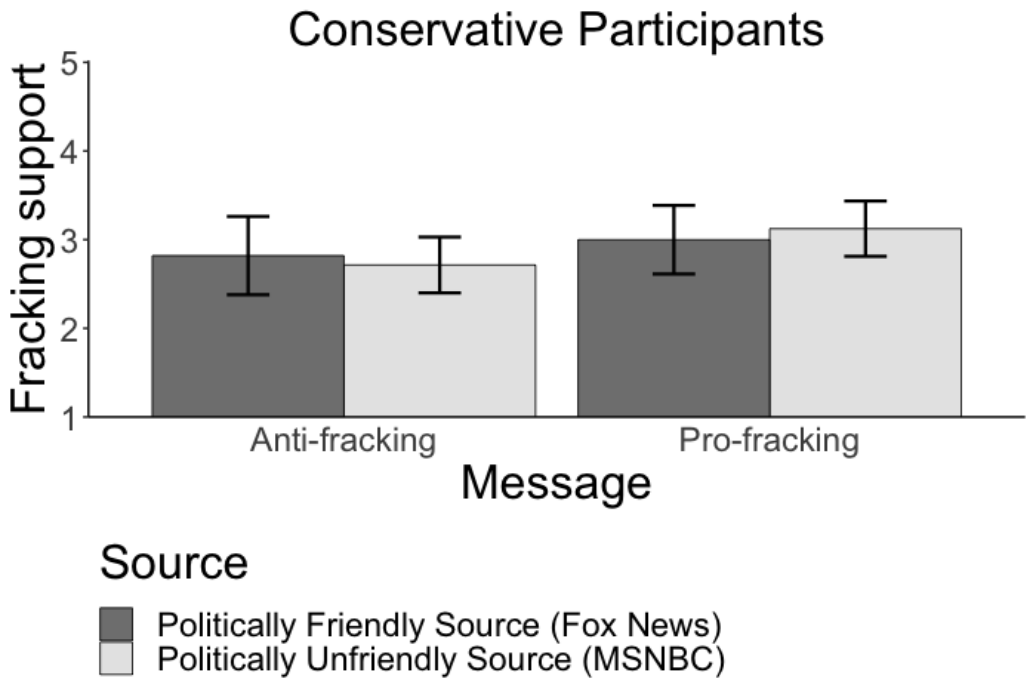


Note. Articles with an ideologically friendly source, MSNBC, are shown on in dark grey. Articles with an ideologically unfriendly source, Fox News, are shown in light grey. Bars represent the estimated marginal means calculated from the ordered logistic regression using the emmeans package (Lenth, 2018) in R, with the mode specified as the "mean.class" argument. Error bars represent 95% confidence intervals.

In terms of fracking attitudes (as seen in Figure 1.3 and Table 1.3), conservative participants did not show evidence for rejecting ideologically unfriendly articles: they tended to have less support for fracking in the anti-fracking article conditions. However, the ideologically friendly source was not particularly persuasive, and none of the pairwise comparisons were significant between conditions (*p*s > .26, *OR*s < 2.39). With only 91 conservatives in the sample, it is hard to draw conclusions from the non-significant findings.

Figure 1.3

The Effect of Experimental Condition on Conservative Participants' Fracking Support in Study 1



Note. Articles with an ideologically friendly source, Fox News, are shown on in dark grey. Articles with an ideologically unfriendly source, MSNBC, are shown in light grey. Bars represent the estimated marginal means calculated from the ordered logistic regression using the *emmeans* package (Lenth, 2018) in R, with the mode specified as the "mean.class" argument. Error bars represent 95% confidence intervals.

Table 1.3

Effect of Experimental Condition on the Ordinal Measure of Fracking Attitudes (Study 1)

	Liberals	Conservatives
Fox News pro-fracking	0.48	0.38
MSNBC anti-fracking	0.12	-0.23
MSNBC pro-fracking	1.20***	0.65
N	518	91

Note. Unstandardized regression coefficients from an ordered logistic regression are reported. Since the Fox News anti-fracking condition is the reference group, the *b*s represent differences between each article condition and the Fox News anti-fracking group. The multinomial logistic regression results from the trichotomous outcome variable can be found in the online supplementary materials (see published article listed in the acknowledgements).
*$p < .05$. **$p < .01$. ***$p < .001$.

Study 1 Discussion

In Study 1, we measured a sample of U.S. adults' perceptions of pro- or anti-fracking articles paired with ideologically friendly or unfriendly sources. For liberal participants, we replicated a classic finding in motivated reasoning: pro-fracking studies were perceived to have worse scientific methods than anti-fracking studies, despite having the exact same methods. Conservative participants did not show significant differences in study quality perceptions by experimental condition, although there were fewer than 20 conservative participants in each condition. With so few conservatives, we only had the power to detect very large effects (*d*s > .9), far bigger than would be predicted by the literature on partisan bias (e.g., Ditto et al., 2019). Whereas conservatives' fracking attitudes did not significantly differ by experimental condition, liberal participants showed more support for fracking after reading pro-fracking articles, particularly in the MSNBC pro-fracking article condition. Although disparaging of pro-fracking study methods, liberals seemed to be persuaded by an ideologically friendly source (MSNBC) presenting ideologically unfriendly information (pro-fracking message).

Study 2

Method

Participants

College students (N = 965) were recruited from a subject pool at a large public university in the western U.S. We collected data from January 2017 to March 2017. Students took the study online and received course credit for completing it. Because we were able to measure the time participants spent taking the study (unlike in Study 1; M = 10.10 minutes, SD = 19.57), we removed participants who completed the study in fewer than 60 seconds (n = 5). Four participants were removed for indicating suspicion that the article was fake or that there were multiple versions of the article. As in Study 1, we excluded participants who incorrectly identified the main argument of the article (n = 227).

Measures

We made two changes to the measures from Study 1. First, we included a continuous measure of fracking support. Participants were asked how much they agreed with the statement, "Fracking should never be legal". They gave responses on a sliding scale from 0–100, with four anchors across the scale: *None at all*, *A little*, *A moderate amount*, *A lot*, and *A great deal*. To be consistent with the other two fracking attitudes variables, we reverse coded the item so that higher scores indicated more support for fracking. Second, we dropped the last option of the trichotomous measure of fracking support and forced participants to choose between "Yes" and "No".

Results

Liberal participants

Study Quality. Experimental condition predicting study quality was significant for liberals (N = 324, R^2_{adj} = .07, F(3, 320) = 9.10, p < .001). Similar to Study 1, liberal participants rated the study as having worse methods when its results were presented as pro-fracking than anti-fracking. Liberals rated the study in both pro-fracking articles (MSNBC M = 3.22, Fox News M = 3.25) as having significantly more flawed methods than the study in anti-fracking articles (MSNBC M = 2.79, Fox News M = 2.88): MSNBC pro vs. Fox News anti (t(320) = 3.03, p = .01, d = 0.49), MSNBC pro vs. MSNBC anti (t(320) = 3.84, p < .001, d = 0.62), Fox News pro vs. Fox News anti (t(320) = 3.42, p = .004, d = 0.53), and Fox News pro vs. MSNBC anti (t(320) = 4.24, p < .001, d = 0.66). As in Study 1, source did not matter for the liberal participants' perception of the two pro-fracking studies (t(320) = 0.28, p = .99, d = 0.05), nor the two anti-fracking ones (t(320) = 0.87, p = .82, d = 0.13). Liberal participants again denigrated the quality of pro-fracking studies presented by both Fox News and MSNBC.

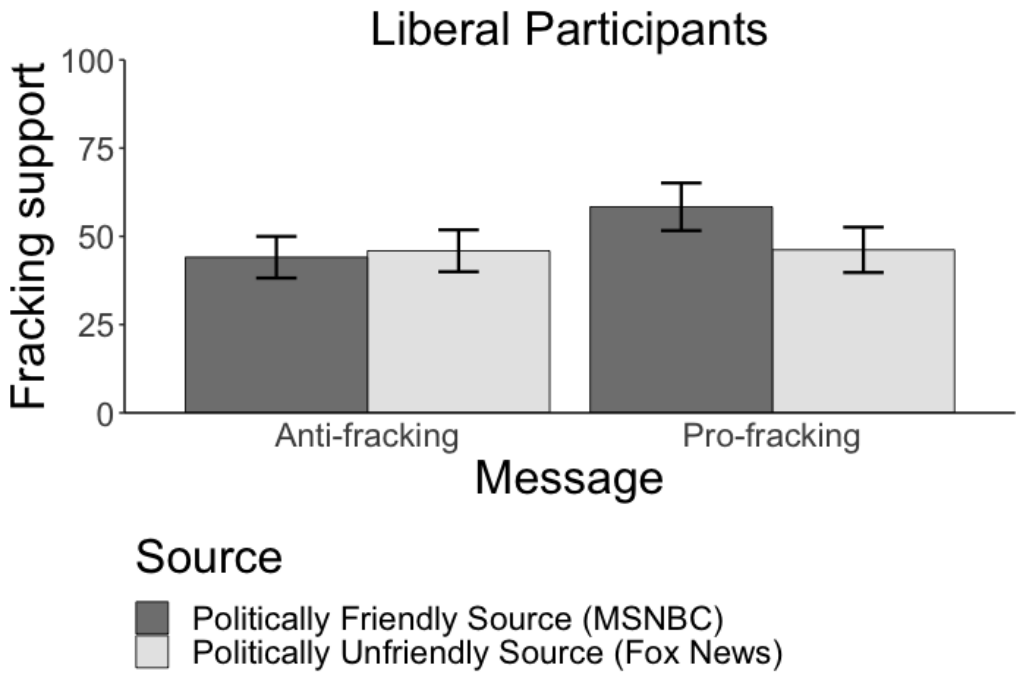
Fracking Attitudes. The regression predicting continuous fracking support was significant for liberal participants (N = 320, R^2_{adj} = .03, F(3, 316) = 3.88, p = .01). As visualized in Figure 1.4, liberal participants' attitudes were relatively similar across conditions, except for those reading ideologically unfriendly information from an ideologically friendly source. Liberals reported the highest amount of fracking support in the MSNBC pro-fracking condition (M = 58.37), which was marginally significantly more than those in the Fox News pro-fracking condition (M = 46.17, t(316) = 2.57, p = .05, d = 0.43), and significantly more than those in both the Fox News anti-fracking condition (M = 45.90, t(316) = 2.73, p = .03, d = 0.44), and MSNBC anti-fracking condition (M = 44.08, t(316) = 3.14, p = 01, d = 0.51).

For the ordered logistic regression (visualized in Figure 1.5), liberals in the MSNBC pro-fracking condition again reported the highest levels of fracking support. However, none of the

conditions were significantly different from the reference group (Fox News pro-fracking: b = 0.01, p = .98, OR = 1.01; MSNBC anti-fracking: b = -0.036, p = .90, OR = 0.96; and MSNBC pro-fracking: b = 0.61, p = .06, OR = 1.85), and none of the pairwise comparisons with Tukey-corrected p-values were significant (ps > .18, ORs < 1.91). Although the pattern persisted, with MSNBC pro-fracking articles engendering the highest levels of fracking support, liberal participants' attitudes were not significantly different between conditions.

Figure 1.4

The Effect of Experimental Condition on Liberal Participants' Fracking Support in Study 2

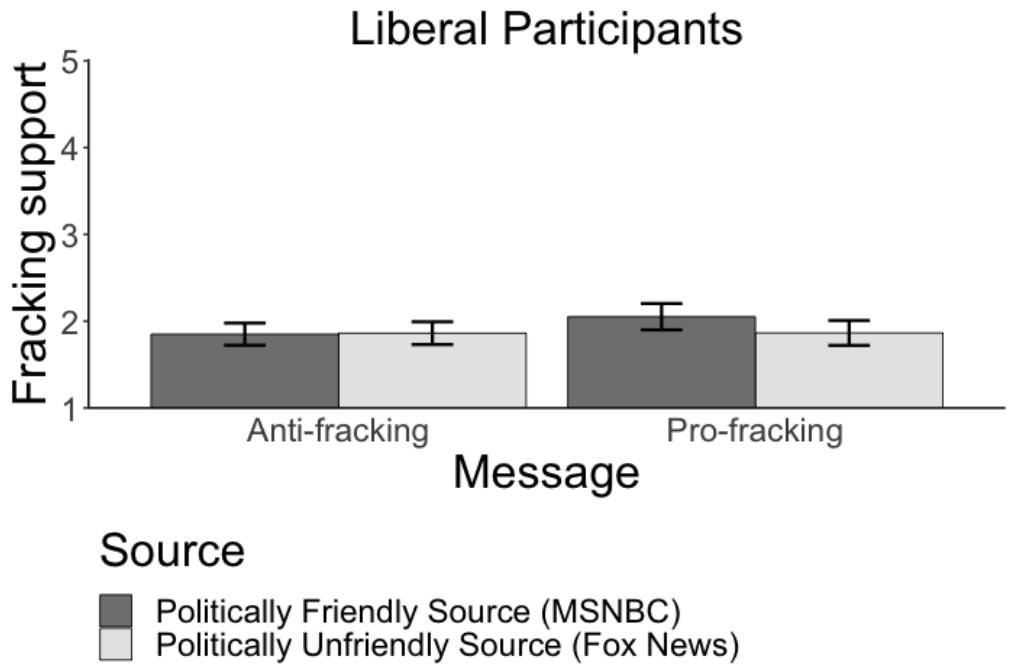


Note. Articles with an ideologically friendly source, MSNBC, are shown on in dark grey. Articles with an ideologically unfriendly source, Fox News, are shown in light grey. Error bars represent 95% confidence intervals around the means.

Liberals showed the highest amount of dichotomous fracking support in the MSNBC pro-fracking condition (26.09%), second highest in the Fox News pro-fracking condition (23.68%), third highest in the MSNBC anti-fracking condition (11.24%), and lowest in the Fox News anti-fracking condition (11.11%). Logistic regression results partially supported these descriptive findings that liberal participants tended to accept information from both ideologically friendly and unfriendly sources. They reported significantly more fracking support in the pro-fracking conditions compared to the reference group of Fox News anti-fracking, (Fox News pro-fracking: $b = 0.91$, $p = .03$, $OR = 2.48$; MSNBC pro-fracking: $b = 1.04$, $p = .02$, $OR = 2.82$). However, the differences were only marginally significant when looking at pairwise comparisons with Tukey-corrected p-values (Fox News pro-fracking: $p = .15$; MSNBC pro-fracking: $p = .08$). None of the other pairwise comparisons were significantly different (ps > .08, ORs < 2.79).

Figure 1.5

The Effect of Experimental Condition on Liberal Participants' Fracking Support in Study 2



Note. Articles with an ideologically friendly source, MSNBC, are shown on in dark grey. Articles with an ideologically unfriendly source, Fox News, are shown in light grey. Bars represent the estimated marginal means calculated from the ordered logistic regression using the *emmeans* package (Lenth, 2018) in R, with the mode specified as the "mean.class" argument. Error bars represent 95% confidence intervals.

Conservative Participants

As in Study 1, the regression predicting study quality was non-significant for conservatives (N = 55, R^2_{adj} = -.03, $F(3, 51) = 0.45$, p = .72). Furthermore, none of the pairwise comparisons between experimental conditions were significant for conservative participants (ps > .76, |ds| < 0.36; highest mean: Fox News pro-fracking and MSNBC anti-fracking Ms = 3.00; lowest mean: Fox News anti-fracking M = 2.71).

Conservative participants also reported nearly equal levels of continuous fracking support in all four conditions (highest mean: MSNBC anti-fracking M = 58.69; lowest mean: Fox News pro-fracking M = 55.77), and the regression was not statistically significant (N = 54, R^2_{adj} = -.06, $F(3, 50) = 0.04$, p = .99). For the ordinal measure of fracking support, there were no significant unstandardized regression coefficients (ps > .53, ORs < 1.61) nor did participants' attitudes differ between condition (ps > .70, ORs < 2.28). For the dichotomous measure, there were not any significant unstandardized regression coefficients from the model (ps > .17, ORs < 3.15) nor any significant pairwise comparisons between conditions (ps > .10, ORs < 7.58; 7 out of 11 conservatives supported fracking in the MSNBC pro-fracking condition, and 3 out of 16 in the anti-fracking condition). However, given that three of the four experimental conditions contained

fewer than 15 conservative participants, it is not surprising to see non-significant and highly variable effects within conservatives.

Study 2 Discussion

A college student sample in Study 2 mostly replicated the results of Study 1, with a few differences. As in Study 1, liberal participants rated studies in pro-fracking articles as having worse methods than those in anti-fracking articles, regardless of source. Additionally, liberal participants showed the most support for fracking when a pro-fracking message was presented by an ideologically friendly source. However, results varied by dependent variable: the continuous variable results showed that MSNBC pro-fracking was a uniquely persuasive condition; the dichotomous results suggested that both pro-fracking conditions were persuasive; and the ordinal variable did not have any significant results by condition. For the few conservative participants in the study, none of the dependent variables had any significant differences by condition.

Study 3

Because Study 1 and Study 2 had so few conservatives, we aimed to have a politically balanced sample for Study 3.

Method

Participants

In May 2018, participants were recruited from Amazon's Mechanical Turk (MTurk) and paid $0.75 to take the online study (preregistered on the website *aspredicted.org*). We recruited 1,214 participants total, although only a subset actually answered any questions since some participants click on the link but decide not to take the study (for example, only 1,029 participants answered a question on the first page). To obtain a more ideologically balanced

sample, we recruited participants in two separate batches to obtain roughly equal numbers of participants who identified as liberal (scoring between 1 and 3 on a 6-point scale of conservatism) or conservative (scoring between 4 and 6). On average, participants took around eight minutes to complete the study (M = 8.41 minutes, SD = 9.90).

Following our preregistration procedure, we removed participants who completed the study in fewer than 60 seconds (n = 57) or who failed an attention check (n = 14). Twelve participants were removed for indicating suspicion that the article was fake or that there were multiple versions of the article. We also excluded any participants who incorrectly identified the main argument of the article they read (n = 119).

Measures

We used the same measures as in Study 2, but added another measure of study quality to directly replicate the question asked in Lord et al., (1979): "How well or poorly was the Yale study conducted?" Participants responded on a -8 (*Very poorly done*) to 8 (*Very well done*) sliding scale. We reverse coded the item so that positive scores indicated poor methods and negative scores indicated good methods.

Results

Liberal participants

Study Quality. Table 1.4 shows the linear regression results of both study quality dependent variables side by side. As in Studies 1 and 2, liberal participants found pro-fracking studies to have worse methods than anti-fracking studies for both sources. Both pro-fracking studies' methods were rated as significantly more flawed (ps < .001, ds > 0.64) and poor (ps < .001, ds > 0.73) than either of the studies in anti-fracking articles. Although liberals found the study in the Fox News pro-fracking article to have the most flawed (M = 3.07) and poor (M = -

0.21) methods of all the conditions, its methods were non-significantly more flawed than the MSNBC pro-fracking condition (M = 2.88, t(471) = 1.71, p = .32, d = 0.22) and marginally significantly more poor (M = -1.33, t(471) = 2.58, p = .05, d = 0.33). While source may have played a small role in liberal participants' evaluation of methods, fracking message was the main driver of perceptions of study quality—even from an ideologically friendly source.

Table 1.4
Effect of experimental condition on perceptions of the scientific methods (Study 3)

	Flawed methods		Poor methods	
	Liberals	Conservatives	Liberals	Conservatives
Intercept	2.31***	2.76***	-3.79***	-2.33***
Fox News pro-fracking	0.76***	-0.31*	3.58***	-0.86
MSNBC anti-fracking	0.01	-0.07	-0.14	0.28
MSNBC pro-fracking	0.57***	-0.18	2.46***	-0.58
N	475	394	475	394
R^2	0.13	0.02	0.19	0.02
Adjusted R^2	0.13	0.01	0.18	0.01
F	24.13***	2.08	35.69***	2.13

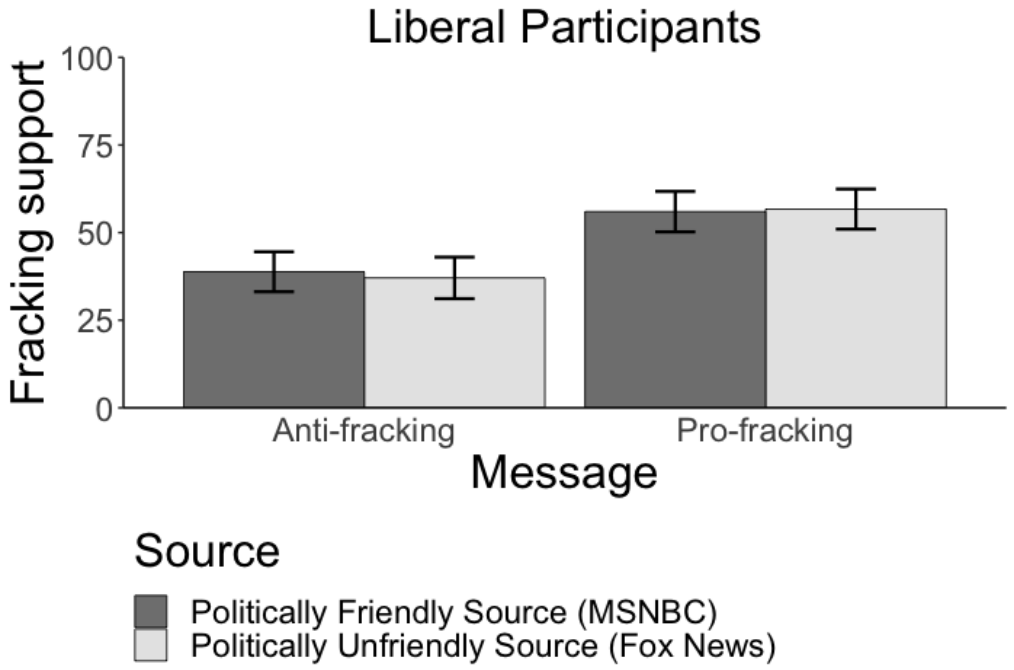
Note. Unstandardized regression coefficients are reported. Since the Fox News anti-fracking condition is the reference group, the intercept represents the mean of this group and *b*s represent differences between each article condition and the Fox News anti-fracking group.
*p < .05. **p < .01. ***p < .001.

Fracking Attitudes. Table 1.5 displays the results for the continuous and dichotomous measures of fracking attitudes. As visualized in Figure 1.6, liberals' fracking support was higher for those reading pro-fracking articles than those reading anti-fracking articles. They reported more continuous fracking support in each pro-fracking condition compared to each anti-fracking condition (ts > 4, ps < .001, ds > 0.53), but non-significantly different levels of support between the two anti-fracking article conditions (t(471) = -0.42, p = .98, d = -0.05) and pro-fracking article conditions (t(471) = 0.18, p = .998, d = 0.02). While fracking message influenced liberals'

attitudes, there was no evidence that the ideologically friendly articles were particularly persuasive.

Figure 1.6

The Effect of Experimental Condition on Liberal Participants' Fracking Support in Study 3



Note. Articles with an ideologically friendly source, MSNBC, are shown on in dark grey. Articles with an ideologically unfriendly source, Fox News, are shown in light grey. Error bars represent 95% confidence intervals around the means

Pairwise comparisons between experimental conditions for the ordinal measure of fracking support showed the same pattern: liberals had more support for fracking after reading pro-fracking articles than anti-fracking articles. Both pro-fracking articles induced higher levels of fracking support than the Fox News anti-fracking article (vs. MSNBC pro: $Z = 3.67$, $p = .001$, $OR = 2.59$; vs. Fox News pro: $Z = 3.38$, $p = .004$, $OR = 2.39$) and the MSNBC anti-fracking

article (vs. MSNBC pro: $Z = 3.69$, $p = .001$, $OR = 2.56$; vs. Fox News pro: $Z = 3.41$, $p = .004$, $OR = 2.37$). For pro-fracking articles ($Z = -0.30$, $p = .99$, $OR = 0.92$) and anti-fracking articles ($Z = -0.04$, $p > .99$, $OR = 0.99$), fracking support did not significantly vary by source.

When asked if they support fracking, liberals were much more likely to say "Yes" in the pro-fracking conditions (MSNBC: 45.38%; Fox News: 38.84%) than in the anti-fracking conditions (MSNBC: 16.39%; Fox News: 15.93%). This stark difference is confirmed statistically by a logistic regression predicting support for fracking (Table 1.5). Additionally, the ideologically friendly source, MSNBC, induced the highest amount of fracking support after a pro-fracking message, although it was not significantly different from the Fox News pro-fracking condition ($Z = 1.02$, $p = .74$, $OR = 1.31$).

Conservative Participants

Study Quality. Surprisingly, conservative participants did not display robust partisan bias: as seen in Table 1.4, experimental condition did not have a significant impact on conservative participants' perceptions of the methods of the study, and none of the experimental conditions were significantly different from each other after adjusting *p*-values for multiple comparisons (*p*s > .08, |*d*s| < 0.34). However, there was still a pattern suggestive of biased assimilation where anti-fracking studies were seen as having worse methods than pro-fracking studies for both the flawed methods (Anti-fracking: $M = 2.72$; Pro-fracking: $M = 2.51$) and poor methods dependent variables (Anti-fracking: $M = -2.19$; Pro-fracking: $M = -3.06$). With the large sample of conservative participants, there was only weak evidence (small effect size and marginally significant) that they disparaged study quality in a motivated fashion.

Table 1.5

Effect of Experimental Condition on Fracking Attitudes (Study 3)

	Continuous fracking support		Dichotomous fracking support	
	Liberals	Conservatives	Liberals	Conservatives
Intercept	37.07***	65.48***	-1.66***	0.14
Fox News pro-fracking	19.64***	12.72**	1.21***	1.32***
MSNBC anti-fracking	1.75	3.88	0.03	0.23
MSNBC pro-fracking	18.91***	16.70***	1.48***	1.33***
N	475	394	475	394
R^2	0.08	0.05		
Adjusted R^2	0.07	0.04		
F	13.08***	6.30***		

Note. Unstandardized regression coefficients are reported. Since the Fox News anti-fracking condition is the reference group, the intercept represents the mean of this group (continuous) or the log odds of those in this group to respond "Yes" (dichotomous), and *b*s represent differences between each article condition and the Fox News anti-fracking group.
*$p < .05$. **$p < .01$. ***$p < .001$.

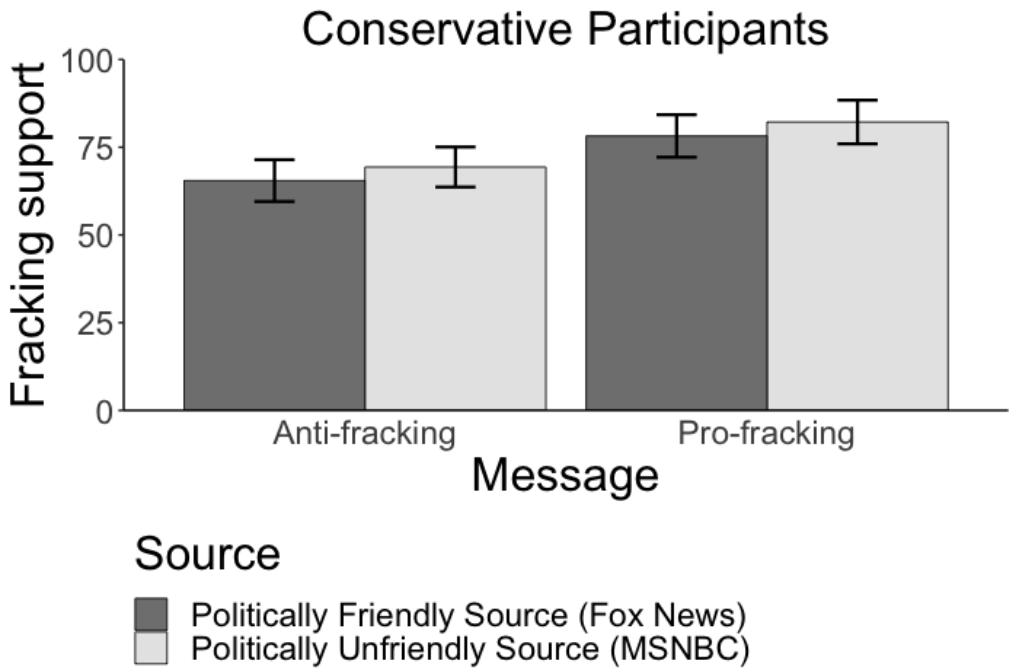
Fracking Attitudes. Similar to liberal participants, conservatives were influenced by the message of the fracking articles across both sources. As seen in Figure 1.7, and displayed in Table 1.5, conservative participants' continuous fracking support increased in the pro-fracking article conditions compared to anti-fracking conditions. Additionally, conservatives reported their lowest levels of fracking support in the Fox News anti-fracking condition, which was significantly lower than either of the two pro-fracking conditions (*t*s < -2.9, *p*s < .02, *d*s < -0.42). Although conservatives were less supportive of fracking in the MSNBC anti-fracking condition than the MSNBC pro-fracking condition ($t(390) = -2.99$, $p = .02$, $d = -0.43$), they had non-significantly different levels of fracking support in the MSNBC anti-fracking condition and the Fox News pro-fracking condition ($t(390) = -2.09$, $p = .16$, $d = -0.29$). Lastly, they did not have significantly different levels of support between the two anti-fracking article conditions ($t(390) = -0.92$, $p = .79$, $d = -0.13$) and pro-fracking article conditions ($t(390) = -0.90$, $p = .80$, $d = -0.13$).

Pairwise comparisons between experimental conditions for the ordinal measure of fracking support showed that conservatives had the least amount of support for fracking in the anti-fracking article conditions. Conservatives who read the Fox News anti-fracking article had significantly less fracking support than those who read either pro-fracking article (vs. Fox News: Z = -3.72, p = .001, OR = 0.38; vs. MSNBC: Z = -4.33, p < .001, OR = 0.32). However, this message effect was not unique to the ideologically friendly Fox News: conservatives who read the MSNBC anti-fracking article also had significantly less fracking support than those who read either pro-fracking article (Fox News: Z = -4.24, p < .001, OR = 0.34; MSNBC: Z = -4.87, p < .001, OR = 0.29). The two pro-fracking (Z = -0.66, p = .91, OR = 0.84) and anti-fracking (Z = 0.41, p = .98, OR = 1.11) articles were non-significantly different from each other.

Additionally, both ideologically friendly and unfriendly sources were effective at promoting anti-fracking messages for the dichotomous measure of support (Table 1.5): while over 80% of conservatives were supportive of fracking after reading a pro-fracking article (Fox News: 81.25%; MSNBC: 81.32%), fewer than 60% were supportive after reading an anti-fracking article (Fox News: 53.54%; MSNBC: 59.26%). Pairwise comparisons confirmed that each anti-fracking article induced significantly less fracking support than each pro-fracking article (Zs < -3.29, ps < .006, ORs < 0.34). Although conservatives had the least amount of fracking support after reading the Fox News anti-fracking article, support was non-significantly different than support in the MSNBC anti-fracking condition (Z = -0.83 p = .84, OR = 0.79), suggesting that the ideologically friendly source was not distinctly persuasive.

Figure 1.7

The Effect of Experimental Condition on Conservative Participants' Fracking Support in Study 3



Note. Articles with an ideologically friendly source, Fox News, are shown on in dark grey. Articles with an ideologically unfriendly source, MSNBC, are shown in light grey. Error bars represent 95% confidence intervals around the means.

Study 3 Discussion

Similar to in Studies 1 and 2, liberal participants in Study 3 showed evidence of partisan bias: they evaluated methodologically identical studies as more flawed when the conclusion was inconsistent with their political identity. There was no evidence of an ideologically friendly source attenuating this effect, as Fox News and MSNBC articles with the same message were assessed similarly. Despite finding pro-fracking studies more flawed, liberal participants reported more support for fracking after reading pro-fracking articles than anti-fracking articles. Although liberals tended to have the highest support for fracking after reading a pro-fracking message from MSNBC, the differences between it and the Fox News pro-fracking article were not significantly different for any of the dependent variables.

Unlike in Studies 1 and 2, in Study 3 we were able to recruit an equal number of liberal and conservative participants. Surprisingly, conservative participants did not show overall significant differences between experimental conditions when evaluating study quality. However, even though the differences were not statistically significant, they were in the opposite direction than the pattern shown by liberal participants: conservatives tended to rate the anti-fracking studies as having worse methods than the pro-fracking studies. In terms of fracking attitudes, conservatives were less supportive of fracking in the anti-fracking conditions than in the pro-fracking conditions. Although the anti-fracking message from the ideologically friendly source tended to induce the least amount of support for fracking, we did not find statistically significant differences by source. No matter the source, both liberal and conservative participants' attitudes tracked the message of the article they read.

General Discussion

Three studies using three separate samples (visitors to the *YourMorals.org* website, college students, and MTurk workers) were conducted to investigate the effect of a media article on fracking attitudes—specifically, articles where a liberal or conservative media source was paired with an anti- or pro-fracking message. We found consistent evidence for partisan bias among liberal participants: they rated pro-fracking messages as having worse methods than anti-fracking messages, despite both articles detailing identical methods. We speculated that ideologically unfriendly messages might be more palatable coming from an ideologically friendly source (i.e., MSNBC pro-fracking article), but we found only limited evidence to support this. Liberals generally had the highest amount of fracking support in the MSNBC pro-fracking article conditions, but there was only partial statistical evidence in Studies 1 and 2 and

no statistically significant differences in Study 3. Overall, liberal participants were more supportive of fracking after reading pro-fracking articles than anti-fracking articles.

With only a few conservative participants in Studies 1 and 2, we did not find any statistically significant differences between experimental condition. For conservative participants in Study 3 (when there was an adequate sample size), anti-fracking studies were generally perceived to have worse scientific methods than pro-fracking studies, although the pairwise comparisons were not statistically significant. For fracking attitudes, conservatives generally tracked the message of the article no matter the source: they were less supportive of fracking after reading anti-fracking messages than pro-fracking messages. Although they tended to have the least amount of fracking support in the Fox News anti-fracking condition, there was no statistical evidence to establish that this ideologically friendly source was particularly persuasive. Nonetheless, the results are promising to the extent that—in the right setting—people are receptive to scientific information about environmental topics.

These studies also add to previous research by including both benefits and costs in one message. Similar studies found that including both benefits and costs of fracking in one message neutralized the effect of the message (Bayer & Ovodenko, 2019; Christensen et al., 2017). However, even after including costs and benefits in one message, we found that participants were less supportive of fracking after reading anti-fracking articles and more supportive after reading pro-fracking articles. This finding suggests that it is not the mere inclusion of costs that neutralize the effects of a benefits-only fracking message, but rather the presentation of a balanced message (i.e., costs and benefits are equal). Moreover, the fracking message was presented by a partisan media source. Whereas most partisan framing manipulations use a group endorsement (e.g., “Democrats/Republicans support this policy”), the current study embeds a

scientific study into a news article from a partisan source, mirroring how people tend to read about scientific studies in their everyday lives.

One surprising finding in this set of studies is that, while denigrating the methods of politically unfriendly messages, partisans treated Fox News and MSNBC similarly when evaluating the methods of the fracking study. This may be due to the nature of the news articles: participants read about a scientific study from researchers at Yale which was discussed by a partisan news source. The author of the article simply detailed the results and conclusions of the Yale researchers. Perhaps, when evaluating the methods of the study, participants were attuned to the distinction between message and messenger—although participants may perceive the source to be biased, they might have recognized that it was simply relaying the results of a study.

Limitations

Because we recruited participants for studies on "Understanding science in the media", participants who signed up may have been particularly interested in science or curious about evaluating science. In Studies 2 and 3, the participants who signed up received course credit or were paid. Our participants may have been specifically motivated to pay attention to the article and take it more seriously than they otherwise would have. Along with motivation to pay attention, other unmeasured confounding variables may also have been at play. While the focus of this study was on news article message and source—and the experimental design was meant to balance confounding variables across conditions—there are many factors involved in determining fracking attitudes, like geography or income. Future research might explore the moderating role that background variables have in determining attitudes, such as how individuals living nearby fracking sites are affected by news message or source differently than those living elsewhere.

Another limitation of this study is inherent in the design: we used a between-participant post-test only design, where we only measured participants' attitudes after reading the article. We designed it this way because we feared that participants would be more likely to suspect that the article was edited if we had asked them political attitudes beforehand. We attempted to hide the fact that the articles were fake by not bringing up anything political before they read the article. However, we were not able to compare pre-test scores to post-test scores, and therefore could only evaluate post-test attitudes rather than attitude change directly. In doing so, we assumed that anti-fracking articles were attitude-consistent for liberals and pro-fracking articles for conservatives. Although opinion polls show that fracking is split along partisan lines (Funk & Kennedy, 2016), not every liberal is anti-fracking and every conservative pro-fracking. Future studies should investigate this paradigm measuring attitudes both pre- and post-test.

Lastly, the source manipulation may have been potentially too subtle. We did not include a direct manipulation check of source (e.g., "What source was the article you read from?") because of concerns that participants would suspect the article was fake or edited. Our biggest worry in designing the study was this suspicion, and therefore we avoided questions that might tip participants off that there were other conditions with other sources. However, not including a manipulation check of source removed our ability to check if participants were aware of the source of the article. While we speculate that most participants did see the source—especially because the articles were typical of real news articles—we cannot rule out the possibility that the source manipulation was too weak. This could have led to the non-significant source effects for both study quality and fracking attitudes.

Future Research

The current studies demonstrated that participants relied on the message of a media article in summarizing science, at least in a research setting and for the issue of fracking. Future research should expand on the generalizability of this finding by investigating different issues. For example, would partisans accept climate change information from both ideologically friendly and unfriendly sources? Climate change articles in the media may be perceived differently than fracking articles in the media. The source manipulation may also be specific to the type of media we presented. Perhaps a popular evangelical preacher would have more influence discussing climate change than a news network. Some researchers suggest that this situation could be the solution to fractured support of renewable energy: In discussing the results of their study which showed strong political division on fracking attitudes, Choma et al. (2016) argue that increasing Republican acceptance of renewable energy "…will probably require a leading Republican politician – as were Nixon and Roosevelt – to take a stand" (p. 115). This cross between message and source is filled with opportunity for explorations of various situational effects. Given the current level of political polarization, it is important to continue studying how environmental science is perceived by the public, especially within a partisan media environment. Researchers should continue to identify interventions that break through political polarization to promote greater recognition of threats to the environment.

References begin on the following page.

References

Adamic, L. A., & Glance, N. (2005). The political blogosphere and the 2004 U.S. election: Divided they blog. In *Proceedings of the 3rd international workshop on Link discovery* (pp. 36–43). New York, New York, USA: ACM Press. https://doi.org/10.1145/1134271.1134277

Alvarez, R. A., Pacala, S. W., Winebrake, J. J., Chameides, W. L., & Hamburg, S. P. (2012). Greater focus needed on methane leakage from natural gas infrastructure. *Proceedings of the National Academy of Sciences, 109*(17), 6435–6440. https://doi.org/10.1073/pnas.1202407109

Andrews, R. N. (2012). Environmental politics and policy in historical perspective. In S. Kaminiecki, M.E. Kraft (Eds.), *The Oxford Handbook of U.S. Environmental Policy*. Oxford and New York: University Press.

Bakshy, E., Messing, S., & Adamic, L. A. (2015). Exposure to ideologically diverse news and opinion on Facebook. *Science, 348*(6239), 1130–1132. https://doi.org/10.1126/science.aaa1160

Barberá, P., Jost, J. T., Nagler, J., Tucker, J. A., & Bonneau, R. (2015). Tweeting from left to right. *Psychological Science, 26*(10), 1531–1542. https://doi.org/10.1177/0956797615594620

Bayer, P., & Ovodenko, A. (2019). Many voices in the room: A national survey experiment on how framing changes views toward fracking in the United States. *Energy Research & Social Science, 56,* 101213. https://doi.org/10.1016/j.erss.2019.05.023

Bergan, D. E. (2012). Partisan stereotypes and policy attitudes. *Journal of Communication, 62*(6), 1102–1120. https://doi.org/10.1111/j.1460-2466.2012.01676.x

Berman, J. (2015, June 4). EPA confirms that fracking poses a risk to drinking water. *Sierra Club*. Retrieved from https://content.sierraclub.org/press-releases/2015/06/epa-confirms-fracking-poses-risk-drinking-water

Bolsen, T., Druckman, J. N., & Cook, F. L. (2014). The influence of partisan motivated reasoning on public opinion. *Political Behavior, 36,* 235–262. https://doi.org/10.1007/s11109-013-9238-0

Bolsen, T., Palm, R., & Kingsland, J. T. (2019). The impact of message source on the effectiveness of communications about climate change. *Science Communication, 41*(4). 464–487. https://doi.org/10.1177/1075547019863154

Boudet, H., Clarke, C., Bugden, D., Maibach, E., Roser-Renouf, C., & Leiserowitz, A. (2014). "Fracking" controversy and communication: Using national survey data to understand public perceptions of hydraulic fracturing. *Energy Policy, 65,* 57–67. https://doi.org/10.1016/j.enpol.2013.10.017

Brandt, A. R., Heath, G. A., Kort, E. A., O'Sullivan, F., Pétron, G., Jordaan, S. M., … Harriss, R. (2014). Methane leaks from North American natural gas systems. *Science, 343*(6172), 733-735. https://doi.org/10.1126/science.1247045

Bullock, J. G. (2011). Elite influence on public opinion in an informed electorate. *American Political Science Review, 105*(3), 496–515. https://doi.org/10.1017/S0003055411000165

Choma, B. L., Hanoch, Y., & Currie, S. (2016). Attitudes toward hydraulic fracturing: The opposing forces of political conservatism and basic knowledge about fracking. *Global Environmental Change, 38,* 108–117. https://doi.org/10.1016/j.gloenvcha.2016.03.004

Christenson, D. P., Goldfarb, J. L., & Kriner, D. L. (2017). Costs, benefits, and the malleability of public support for "Fracking". *Energy Policy, 105*, 407–417. http://dx.doi.org/10.1016/j.enpol.2017.03.002

CIPA. (n.d.) The economic benefits of hydraulic fracturing. *California Independent Petroleum Association*. Retrieved from https://www.cipa.org/i4a/pages/index.cfm?pageID=749

Ciuk, D. J., & Yost, B. A. (2016). The effects of issue salience, elite influence, and policy content on public opinion. *Political Communication, 33*(2), 328–345. https://doi.org/10.1080/10584609.2015.1017629

Cohen, G. L. (2003). Party over policy: The dominating impact of group influence on political beliefs. *Journal of Personality and Social Psychology, 85*(5), 808–822. https://doi.org/10.1037/0022-3514.85.5.808

Davis, C., & Fisk, J. M. (2014). Energy abundance or environmental worries? Analyzing public support for fracking in the United States. *Review of Policy Research, 31*(1), 1–16. https://doi.org/10.1111/ropr.12048

Ditto, P. H., Liu, B. S., Clark, C. J., Wojcik, S. P., Chen, E. E., Grady, R. H., … Zinger, J. F. (2019). At least bias is bipartisan: A meta-analytic comparison of partisan bias in liberals and conservatives. *Perspectives on Psychological Science, 14*(2), 273–291. https://doi.org/10.1177/1745691617746796

Ditto, P. H., & Lopez, D. F. (1992). Motivated skepticism: Use of differential decision criteria for preferred and nonpreferred conclusions. *Journal of Personality and Social Psychology, 63*(4), 568–584. https://doi.org/10.1037/0022-3514.63.4.568

Ditto, P. H., & Mastronarde, A. J. (2009). The paradox of the political maverick. *Journal of Experimental Social Psychology, 45*(1) 295–298. https://doi.org/10.1016/j.jesp.2008.10.002

Ditto, P. H., Scepansky, J. A., Munro, G. D., Apanovitch, A. M., & Lockhart, L. K. (1998). Motivated sensitivity to preference-inconsistent information. *Journal of Personality and Social Psychology, 75*(1), 53–69. https://doi.org/10.1037/0022-3514.75.1.53

Dunlap, R. E., Xiao, C., & McCright, A. M. (2001). Politics and environment in America: Partisan and ideological cleavages in public support for environmentalism. *Environmental Politics, 10*(4), 23–48. https://doi.org/10.1080/714000580

Eagly, A. H., Wood, W., & Chaiken, S. (1978). Causal inferences about communicators and their effect on opinion change. *Journal of Personality and Social Psychology, 36*(4), 424–435. https://doi.org/10.1037/0022-3514.36.4.424

Ehret, P. J., Van Boven, L., & Sherman, D. K. (2018). Partisan barriers to bipartisanship: Understanding climate policy polarization. *Social Psychological and Personality Science, 9*(3), 308–318. https://doi.org/10.1177/1948550618758709

EPA. (2016). Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report). *U.S. Environmental Protection Agency*. Retrieved from https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990

Fox News. (2015, June 2). EPA declares no 'widespread' harm to drinking water from fracking, boosting industry. *Fox News*. Retrieved from https://www.foxnews.com/politics/epa-declares-no-widespread-harm-to-drinking-water-from-fracking-boosting-industry

Fry, M., Briggle, A., & Kincaid, J. (2015). Fracking and environmental (in)justice in a Texas city. *Ecological Economics, 117,* 97–107. http://dx.doi.org/10.1016/j.ecolecon.2015.06.012

Funk, C., & Kennedy, B. (2016). The politics of climate. *Pew Research Center*. Retrieved from https://assets.pewresearch.org/wp-content/uploads/sites/14/2016/10/14080900/PS_2016.10.04_Politics-of-Climate_FINAL.pdf

Galli, M. (2019, December 19). Trump should be removed from office. *Christianity Today.* Retrieved from https://www.christianitytoday.com/ct/2019/december-web-only/trump-should-be-removed-from-office.html

Guisinger, A., & Saunders, E. N. (2017). Mapping the boundaries of elite cues: How elites shape mass opinion across international issues. *International Studies Quarterly, 61*(2), 425–441. https://doi.org/10.1093/isq/sqx022

Hart, W., Albarracín, D., Eagly, A. H., Brechan, I., Lindberg, M. J., & Merrill, L. (2009). Feeling validated versus being correct: A meta-analysis of selective exposure to information. *Psychological Bulletin, 135*(4), 555–588. https://doi.org/10.1037/a0015701

Howarth, R. W., Santoro, R., & Ingraffea, A. (2011). Methane and the greenhouse-gas footprint of natural gas from shale formations. *Climatic Change, 106,* 679–690. https://doi.org/10.1007/s10584-011-0061-5

Iyengar, S., & Hahn, K. S. (2009). Red media, blue media: Evidence of ideological selectivity in media use. *Journal of Communication, 59*(1), 19–39. https://doi.org/10.1111/j.1460-2466.2008.01402.x

Karlstrøm, H., & Ryghaug, M. (2014). Public attitudes towards renewable energy technologies in Norway. The role of party preferences. *Energy Policy, 67,* 656–663. http://dx.doi.org/10.1016/j.enpol.2013.11.049

Kraft, P. W., Lodge, M., & Taber, C. S. (2015). Why people "Don't trust the evidence": Motivated reasoning and scientific beliefs. *The ANNALS of the American Academy of Political and Social Science, 658*(1), 121–133. https://doi.org/10.1177/0002716214554758

Lenth, R. (2018). emmeans: Estimated marginal means, aka least-squares means. R package version 1.2.2. https://CRAN.R-project.org/package=emmeans

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37*(11), 2098–2109. https://doi.org/10.1037/0022-3514.37.11.2098

McCright, A. M., Dentzman, K., Charters, M., & Dietz, T. (2013). The influence of political ideology on trust in science. *Environmental Research Letters, 8*, 044029. https://doi.org/10.1088/1748-9326/8/4/044029

McCright, A. M., & Dunlap, R. E. (2003). Defeating Kyoto: The conservative movement's impact on U.S. climate change policy. *Social Problems, 50*(3), 348–373. https://doi.org/10.1525/sp.2003.50.3.348

McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001-2010. *Sociological Quarterly, 52*(2), 155–194. https://doi.org/10.1111/j.1533-8525.2011.01198.x

McCright, A. M., Xiao, C., & Dunlap, R. E. (2014). Political polarization on support for government spending on environmental protection in the USA , 1974 – 2012. *Social Science Research, 48*, 251–260. https://doi.org/10.1016/j.ssresearch.2014.06.008

Mitchell, A., Gottfried, J., Kiley, J., & Matsa, K. E. (2014, October 21). Political polarization & media habits. *Pew Research Center*. Retrieved from http://www.journalism.org/2014/10/21/political-polarization-media-habits/

Mullinix, K. J. (2016). Partisanship and preference formation: Competing motivations, elite polarization, and issue importance. *Political Behavior, 38,* 383–411. https://doi.org/10.1007/s11109-015-9318-4

Newell, R. G., & Raimi, D. (2014) Implications of shale gas development for climate change. *Environmental Science and Technology, 48,* 8360−8368. https://doi.org/10.1021/es4046154

Petersen, M. B., Skov, M., Serritzlew, S., & Ramsøy, T. (2013). Motivated reasoning and political parties: Evidence for increased processing in the face of party cues. *Political Behavior, 35,* 831–854. https://doi.org/10.1007/s11109-012-9213-1

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification*. New York: Oxford University Press.

Raimi, K. T., & Leary, M. R. (2014). Belief superiority in the environmental domain: Attitude extremity and reactions to fracking. *Journal of Environmental Psychology, 40*, 76–85. https://doi.org/10.1016/j.jenvp.2014.05.005

Rodriguez, C. G., Moskowitz, J. P., Salem, R. M., & Ditto, P. H. (2017). Partisan selective exposure: The role of party, ideology and ideological extremity over time. *Translational Issues in Psychological Science, 3*(3), 254–271. https://doi.org/10.1037/tps0000121

Sovacool, B. K. (2014). Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracturing (fracking). *Renewable and Sustainable Energy Reviews, 37*, 249–264. http://dx.doi.org/10.1016/j.rser.2014.04.068

Stokes, L. C., & Warshaw, C. (2017). Renewable energy policy design and framing influence public support in the United States. *Nature Energy, 2*, 17107. https://doi.org/10.1038/nenergy.2017.107

Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science, 50*(3), 755–769. https://doi.org/10.1111/j.1540-5907.2006.00214.x

Unsworth, K. L., & Fielding, K. S. (2014). It's political: How the salience of one's political identity changes climate change beliefs and policy support. *Global Environmental Change, 27*, 131–137. https://doi.org/10.1016/j.gloenvcha.2014.05.002

Van Boven, L., Ehret, P. J., & Sherman, D. K. (2018). Psychological barriers to bipartisan public support for climate policy. *Perspectives on Psychological Science, 13*(4), 492–507. https://doi.org/10.1177/1745691617748966

Vasi, I. B., Walker, E. T., Johnson, J. S., & Tan, H. F. (2015). "No fracking way!" Documentary film, discursive opportunity, and local opposition against hydraulic fracturing in the United States, 2010 to 2013. *American Sociological Review, 80*(5), 934–959. https://doi.org/10.1177/0003122415598534

Washburn, A. N., & Skitka, L. J. (2018). Science denial across the political divide: Liberals and conservatives are similarly motivated to deny attitude-inconsistent science. *Social Psychological and Personality Science, 9*(8), 972–980. https://doi.org/10.1177/1948550617731500

CHAPTER 2

Abstract

One promising method of climate change communication involves highlighting the 97% scientific consensus on anthropogenic climate change. Multiple experimental studies have shown that reading a short statement about the scientific consensus can increase people's perceptions of the consensus, and consequently improve other climate attitudes. The current study adds to this literature by investigating how participants respond to a consensus statement embedded within a news article. Across three online experimental studies (Total N = 2,786), participants were randomly assigned to read a news article about climate change or a control condition where they answered dependent variables before reading an article. For one of the news articles, a statement containing information about the 97% consensus was embedded at the end. Across all three studies, participants in consensus conditions had increased perceptions of the scientific consensus compared to those who read articles without consensus information or those in the control group. Furthermore, the news article was just as effective as an overt consensus statement. Effects on other climate change attitudes (e.g., belief, risk) were generally limited, although they varied across sample. Lastly, there was no evidence for a backfire effect among conservative participants. The findings and limitations are situated in context with similar research, and implications for climate change communications are explored.

Using a News Article to Convey Climate Science Consensus Information

Global climate change presents a wide array of risks to both human society and ecological systems. Importantly, a current scientific report suggests that, despite the documented warming that has already occurred, there is still time to curb greenhouse gas emissions and stabilize global temperature increases to 1.5º C above pre-industrial levels (IPCC, 2018). Achieving this goal will require governments around the world to reduce emissions in their countries, and public support of these emissions curbing policies will be vital. In the U.S., however, climate change has become a politically polarized topic, a trend that appears to be unique to the American public (Hornsey et al., 2018). For example, a recent poll shows that 84% of liberal Democrats and only 14% of conservative Republicans stated that human activity contributes a great deal to climate change (Funk & Hefferon, 2019). More strikingly, 78% of Democrats believe that climate change should be a top priority for the president and congress, but only 21% of Republicans agree, making it one of the most polarized topics from a recent poll (Pew, 2020).

To increase overall public support for addressing climate change, various social science researchers have conducted experimental studies to influence engagement with and belief in climate change. One prominent approach involves communicating the scientific consensus, whereby researchers inform participants that 97% of climate scientists agree that human-caused global warming is happening. Known as the Gateway Belief Model (GBM), this theory predicts that being exposed to a consensus message increases perceived scientific consensus, which leads to an increase in beliefs about climate change and subsequently produces higher levels of support for action on climate change (van der Linden et al., 2015). Originating from correlational studies (Ding et al., 2011; McCright et al., 2013), the model has sparked abundant experimental work on

consensus messaging (e.g., Brewer & McKnight, 2017; Deryugina & Shurchkov, 2016; Dixon et al., 2017; Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; van der Linden, Leiserowitz, et al., 2019) as well as numerous debates on the topic (Dixon et al., 2019; Kahan, 2017; Kerr & Wilson, 2018; Ma et al., 2019; van der Linden et al., 2017, 2018; van der Linden, Maibach, et al., 2019). Although most studies provide support for the GBM (see Cook, 2019 for an overview), some work casts doubt on the model and consensus messaging overall (Kahan, 2017; Kerr & Wilson, 2018; Ma et al., 2019). Nevertheless, there continues to be abundant research on the model.

Many of the studies using consensus messages to convey climate science agreement provide participants with a single statement. Furthermore, all of these experimental studies highlight scientific consensus as the central part of their experimental manipulation—directly focusing on it. While this increases internal validity by isolating consensus information, it also limits ecological validity. Perhaps a social media post or a short TV ad could focus solely on scientific consensus information, but many people will be exposed to consensus information in more subtle or casual ways. For example, if a news article is about an environmental story, is it effective for the article to mention the scientific consensus? Or is consensus messaging only effective if it is the focal point of a message? The current set of studies adds to the research on consensus messaging by examining a potential boundary condition. Across three samples, we test if embedding consensus information to the end of an environmental article is an effective way of communicating the consensus.

Literature Review

The Gateway Belief Model

A two-step theoretical model, the GBM posits that increases in consensus beliefs (pre-post) predict increases in beliefs about climate change (belief in global warming, belief in anthropogenic global warming, worry about global warming) which predict support for public action on global warming (van der Linden et al., 2015). Given that the scientific evidence for climate change is complex, most people do not directly examine the evidence themselves. Rather, people use agreement among scientists as an indicator of the strength of the evidence for climate change which in turn informs their beliefs about climate change, further leading to worry and policy support (Lewandowsky et al., 2013; van der Linden et al., 2015). Studies that use a pre-post design provide direct support for the theory (Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; Goldberg, van der Linden, Ballew, Rosenthal, Gustafson, et al., 2019; van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2014). Other experimental studies, using fully between-groups designs, indirectly support the theory by showing that participants have higher perceptions of the scientific consensus on climate change after receiving a consensus message than participants in a control group (Bolsen & Druckman, 2018; Brewer & McKnight, 2017; Cook et al., 2017; Cook & Lewandowsky, 2016; Myers et al., 2015). Although one study suggests that introducing uncertainty into a consensus message undermines its effectiveness (Bolsen & Druckman, 2018), another study found that a consensus message was effective even in the face of misinformation (Cook et al., 2017). Despite the variation in study designs, the experimental component of the GBM—that consensus messages increase perceived consensus—is well-supported.

The effectiveness of the GBM on other climate change attitudes, however, is less clear. While some between-groups studies find that participants who read a consensus message have more belief in global warming and support for action (Bolsen et al., 2014; Bolsen & Druckman,

2018; Brewer & McKnight, 2017; Cook & Lewandowsky, 2016; Deryugina & Shurchkov, 2016), other experiments (or other dependent variables within the same studies) do not show that the consensus message is effective for downstream climate change beliefs (Bolsen et al., 2014; Cook et al., 2017; Dixon et al., 2017; Kahan, 2017). Kerr and Wilson (2018) used a longitudinal design to test the effect of perceived consensus on later climate change beliefs but did not find a significant effect; however, van der Linden et al. (2018) found a significant effect using the same design in a different sample. Interestingly, most studies that use a pre-post design find support for the GBM, including the downstream effects of perceived consensus on climate change beliefs and support for action (Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; Goldberg, van der Linden, Ballew, Rosenthal, Gustafson, et al., 2019; van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2014).

Ways of Communicating the Consensus

Despite the plethora of research on consensus messaging, most studies use a single phrase like, "97% of climate scientists have concluded that human-caused climate change is happening" (van der Linden et al., 2014, p. 257). Myers et al. (2015) tested the effectiveness of variations of this phrase by manipulating the exact number used, finding that wording using "97" was more effective than saying "9 out of 10" or "Overwhelming majority" of climate scientists. Similarly, Deryugina and Shurchkov (2016) demonstrated that participants were sensitive to consensus conveyed with specific numbers rather than just being generally described: participants were influenced by the "hard info" of specific numbers but not the general description of consensus. Examining a variety of different textual and visual approaches to conveying consensus information, van der Linden et al. (2014) provide evidence that the simple text or a pie chart are the most effective ways of relaying this information.

Other studies take a more creative approach in how they present the consensus. For example, Harris et al. (2019) suggest that consensus is best communicated if participants experience it, such as viewing silhouettes of ten scientists with nine agreeing scientists shaded in green and one dissenting scientist in red. Brewer and McKnight (2017) utilize a late-night talk show video clip where the host discusses the scientific consensus, finding that the clip was effective in influencing participants' climate change beliefs. Additionally, although not explicitly investigating the GBM or consensus messaging, Skurka et al. (2019) presented participants with a late-night comedy show clip where the host discussed the science of climate change and the scientific consensus, and found that overall the video had a small but significant positive effect on various climate change beliefs. Testing a consensus medium more formally, Goldberg, van der Linden, Ballew, Rosenthal, Gustafson, et al. (2019) gave participants a video explaining the scientific consensus or a transcript of the video. While both experimental conditions increased participants' perceived consensus relative to a control, the video was especially convincing and was more effective than the transcript alone.

All of these methods of communicating the consensus feature it prominently and nearly all solely focus on the scientific consensus. The video used in Skurka et al. (2019) is not focused only on consensus information, but it does center on climate science. Myers et al. (2015) inserted an ad about consensus within a larger news page, but the ad was very prominent within the page. The current ways of communicating consensus information led us to our first research question:

RQ1: Is scientific consensus information still effective if it is simply embedded within a longer message?

To answer this question, we added a consensus message to the end of a news article about a recent study on climate change. Despite the variety of methods that researchers have used to

communicate consensus messages, online news articles as a medium are noticeably missing. One previous study on consensus messaging used news articles as its medium, but the articles were centered on the consensus information and none of the topics involved climate change (Chinn et al., 2018). Another study relied on news articles to frame uncertainty in various ways, although the news article discussing consensus was focused on scientific disagreement and debate (Gustafson & Rice, 2019). Online news articles are common ways for people to quickly receive news (Wilkins et al., 2018), presenting an opportunity for communicating the consensus. On one hand, it seems that consensus messaging is effective across a range of mediums, and thus will be effective for news articles. However, there is some evidence that responses are sensitive to the way consensus messages are portrayed (e.g., Deryugina & Shurchkov, 2016; Myers et al., 2015). The current study tests the limits of consensus messaging effectiveness by adding a consensus message to the end of a news article.

Politically Driven Responses to Consensus Messaging

Many studies using consensus messaging also investigate its interactions with political ideology. Examining the direct link between treatment and belief in consensus, some experiments find that conservative participants display stronger treatment effects than liberal participants (Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2015). One reason may be that conservatives' climate change beliefs are less stable and therefore more susceptible to influence (Jenkins-Smith et al., 2020). Or, perhaps, conservatives begin with low estimates of the consensus and thus have more room to move upwards while liberals exhibit a ceiling effect. Substantiating this possibility, Zhang et al. (2018) demonstrated that people in geographic regions with the lowest levels of pre-treatment consensus estimates displayed the largest increases after exposure to a

consensus message. Despite these few examples of an interaction effect, other studies show no interaction between political ideology and consensus messaging on perceptions of consensus (Brewer & McKnight, 2017; Cook et al., 2017; Myers et al., 2015).

On the other hand, a few studies find an interaction in the opposite direction: a backfire effect, where consensus messages provoke less belief in climate change for conservative participants. In particular, Cook and Lewandowsky (2016) found that a consensus message increased political polarization, where free market supporters reported less belief in climate change after the message than those in a control condition. Ma et al. (2019) demonstrated that consensus messages led to increased psychological reactance for Republican and Independent climate skeptics, which in turn was associated with less belief in climate change (also see: Dixon et al., 2019; van der Linden, Maibach, et al., 2019). Finally, Kahan et al. (2011) showed that conservative minded individuals saw climate scientists as having less expertise if they discussed the consensus.

The potentially complex relation between politics and consensus messaging led to our second research question:

RQ2: Will politics moderate the relation between consensus messaging and perceived consensus or climate change beliefs?

Based on previous studies, we would expect either a) no moderation between politics and message for perceived consensus, or b) moderation between politics and message for perceived consensus, such that conservatives show higher treatment effects than liberals. However, the current study tests consensus messaging differently than previous research. If a consensus message is presented at the end of an article about climate change, perhaps conservatives will have tuned out and not picked up on the message. On the contrary, research in motivated

reasoning provides evidence that individuals do not just immediately dismiss counter-attitudinal information; rather, they actually engage with it and look for reasons to disprove the information (Ditto et al., 1998; Ditto & Lopez, 1992; Lord et al., 1979; Taber & Lodge, 2006). For example, Garrett (2009) found that the amount of counter-attitudinal information in an online news story was positively related to how much time participants spent reading it. Therefore, we would not expect conservatives to dismiss consensus messaging in a news article any more than they would in other mediums, especially within an experimental setting where they are specifically asked to read the article.

For the direct relation between consensus messaging and other climate change beliefs, previous evidence is mixed on whether politics moderates the relation. Some studies show that neither liberals nor conservatives have increased belief in climate change after a consensus message (e.g., Dixon et al., 2017), other studies show that conservatives have less belief after a consensus message (e.g., Cook & Lewandowsky, 2016), others show decreased polarization (Bolsen et al., 2014), and finally some studies show that consensus messages work no matter the politics of participants (e.g., Brewer & McKnight, 2017; Myers et al., 2015). We did not have any specific prediction on whether politics would moderate the effect of the consensus message on climate change beliefs.

Study 1

Materials and Method

Participants and Procedure

College students (N = 559) from a large public university in the southwestern U.S. participated in a study about evaluating news articles in exchange for extra credit in social science courses. After excluding participants for not responding to (n = 30) or incorrectly

answering an attention check (n = 38), for expressing suspicion that the article they read was fake (n = 8), and for not allowing their data to be included in analyses after debriefing (n = 11), the final sample size was 472. The sample was mostly female (78% female, 21% male, <1% non-binary) and majority Asian or Latinx (34% Asian, 33% Latina/o/x, 14% White, 19% Other).

Participants were randomly assigned to one of five conditions: four article conditions and one control condition. In all conditions, participants first consented to take part in the study, which was approved by the university's IRB. Participants in the treatment conditions were then asked to read an article, answer questions about the article, answer questions about their attitudes on climate change, and finally answer demographic questions. When shown the article, participants could not advance the page until 60 seconds had elapsed. Participants in the control condition were also assigned to read an article and answer the same questions, but they first answered questions about perceived consensus and their climate change attitudes before reading the article. At the end of the survey, all participants were debriefed and thanked for their time.

Stimulus Materials

In an initial study using similar articles (but without any consensus manipulations), we found a relation between interest in the articles and belief in global warming.[5] Therefore, we created four news articles: a boring article without consensus information, a boring article with consensus information, an interesting article without consensus information, and an interesting article with consensus information. For the interesting articles—titled, "Study: Beer prices could double because of climate change" (Chappell, 2018)—we slightly edited the text of a real news article (Borenstein, 2018) describing the results of a study that found that climate change is going

[5] For a brief discussion of the design and results of this initial study, see Appendix A. The stimulus materials were similar to the current set of studies (i.e., using news articles about climate change), but we did not include a consensus manipulation.

to increase the price of beer (Xie et al., 2018). Taking on the logo and look of an *AP News* article, the text described how beer prices are projected to increase because of losses in barley production, and discussed some of the impacts of climate change. To craft the boring articles, we took text from a scientific paper on beech trees (Geßler et al., 2006) and included text that described how climate change is going to negatively affect beech trees. For the consensus articles, we also added the following text as the second to last paragraph:

> Climate scientists are in agreement about the effect of human activities on global warming, with at least 97% of climate scientists concluding that human-caused climate change is happening. A recent report by a collection of scientists concluded that human activity has already led to a 1°C increase in average global temperature, with worsening impacts as warming increases.

Importantly, the consensus message was not the main point of the consensus articles; rather, the articles detailed an outcome of climate change and only mentioned the scientific consensus at the end of the articles. The full text of all four articles, as well as all study materials and data, are available online (https://osf.io/cq8wp/).

Measures

Responses to the Article. To maintain the cover story of evaluating a news article, we asked participants a few questions about the article and facts within it (see the OSF page for all study questions). Included in these questions were two items measuring interest in the article, "How interesting/boring [reverse coded] did you find the article", that were scored from 0 (*Not at all*) to 10 (*Extremely*) and averaged together as an index of interest in the article (M = 4.54, SD = 2.62, standardized α = .85). Additionally, one item measured the difficulty of the article, "This

article was difficult to read", scored on a scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*) as a way to measure participants' perceptions of reading the article (M = 3.78, SD = 1.89).

Perceived Scientific Consensus. We assessed participants' perceptions of the scientific consensus using one item, "What percentage of climate scientists agree that humans are causing global warming", measured on a sliding scale from 0 to 100 (M = 83.93, SD = 15.05).

Belief in Climate Change. Belief in climate change was assessed with six items adapted from Dixon et al. (2017), such as "Climate change is a process that is already underway." The response scale ranged from 1 (*Strongly disagree*) to 7 (*Strongly agree*), and the items were averaged to create an index of belief in climate change (M = 5.99, SD = 0.80, α = .74).

Risk of Climate Change. To assess participants' perceived risk of climate change, we used three questions (from Kellstedt et al., 2008) asking about the risk that global warming and climate change will have on public health, the economy, and the environment (e.g., "In your opinion, what is the risk of global warming and climate change exerting a significant impact on public health in your state?"). Responses were measured on a scale from 1 (*No risk*) to 7 (*A lot of risk*) and averaged together to create an index of perceived risk (M = 5.74, SD = 1.14, α = .85).

Impact of Climate Change. Similarly, we used three items from the same study (Kellstedt et al., 2008) to assess participants' perceptions of the personal impact that climate change will have on their health, their economic situation, and the environment in which they live (e.g., "Global warming and climate change will have a noticeably negative impact on my health in the next 25 years"). Responses were measured on a scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*) and averaged together to create an index of personal impact (M = 5.95, SD = 0.84, α = .79).

Support for More Action on Global Warming. We included one item intended to measure participants' support for people to take more action towards global warming: "Do you think people should be doing more or less to reduce global warming" (from van der Linden, Leiserowitz, et al., 2019). Responses were measured on a scale from 1 (*Much less*) to 7 (*Much more*), with the midpoint at 4 (*Same amount*) (M = 6.54, SD = 0.97).

Political Ideology. We measured participants' political ideology with one item from 1 (*Very liberal*) to 7 (*Very conservative*), and the sample was heavily skewed towards liberal (M = 2.84, SD = 1.31).

Demographics. Lastly, we measured participants' demographics, including race and ethnicity, gender, and subjective socioeconomic status (Adler et al., 2000).

Results

As expected, participants found the article about beer (M = 5.82, SD = 2.19) much more interesting than the article about beech trees (M = 3.25, SD = 2.37), Welch's $t(460.84) = 12.16$, $p < .001$, $d = 1.13$.[6] However, both articles displayed largely the same pattern of results on climate change beliefs and perceived consensus. Appendix A includes the results split by all four articles, but for the rest of this section we collapse the boring and interesting articles to produce three groups: control, no consensus articles, and consensus articles.

Perceived Consensus

We conducted a linear regression with perceived consensus as the dependent variable and dummy-coded experimental condition as the independent variables. Perceptions of scientific consensus were significantly different by condition, $R^2 = .04$, $F(2, 468) = 9.98$, $p < .001$. Consistent with the GBM, participants who read articles that included consensus information (*M*

[6] Because participants in the control condition still read the article and rated how interesting they found it, we were able to include them as part of analyses using interest as the outcome variable.

= 87.36, *SD* = 13.31) had significantly higher perceptions of the scientific consensus than those in the control group (*M* = 79.54, *SD* = 15.84), *b* = 7.82, 95% CI_{boot} [4.22, 11.53], $p < .001$, *d* = 0.54.[7] Additionally, perceived consensus in the condition with no consensus (*M* = 82.83, *SD* = 15.56) was higher than in the control group, although the difference was only marginally significant, *b* = 3.29, 95% CI_{boot} [-0.59, 7.10], *p* = .07, *d* = 0.22. Even when presented in a subtle way, a consensus message was effective at garnering higher levels of scientific consensus perceptions.[8]

Climate Change Attitudes

To test the impact of article condition on climate change attitudes, we conducted linear regressions with each climate change attitude variable as the outcomes and dummy-coded experimental condition as the independent variables, displayed in Table 2.1. Compared to those in the control condition, participants who read the article with consensus information reported significantly more belief in climate change, perceived risk, and perceived impact than those in the control condition. Additionally, those who read the no consensus article reported significantly higher perceptions of risk and impact of climate change. However, participants' levels of support for action did not significantly vary by condition.

[7] As would be expected, the perceived consensus variable was heavily negatively skewed. Most studies in consensus messaging still analyze this outcome variable using parametric tests (e.g., *t* tests, regression). Unless otherwise stated, throughout the rest of the paper we report bias-corrected and accelerated (BCa) bootstrapped confidence intervals for all regressions. Additionally, regressions with robust standard errors are reported in Appendix A.

[8] Since the GBM predicts that changes in perceived consensus lead to changes in climate change attitudes, we also tested mediation models with the four climate change attitudes variables as outcomes and perceived consensus as the mediator, using consensus article compared to control as the treatment. The consensus article had a significant positive indirect effect on each outcome variable through perceived consensus, although without a pre-post design we could not directly test the GBM. Similar mediation results for each study are shown in Appendix A.

Table 2.1

Linear Regressions with Experimental Condition Predicting Climate Change Attitudes, Study 1

	Belief *b* (95% CI_{boot})	Risk *b* (95% CI_{boot})	Impact *b* (95% CI_{boot})	Support for action *b* (95% CI_{boot})
Intercept	5.83*** (5.65, 5.99)	5.47*** (5.23, 5.69)	5.73*** (5.53, 5.91)	6.43*** (6.17, 6.62)
Article without consensus	0.14 (-0.07, 0.36) *d* = 0.18	0.32* (0.04, 0.61) *d* = 0.29	0.28** (0.06, 0.52) *d* = 0.33	0.08 (-0.17, 0.36) *d* = 0.08
Article with consensus	0.26** (0.08, 0.47) *d* = 0.33	0.35* (0.09, 0.63) *d* = 0.31	0.28** (0.07, 0.51) *d* = 0.34	0.19 (-0.03, 0.47) *d* = 0.20
N	472	472	472	472
R_2	0.02	0.01	0.02	0.01
F	3.63*	3.53*	4.40*	1.45

Note. Confidence intervals are bias-corrected and accelerated (BCa). Because the condition variables were dummy coded, the intercept represents the mean of the control condition and the unstandardized coefficients represent the differences between each experimental group and the control condition.
*$p < .05$. **$p < .01$. ***$p < .001$.

Moderation by Political Ideology

Lastly, we examined if the impact of condition was dependent on participants' political ideology, conducting a linear regression with the interaction between centered ideology and condition predicting climate change attitudes. Ideology did not significantly moderate the effect of the no consensus article on perceived consensus (b = -1.61, 95% CI_{boot} [-4.53, 1.40], p = .23), nor the effect of the consensus article on perceived consensus (b = 0.25, 95% CI_{boot} [-2.72, 3.09], p = .86). Similarly, ideology was not a significant moderator of either article on beliefs (no consensus: b = -0.04, 95% CI_{boot} [-0.21, 0.13], p = .60; consensus: b = -0.09, 95% CI_{boot} [-0.25, 0.08], p = .23), impact (no consensus: b = -0.02, 95% CI_{boot} [-0.20, 0.16], p = .79; consensus: b = -0.04, 95% CI_{boot} [-0.22, 0.13], p = .61), or support for action (no consensus: b = -0.04, 95% CI_{boot} [-0.28, 0.16], p = .65; consensus: b = 0.04, 95% CI_{boot} [-0.15, 0.23], p = .65). Lastly, although ideology was a significant moderator of risk perceptions for the no consensus article (b = -0.19, 95% CI_{boot} [-0.44, 0.02], p = .049), it was a not a significant moderator for the consensus article, b = -0.17, 95% CI_{boot} [-0.41, 0.05], p = .10. Political ideology did not moderate the effect of the consensus article on perceived consensus or the other climate change attitudes.

Study 1 Discussion

In Study 1, we presented college students with articles about the effects of climate change on trees or beer, withholding the consensus message until the very end of the article. This subtle consensus message—unlike other messages used in the literature—mirrors how people might receive consensus information in their daily news browsing. Despite the covert nature of the manipulation, participants who received a consensus message reported significantly higher levels of scientific consensus than those in the control condition. Additionally, there was a significant effect of the consensus article on climate change beliefs and a significant effect of both articles

on perceived risk and impacts of climate change. The results not only support previous research on consensus messaging, but they also suggest that consensus messages do not necessarily need to be overt—they can still be effective even if placed at the end of a news article.

Study 2

Materials and Method

Participants and Procedure

Participants (N = 1,501) were recruited from the publicly available online website *YourMorals.org*, where people can take surveys on various moral, political, and personality topics in exchange for their scores and information about the topics. Given the focus of the current studies on climate and polarization in the U.S., we only analyzed data from participants from the U.S. (N = 1,077). Using G*Power software to calculate power, a target sample size was set at 969 with 0.80 power to detect a small effect in a one-way design with three groups. Similar to in Study 1, we excluded participants who did not answer (n = 100) or failed an attention check (n = 51), resulting in a final sample size of 926. The sample was mostly male (25% female) with an average age of 35.09 years (SD = 13.89). As is common with visitors to the *YourMorals.org* website, the sample was highly educated: 61% completed or in college, 33% completed or in graduate or professional school, and 6% completed high school with no college experience.

The design of the study was nearly identical to that of Study 1, except that we only used the articles about beer, resulting in three conditions: article with no consensus information, article with consensus information, and a control condition where participants answered questions about climate change before reading the article.

Measures

The measures were the same as those used in Study 1, with three differences. First, the setup of the *YourMorals.org* website requires that participants enter demographic information upon website registration. This includes information like gender, age, education, religiosity, and socioeconomic status. They also report their political ideology on a scale from 1 (*Very liberal*) to 7 (*Very conservative*), with the additional options of "Don't know/Not political", "Libertarian", and "Other." In analyzing ideology, we only included those who responded on the 1 to 7 scale (n = 741); the sample was heavily skewed towards liberal (M = 2.88, SD = 1.64). Second, visitors to the website list their political party upon registration, and those who do not select a party are given the option to select a party they lean towards. In analyzing party, we grouped "Democrat" with those who lean "Closer to Democrat", and "Republican" with those who lean "Closer to Republican" (43% Democrat, 32% Independent, 24% Republican). Third, we reduced the two questions about article interest to just one question about how boring the article was. Like in Study 1, the indices of belief (α = .89), risk (α = .93), and impact (α = .91) showed good reliability.

Results

Perceived Consensus

Most likely due to the highly educated nature of the sample, perceptions of consensus were extremely high in all conditions. Despite the overall high scores, as in Study 1, perceptions of consensus varied significantly by condition and participants were sensitive to the consensus message in the article, R_2 = .02, $F(2, 923) = 9.62$, $p < .001$. Compared to those in the control condition (M = 88.87, SD = 19.85), participants who read an article with consensus information reported significantly higher levels of perceived consensus (M = 93.63, SD = 12.67), b = 4.76, 95% CI_{boot} [2.23, 7.58], p = .001, d = 0.26. Those who read just the article without consensus

information did not vary significantly from the control group (M = 87.46, SD = 21.08), b = -1.41, 95% CI_{boot} [-4.63, 1.82], p = .34, d = -0.08.

Climate Change Attitudes

Experimental condition had various effects on the downstream climate change attitudes. Participants' belief in climate change, R^2 = .01, $F(2, 899) = 3.79$, p = .02, varied significantly by experimental condition, although neither article condition had an individually significant effect on belief. Interestingly, participants' belief in climate change was marginally significantly lower in the no consensus condition (M = 5.87, SD = 1.29) than in the control condition (M = 6.06, SD = 1.19), b = -0.18, 95% CI_{boot} [-0.39, 0.01], p = .07, d = -0.15. However, participants' level of climate change belief in the consensus condition (M = 6.14, SD = 1.15) was higher than it was in the control condition, although the difference was not significantly different, b = 0.08, 95% CI_{boot} [-0.10, 0.27], p = .39, d = 0.07. In a similar pattern of results, support for action varied significantly by condition, R^2 = .01, $F(2, 909) = 3.21$, p = .04, where those in the control condition reported the highest levels of support for action (M = 6.10, SD = 1.47). Participants in the no consensus condition (M = 5.81, SD = 1.69) reported significantly less support for action than those in the control condition, (b = -0.29, 95% CI_{boot} [-0.54, -0.04], p = .02, d = -0.18), but those in the consensus condition (M = 6.07, SD = 1.51) had nonsignificantly less support than the control, b = -0.02, 95% CI_{boot} [-0.26, 0.22], p = .86, d = -0.01.

For risk perceptions, R^2 = .004, $F(2, 909) = 1.84$, p = .16, and impact, R^2 = .01, $F(2, 903) = 2.33$, p = .10, attitudes did not vary significantly by condition. Compared to the control condition (M = 5.15, SD = 1.69), participants' risk perception was nonsignificantly lower in the no consensus condition (M = 4.97, SD = 1.80, b = -0.18, 95% CI_{boot} [-0.47, 0.09], p = .20, d = -0.10), and nonsignificantly higher in the consensus condition (M = 5.23, SD = 1.67), b = 0.08,

95% CI_{boot} [-0.20, 0.35], p = .57, d = 0.05. Similarly, compared to the control (M = 5.01, SD = 1.71), participants' perception of impacts was nonsignificantly lower in the no consensus condition (M = 4.74, SD = 1.80, b = -0.26, 95% CI_{boot} [-0.54, 0.02], p = .06, d = -0.15), and nonsignificantly higher in the consensus condition (M = 5.01, SD = 1.76), b = 0.01, 95% CI_{boot} [-0.28, 0.27], p = .97, d = 0.003.

Moderation by Political Ideology

As seen in Table 2.2, there was a significant interaction between ideology and the consensus article condition on perceived consensus. Liberals (estimated mean for those with a score of 2 on ideology) in the consensus article condition (M = 95.33) had a similar level of perceived consensus as those in the control condition (M = 94.17), b = 1.16, t(735) = 0.77, p = .44. However, conservatives reported significantly higher levels of perceived consensus in the consensus article condition (M = 87.45) than in the control condition, (M = 75.93), b = 11.52, t(735) = 3.92, p < .001. Neither liberals (M = 95.63, b = 1.46, t(735) = 0.95, p = .35) nor conservatives (M = 72.42, b = -3.51, t(735) = 1.24, p = .22) in the no consensus conditions were significantly different than the control. In other words, the consensus message was effective for conservatives but not for liberals.[9] As visualized in Figure 2.1, this interaction seems to be partly due to a ceiling effect for liberals. For all of the other climate change attitudes (Table 2.2), ideology was not a significant moderator, indicating that this interaction was unique to perceived consensus.

[9] A similar pattern can be found when using political party rather than ideology, as shown in Appendix A.

Table 2.2

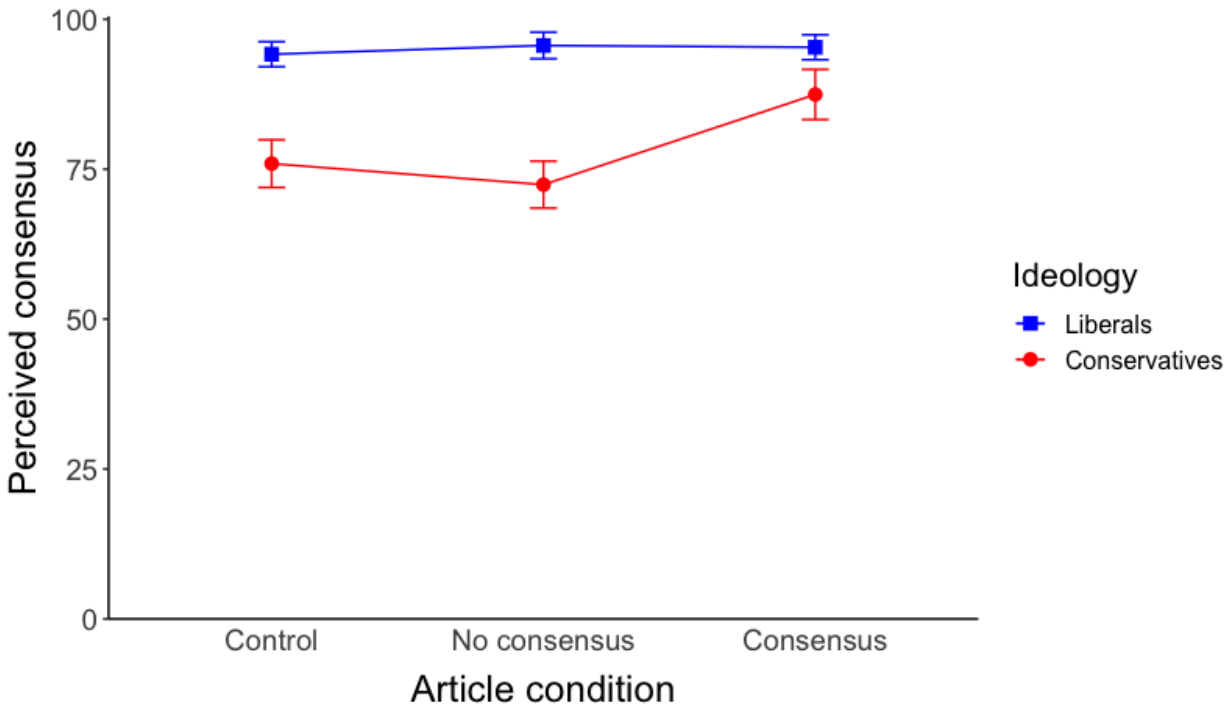
Linear Regressions for the Interaction Between Condition and Ideology, Study 2

	Perceived consensus *b* (95% CI_{boot})	Belief *b* (95% CI_{boot})	Risk *b* (95% CI_{boot})	Impact *b* (95% CI_{boot})	Support for action *b* (95% CI_{boot})
Intercept	90.14*** (87.69, 91.94)	6.17*** (6.06, 6.27)	5.27*** (5.11, 5.43)	5.14*** (4.96, 5.29)	6.22*** (6.08, 6.34)
Article no consensus	0.36 (-2.27, 3.04)	-0.01 (-0.16, 0.12)	0.08 (-0.13, 0.29)	0.01 (-0.22, 0.23)	-0.08 (-0.26, 0.10)
Article with consensus	3.45* (0.96, 6.15)	0.11 (-0.05, 0.25)	0.10 (-0.12, 0.32)	0.04 (-0.21, 0.28)	0.04 (-0.15, 0.23)
Conservatism	-4.56*** (-6.71, -2.88)	-0.49*** (-0.59, -0.40)	-0.65*** (-0.75, -0.52)	-0.64*** (-0.75, -0.53)	-0.58*** (-0.70, -0.48)
Conserv.*No consensus	-1.24 (-3.89, 1.31)	-0.08 (-0.20, 0.04)	-0.11 (-0.26, 0.04)	-0.07 (-0.22, 0.08)	-0.11 (-0.27, 0.05)
Conserv.*Consensus	2.59** (0.51, 4.76)	0.08 (-0.06, 0.21)	0.05 (-0.11, 0.19)	0.07 (-0.09, 0.23)	0.11 (-0.05, 0.26)
N	741	720	730	724	730
R^2	0.20	0.51	0.46	0.40	0.46
F	36.37***	146.87***	125.81***	95.86***	125.08***

Note. Confidence intervals are bias-corrected and accelerated (BCa). Because the condition variables were dummy coded and conservatism was mean centered, the intercept represents the mean of the control condition for those with average conservatism.
*p < .05. **p < .01. ***p < .001.

Figure 2.1

Interaction Between Political Ideology and Condition on Perceived Consensus



Note. The line for liberals shows the estimated marginal means predicted for those scoring 2 on ideology, and the line for conservatives shows predicted means for those scoring 6 on ideology. Error bars show 95% CIs.

Study 2 Discussion

This follow-up experiment demonstrated once again that news articles with consensus messages, even when the main topic is not the scientific consensus, can be effective mediums. Compared to a control condition, participants reported higher levels of perceived consensus after reading an article with consensus information, but not after reading the same article without the consensus message. Unlike in Study 1, the consensus message did not have significant effects for other climate change attitudes. However, for two of these dependent variables—belief in climate

change and support for action—experimental condition explained a significant amount of variation. For these variables, the pattern emerged where participants' attitudes were lower for those in the no consensus condition than in the control condition, but nonsignificantly different between those in the consensus condition and control condition. However, only one of the effects was significant (no consensus lower than control for support for action), suggesting that the overall impact of condition for downstream climate change attitudes was very limited.

Additionally, the Study 2 sample displayed significant moderation with political ideology on perceived consensus. Liberals reported very high perceptions of the scientific consensus no matter their experimental condition, while conservatives—with low consensus perceptions in the control condition—were significantly influenced by the consensus message, with those reading the article with consensus having higher levels of perceived consensus than the control condition. This finding is in line with other research showing that conservatives may be especially responsive to consensus information (Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; van der Linden et al., 2015; Zhang et al., 2018). Ideology was not a significant moderator for either article condition on the other climate change attitudes, indicating that this moderation was limited to perceptions of consensus.

Study 3

Study three was conducted with two goals in mind: first, to replicate Studies 1 and 2 in a larger sample; and second, to test the effect of the consensus article against a commonly used consensus message. The study compared the current consensus manipulation within a news article to a manipulation commonly used by other studies that use consensus messaging.

Methods and Materials

Participants and Procedure

The study was preregistered (*aspredicted.org*) and recruited U.S. participants from Amazon Mechanical Turk (AMT). We designed the study to have 80% power to detect a very small interaction effect (f_2 = .01) between experimental condition and ideology, leading to a target sample size of 1,095 (calculated using G*Power; Faul et al., 2007). In total, 1,150 people consented to take the study. Following our preregistered analyses, we excluded those who incorrectly answered (n = 63) or failed to answer (n = 20) an attention check, those who expressed suspicion that the news article was fake (n = 2), and those who did not wish for their data to be included (n = 17), resulting in a final sample size of 1,048. The sample was majority male (63%) and White (70%), with an average age of 37.67 years old (*SD* = 11.98). The sample was relatively balanced politically, with a mean ideology score of 4.00 out of 7 (where 1 = *Very liberal* and 7 = *Very conservative*). All materials and data are available online (https://osf.io/cq8wp/).

The design of the study was very similar to that of Studies 1 and 2, with two differences. First, we added an experimental condition where participants read a statement that read, "97% of climate scientists have concluded that human-caused climate change is happening." This statement was not embedded in an article and was only accompanied by a logo from the American Association for the Advancement of Science ([AAAS], as used in van der Linden et al., 2014). The remaining three conditions stayed the same as in Study 1: an article with no consensus information, an article with consensus information, and a control group that read the article or statement after responding to the climate change dependent variables. Participants could not advance from the statement-only page for 10 seconds and from the article page for 60 seconds. Whereas participants who read one of the news articles answered the same items as in

Study 2 about beer (e.g., relevance, importance), participants who read the statement answered the same items about AAAS (e.g., relevance and importance of AAAS).

The second change from Studies 1 and 2 was an adjustment to the dependent variables. Because of the similarity of the risk and impact measures, and to reduce the time for the study, we removed the three items assessing participants' perceived risk. In addition, given the extreme skew of the 0 to 100 perceived consensus variable, we also included a second measure of perceived consensus. Participants responded to the prompt, "A vast majority of climate scientists agree that humans are causing global warming" (adapted from Brewer & McKnight, 2017) by indicating their agreement on a scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*). This item was added to capture a more normally distributed measure of perceived consensus, although scores were still very high (M = 5.92, SD = 1.12). As in Studies 1 and 2, the scales of climate change belief (α = .84) and impact (α = .83) showed good reliability.

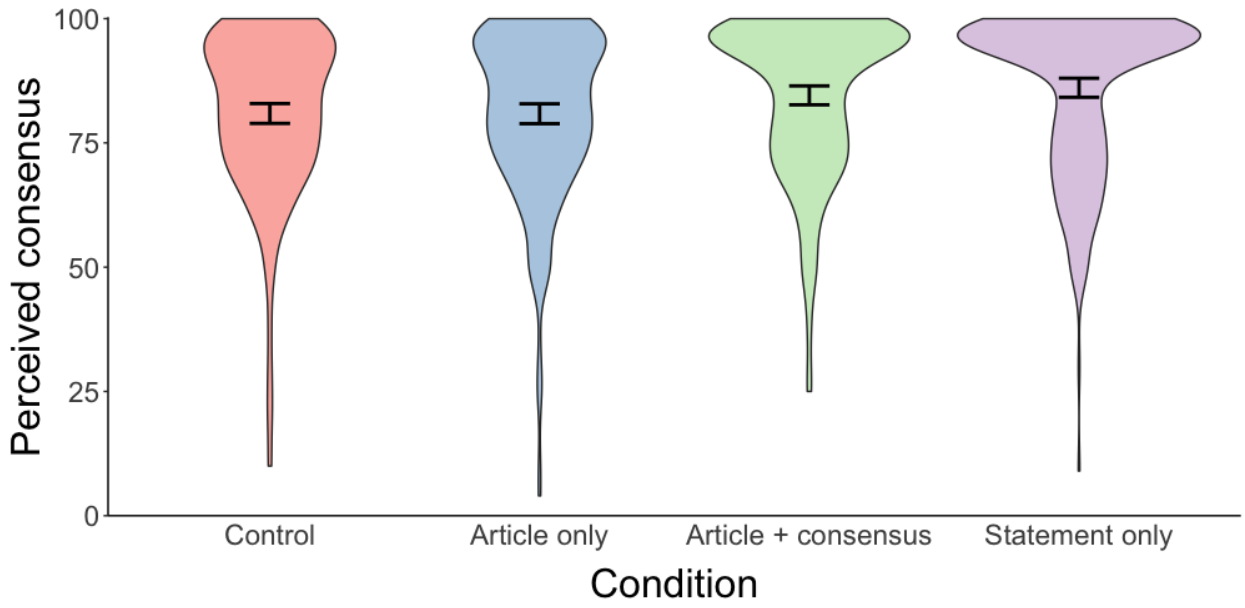
Results

Visualized in Figure 2.2, experimental condition explained a significant amount of variance in the 0-100 perceived consensus variable, R^2 = .02, $F(3, 1{,}043) = 7.06$, $p < .001$. Specifically, those who read an article with consensus information had significantly higher perceived consensus (M = 84.57, SD = 15.54) than those in the control group (M = 80.92, SD = 16.53), b = 3.65, 95% CI_{boot} [0.93, 6.35], p = .01, d = 0.23. Similarly, those in the statement-only group (M = 86.09, SD = 15.66) also had significantly higher perceptions of consensus than those in the control group, b = 5.18, 95% CI_{boot} [2.41, 7.89], $p < .001$, d = 0.32. Those who read the article without consensus information (M = 80.86, SD = 16.50) were not significantly different than the control group, b = -0.06, 95% CI_{boot} [-2.84, 2.74], p = .97, d = -0.004. Lastly, as specified in our preregistration, we also tested the effect of the article with consensus compared

to just the consensus statement; the two groups were not significantly different, b = 1.53, Tukey-adjusted p = .70, d = .10.

Figure 2.2

The Effect of Condition on Perceived Consensus



Note. The distributions of perceived consensus scores are displayed separately for each condition, with 95% confidence intervals around each group mean shown in black.

In contrast, the regression using perceived consensus on a Likert scale did not show differences by experimental condition, R_2 = .005, F(3, 1044) = 1.75, p = .16. Those in the control group had an average of 5.87 (SD = 1.00), which was nonsignificantly higher than those in the no consensus group (b = -0.04, 95% CI_{boot} [-0.23, 0.14], p = .66, d = -0.04), nonsignificantly lower than those in the article with consensus group (b = 0.11, 95% CI_{boot} [-0.07, 0.29], p = .25, d = 0.10), and nonsignificantly lower than those in the statement-only group, b = 0.15, 95% CI_{boot} [-

0.04, 0.34], p = .12, d = 0.14. Lastly, the two consensus groups were nonsignificantly different from each other, b = 0.04, p = .98, d = 0.03. Although differences emerged with the 0-100 variable, there were surprisingly no differences between experimental conditions when perceived consensus was measured on a Likert scale.

Unlike in Study 1, experimental condition was not a significant predictor of climate change beliefs, perceived impacts, or support for action (Table 2.3). Moreover, participants who read the article with consensus information and those in the statement-only group were nonsignificantly different on belief (b = 0.08, Tukey-adjusted p = .90, d = 0.06), impact (b = 0.02, Tukey-adjusted p = .997, d = 0.02), and support for action, b = 0.15, Tukey-adjusted p = .70, d = 0.10.

Moderation by Political Ideology

For the 0-100 perceived consensus variable, political ideology did not significantly moderate the impact of the no consensus article (b = 0.67, 95% CI_{boot} [-0.76, 2.14], p = .33), the consensus article (b = -0.20, 95% CI_{boot} [-1.50, 1.15], p = .78), or the statement, b = 0.10, 95% CI_{boot} [-1.10, 1.45], p = .89. In other words—unlike in Study 2 but similar to Study 1—the articles and statement were not differentially effective for participants across the political spectrum. Unsurprisingly, for the Likert perceived consensus variable, political ideology also did not moderate the impact of the no consensus article (b = 0.03, 95% CI_{boot} [-0.06, 0.12], p = .56), the consensus article (b = -0.01, 95% CI_{boot} [-0.09, 0.07], p = .89), or the statement, b = 0.02, 95% CI_{boot} [-0.07, 0.12], p = .70. Neither the articles nor the statement were effective in increasing the Likert perceived consensus variable, and this did not vary across ideology. As displayed in Table 2.3, ideology was not a significant moderator for any of the three other climate change attitudes dependent variables.

Table 2.3

Linear Regressions for the Main Effects and Interaction Between Condition and Ideology, Study 3

	Belief		Impact		Support for action	
	b (95% CI_{boot})	*b* (95% CI_{boot})	*b* (95% CI_{boot})	*b* (95% CI_{boot})	*b* (95% CI_{boot})	*b* (95% CI_{boot})
Intercept	5.04***	5.06***	5.16***	5.16***	5.34***	5.37***
	(4.90, 5.19)	(4.93, 5.18)	(5.00, 5.29)	(5.02, 5.30)	(5.14, 5.52)	(5.18, 5.53)
Article no consensus	0.09	0.09	0.04	0.04	0.18	0.16
	(-0.12, 0.30)	(-0.10, 0.28)	(-0.16, 0.24)	(-0.16, 0.24)	(-0.08, 0.47)	(-0.08, 0.42)
Article with consensus	0.12	0.05	-0.05	-0.08	0.18	0.11
	(-0.09, 0.33)	(-0.14, 0.24)	(-0.27, 0.17)	(-0.30, 0.13)	(-0.08, 0.47)	(-0.14, 0.35)
Statement only	0.04	0.03	-0.07	-0.07	0.03	0.01
	(-0.19, 0.25)	(-0.16, 0.22)	(-0.28, 0.14)	(-0.27, 0.13)	(-0.25, 0.31)	(-0.25, 0.27)
Conservatism		-0.31***		-0.17***		-0.35***
		(-0.38, -0.24)		(-0.24, -0.10)		(-0.43, -0.26)
Conservatism*No consensus		0.06		0.04		0.10
		(-0.04, 0.15)		(-0.06, 0.15)		(-0.03, 0.22)
Conservatism*Consensus		-0.09		-0.06		-0.05
		(-0.18, 0.01)		(-0.17, 0.05)		(-0.18, 0.07)
Conservatism*Statement		-0.04		-0.004		0.01
		(-0.13, 0.06)		(-0.11, 0.10)		(-0.11, 0.15)
N	1,048	1,045	1,047	1,045	1,047	1,045
R_2	0.001	0.27	0.001	0.08	0.003	0.17
F	0.45	54.61***	0.41	13.25***	0.96	29.71***

Note. Confidence intervals are bias-corrected and accelerated (BCa). Because the condition variables were dummy coded and

conservatism was mean centered, the intercept of the smaller models represents the mean of the control condition and the intercept of the larger models represents the mean of the control condition for those with average conservatism. Effect sizes between treatment and control can be calculated using the regression coefficients and the full sample standard deviations (belief *SD* = 1.27, impact *SD* = 1.26, support for action *SD* = 1.62).
*$p < .05$. **$p < .01$. ***$p < .001$.

Study 3 Discussion

Study 3 was conducted to replicate Studies 1 and 2 in a different sample and to compare the effect of the consensus article with a traditional consensus statement. Similar to Studies 1 and 2, participants who read the article with a consensus message—but not those who read the same article without a consensus message—had significantly higher perceptions of the consensus. Participants who read a consensus statement only also had significantly higher consensus perceptions and were not significantly different than those in the consensus article condition. The results find some support for the GBM and suggest that—even when embedded at the end of an article that does not focus on consensus—a consensus message increases belief that climate scientists are in agreement about human-caused climate change.

However, the results also point to some limitations of consensus messaging. First, similar to Study 2 but unlike Study 1, neither of the articles nor the consensus statement improved climate change attitudes compared to a control condition. This is in line with other research on the GBM and points to the limited direct impact that consensus messages can have on downstream climate change beliefs. Second, consensus messages were only effective when perceived consensus was measured on a scale from 0-100 and not when measured as a Likert scale of agreement that the vast majority of climate scientists agree that climate change is human-caused. This could be due to a ceiling effect—the average score was nearly 6 out of 7—or the ambiguity of "vast majority." We used this term to convey that a strong majority, but it is unclear whether participants interpreted this as 60%, 70%, 80%, 90%, 99%, or some other percentage. There may have been more variance in responses if all participants had interpreted this as 97% or a similarly high percentage. Moreover, this is in line with previous research that it is important to convey 97% in consensus messages rather than just stating a majority (Deryugina

& Shurchkov, 2016; Myers et al., 2015); this distinction between 97% and majority may play a role not only in experimental manipulations (e.g., effectiveness of 97% messages vs. others) but also in the measurement of the dependent variable.

General Discussion

Three studies were conducted to test if an article with consensus information embedded towards the end could be an effective way to convey a consensus message. Across all three samples, this article significantly increased perceptions of consensus compared to a control group. Moreover, reading an identical article without consensus information did not increase perceived consensus, demonstrating that the specific consensus information embedded in the article played the key causal part in influencing perceptions. In Study 1, the consensus article also led to increased belief in climate change, perceived risk of climate change, and impacts of climate change; the same effects, however, were not significant in Studies 2 and 3. In Study 2, the effect of the consensus article on perceived consensus was significantly moderated by political ideology, such that the article was more effective for conservatives than for liberals; the same interaction, however, was not significant in Studies 1 or 3. In Study 3, both the article with consensus and a straightforward consensus statement were effective in increasing perceptions of consensus, although only when perceived consensus was measured from 0 to 100. Overall, the series of studies provides evidence that embedding consensus information into an article is an effective way to communicate consensus information. Furthermore, the results suggest that consensus information does not provoke a backfire effect among conservatives. Across three large studies—and one specifically powered to find a small interaction effect—political ideology did not moderate the effect of consensus information on climate change belief, risk perceptions, perceived impact, or support for action. Although Study 2 found that the consensus article was

more effective for conservatives than liberals (for perceived consensus), ideology overall had little impact on the effectiveness of the various experimental conditions.

The set of studies has a few important implications for climate change communication. The present findings suggest that consensus information is still effective (at least for perceived consensus) even when it is not the center of a message or the main point of an article. Traditional ways of communicating scientific consensus in experiments rely on very straightforward and overt messages, unique to a research experiment. The current studies use an ecologically valid way of communicating consensus—through a news article—and find it to be just as effective as an overt message. Given this potential, journalists may be able to add some consensus information at the end of an article, even if it were not the main subject. Because the current findings provide no evidence of a backfire effect among conservatives, there seems to be little downside to adding consensus messages to news articles on climate change whenever possible. If anything, there may be a ceiling effect once enough of the public is familiar with the scientific consensus (which has not happened yet, Leiserowitz et al., 2019). Until then, however, climate change communicators should continue to find ways of communicating the consensus through various mediums.

The results also highlight the limitations of consensus messaging. While there is mixed evidence that consensus messages influence belief in climate change or policy attitudes, there is robust evidence that these messages lead to increases in perceived consensus—similar to the current findings. On one hand, it could be that the true effect of consensus messages on downstream climate change attitudes (e.g., belief, worry, policy support) is extremely small and therefore most studies are underpowered to detect this effect. In the current experiments, for example, Study 2 was powered to detect a small effect but underpowered to detect a very small

effect. Current consensus research may just be missing the true effect of consensus on attitudes if the true effect is very small. On the other hand, however, there may not be a true effect of consensus messaging on downstream climate change attitudes (or one so small that it is trivial). In this case, consensus studies may just be picking up on a manipulation check: give participants a statement about 97% scientific agreement and then ask them what percentage of scientists agree. Rather than responding with their true beliefs, participants in consensus conditions may be reporting higher levels of perceived consensus because they just received this specific information. Future work on consensus messaging should carefully consider ways to disentangle finding a true effect of experimental manipulations from a manipulation check.

Limitations

The current set of studies has a number of limitations. For example, it relied on convenience samples that are not representative of the general population. There is robust evidence that experiments using students, AMT, and other convenience samples have similar results as those using more representative samples (Buhrmester et al., 2011; Casler et al., 2013; Coppock et al., 2018; Crump et al., 2013; Kees et al., 2017; Mullinix et al., 2015); however, given that these samples may differ on key moderating variables (e.g., ideology), there may be differences in the observed treatment effects compared to those of nationally representative samples (Boas et al., 2020; Druckman & Kam, 2011). Moreover, all three samples were likely more liberal than the general population and—although we tested for moderation between ideology and treatment—we may not have captured the behavior of representative liberals and conservatives (for more on AMT and political ideology, see Clifford et al., 2015).

The set of experiments tested the hypotheses using only one news article and one scientific article (Study 1). Although the results may generalize to other news articles, there

could be specific aspects of the specific article used that influenced the results. For example, because the article focused on the effects of climate change on beer, perhaps participants were particularly intrigued by the article and paid more attention to it. Or participants might have found the article compelling and therefore more credible and convincing. However, by comparing the article with consensus information to the same article without the information, we aimed to isolate the specific impacts of consensus information by keeping the article constant. Future research should investigate different types of articles to test if the type of article interacts with consensus information.

In the study design, we forced participants to stay on the page for at least 60 seconds which, along with the fact that participants were asked to read the article as part of a paid study, increased the likelihood that they would read the full article. Although this was helpful to maximize participant engagement, it also reduced the ecological validity of the experiments. When people typically read news online, they are not forced to stay on the page for a certain amount of time or read an entire article. People likely simply read headlines or the first few paragraphs of an article—if consensus information is embedded at the end of an article, many people may never see it. The current studies extend research on the GBM by using a subtle manipulation in a commonly seen online format, but more research is needed to increase the ecological validity of the manipulation in order to fully generalize to real online behavior.

Conclusion

The current research demonstrates that consensus messages can effectively convey information about the scientific consensus even if they are embedded towards the end of a news article. Despite the limitations of the study, it has important implications for climate change communication. A recent news article highlights how the last paragraph can be strategically

used. The article—on a conservative news site, Fox News—describes how a recent scientific study suggests that half of the world's beaches will disappear by 2100 (Ciaccia, 2020). The article explains some of the study's results, discusses global warming and its effects, and quotes the study's author talking about how reductions in greenhouse gas emissions can still be effective to mitigate some of the effects of global warming on coastline. The last paragraph states:

> Skeptics have largely dismissed fears over man's impact on global warming, saying climate change has been going on since the beginning of time. They also claim the dangers of a warming planet are being wildly exaggerated and question the impact that fossil fuels have had on climate change. (Ciaccia, 2020, para. 15)

The article ends after this paragraph, with no mention of scientific consensus or the relative strength of the evidence to support the skeptics' claims. Research suggests that this strategy of false balance—implying there is equivalent evidence on both sides a debate (when the evidence actually strongly favors one side)—can lower perceived consensus and increase polarization, although there are ways to correct the misinformation (Cook et al., 2017). This example demonstrates that the last paragraph can be used to convey consensus information—even non-scientific information—and therefore points to the importance of continuing to study people's perceptions of consensus information in ecologically valid ways.

References

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, *19*(6), 586–592. https://doi.org/10.1037/0278-6133.19.6.586

Boas, T. C., Christenson, D. P., & Glick, D. M. (2020). Recruiting large online samples in the United States and India: Facebook, Mechanical Turk, and Qualtrics. *Political Science Research and Methods*, *8*(2), 232–250. https://doi.org/10.1017/psrm.2018.28

Bolsen, T., & Druckman, J. N. (2018). Do partisanship and politicization undermine the impact of a scientific consensus message about climate change? *Group Processes & Intergroup Relations*, *21*(3), 389–402. https://doi.org/10.1177/1368430217737855

Bolsen, T., Leeper, T. J., & Shapiro, M. A. (2014). Doing what others do: Norms, science, and collective action on global warming. *American Politics Research*, *42*(1), 65–89. https://doi.org/10.1177/1532673X13484173

Borenstein, S. (2018, October 15). Global warming to leave us crying in our costlier beer. *AP News*. https://apnews.com/3f7f6cab367a489fb41d728f8a69f63b

Brewer, P. R., & McKnight, J. (2017). "A statistically representative climate change debate": Satirical television news, scientific consensus, and public perceptions of global warming. *Atlantic Journal of Communication*, *25*(3), 166–180. https://doi.org/10.1080/15456870.2017.1324453

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, *6*(1), 3–5. https://doi.org/10.1177/1745691610393980

Casler, K., Bickel, L., & Hackett, E. (2013). Separate but equal? A comparison of participants and data gathered via Amazon's MTurk, social media, and face-to-face behavioral testing. *Computers in Human Behavior*, *29*(6), 2156–2160. https://doi.org/10.1016/j.chb.2013.05.009

Chappell, B. (2018, October 16). Beer prices could double because of climate change, study says. *NPR*. https://www.npr.org/2018/10/16/657778326/climate-change-could-make-beer-prices-double-study-says

Chinn, S., Lane, D. S., & Hart, P. S. (2018). In consensus we trust? Persuasive effects of scientific consensus communication. *Public Understanding of Science*, *27*(7), 807–823. https://doi.org/10.1177/0963662518791094

Ciaccia, C. (2020, March 2). Half of world's beaches will disappear by 2100 because of climate change, experts say. *Fox News*. https://www.foxnews.com/science/half-worlds-beaches-disappear-by-2100-climate-change

Clifford, S., Jewell, R. M., & Waggoner, P. D. (2015). Are samples drawn from Mechanical Turk valid for research on political ideology? *Research & Politics*, *2*(4), 1–9. https://doi.org/10.1177/2053168015622072

Cook, J. (2019, August 7). The consensus on consensus messaging. *Skeptical Science*.

Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using bayesian networks. *Topics in Cognitive Science*, *8*(1), 160–179. https://doi.org/10.1111/tops.12186

Cook, J., Lewandowsky, S., & Ecker, U. K. H. (2017). Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLoS ONE*, *12*(5), e0175799. https://doi.org/10.1371/journal.pone.0175799

Coppock, A., Leeper, T. J., & Mullinix, K. J. (2018). Generalizability of heterogeneous treatment effect estimates across samples. *Proceedings of the National Academy of Sciences, 115*(49), 12441–12446. https://doi.org/10.1073/pnas.1808083115

Crump, M. J. C., McDonnell, J. V., & Gureckis, T. M. (2013). Evaluating Amazon's Mechanical Turk as a tool for experimental behavioral research. *PLoS ONE, 8*(3), e57410. https://doi.org/10.1371/journal.pone.0057410

Deryugina, T., & Shurchkov, O. (2016). The effect of information provision on public consensus about climate change. *PLoS ONE, 11*(4), e0151469. https://doi.org/10.1371/journal.pone.0151469

Ding, D., Maibach, E. W., Zhao, X., Roser-Renouf, C., & Leiserowitz, A. (2011). Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nature Climate Change, 1*, 462–466. https://doi.org/10.1038/nclimate1295

Ditto, P. H., & Lopez, D. F. (1992). Motivated skepticism: Use of differential decision criteria for preferred and nonpreferred conclusions. *Journal of Personality and Social Psychology, 63*(4), 568–584. https://doi.org/10.1037/0022-3514.63.4.568

Ditto, P. H., Scepansky, J. A., Munro, G. D., Apanovitch, A. M., & Lockhart, L. K. (1998). Motivated sensitivity to preference-inconsistent information. *Journal of Personality and Social Psychology, 75*(1), 53–69. https://doi.org/10.1037/0022-3514.75.1.53

Dixon, G., Hmielowski, J., & Ma, Y. (2017). Improving climate change acceptance among U.S. conservatives through value-based message targeting. *Science Communication, 39*(4), 520–534. https://doi.org/10.1177/1075547017715473

Dixon, G., Hmielowski, J., & Ma, Y. (2019). More evidence of psychological reactance to consensus messaging: A response to van der Linden, Maibach, and Leiserowitz (2019).

Environmental Communication, 1–7. https://doi.org/10.1080/17524032.2019.1671472

Druckman, J. N., & Kam, C. D. (2011). Students as experimental participants: A defense of the "narrow data base." In J. N. Druckman, D. P. Green, J. H. Kuklinski, & A. Lupia (Eds.), *Cambridge handbook of experimental political science*. Cambridge University Press.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Funk, C., & Hefferon, M. (2019, November 25). U.S. public views on climate and energy. *Pew Research Center*. https://www.pewresearch.org/science/2019/11/25/u-s-public-views-on-climate-and-energy/

Garrett, R. K. (2009). Echo chambers online?: Politically motivated selective exposure among Internet news users. *Journal of Computer-Mediated Communication*, *14*(2), 265–285. https://doi.org/10.1111/j.1083-6101.2009.01440.x

Geßler, A., Keitel, C., Kreuzwieser, J., Matyssek, R., Seiler, W., & Rennenberg, H. (2006). Potential risks for European beech (Fagus sylvatica L.) in a changing climate. *Trees*, *21*, 1–11. https://doi.org/10.1007/s00468-006-0107-x

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., Gustafson, A., & Leiserowitz, A. (2019). The experience of consensus: Video as an effective medium to communicate scientific agreement on climate change. *Science Communication*, *41*(5), 659–673. https://doi.org/10.1177/1075547019874361

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). The role of anchoring in judgments about expert consensus. *Journal of Applied Social Psychology*, *49*(3), 192–200. https://doi.org/10.1111/jasp.12576

Gustafson, A., & Rice, R. E. (2019). The effects of uncertainty frames in three science communication topics. *Science Communication*, *41*(6), 679–706. https://doi.org/10.1177/1075547019870811

Harris, A. J. L., Sildmäe, O., Speekenbrink, M., & Hahn, U. (2019). The potential power of experience in communications of expert consensus levels. *Journal of Risk Research*, *22*(5), 593–609. https://doi.org/10.1080/13669877.2018.1440416

Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). Relationships among conspiratorial beliefs, conservatism and climate scepticism across nations. *Nature Climate Change*, *8*, 614–620. https://doi.org/10.1038/s41558-018-0157-2

IPCC. (2018). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*. World Meteorological Organization.

Jenkins-Smith, H. C., Ripberger, J. T., Silva, C. L., Carlson, D. E., Gupta, K., Carlson, N., Ter-Mkrtchyan, A., & Dunlap, R. E. (2020). Partisan asymmetry in temporal stability of climate change beliefs. *Nature Climate Change*, *10*, 322–328. https://doi.org/10.1038/s41558-020-0719-y

Kahan, D. (2017). The "Gateway Belief" illusion: reanalyzing the results of a scientific-consensus messaging study. *Journal of Science Communication*, *16*(05). https://doi.org/10.22323/2.16050203

Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147–174. https://doi.org/10.1080/13669877.2010.511246

Kees, J., Berry, C., Burton, S., & Sheehan, K. (2017). An analysis of data quality: Professional panels, student subject pools, and Amazon's Mechanical Turk. *Journal of Advertising, 46*(1), 141–155. https://doi.org/10.1080/00913367.2016.1269304

Kellstedt, P. M., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis*, *28*(1), 113–126. https://doi.org/10.1111/j.1539-6924.2008.01010.x

Kerr, J. R., & Wilson, M. S. (2018). Perceptions of scientific consensus do not predict later beliefs about the reality of climate change: A test of the gateway belief model using cross-lagged panel analysis. *Journal of Environmental Psychology*, *59*, 107–110. https://doi.org/10.1016/j.jenvp.2018.08.012

Leiserowitz, A., Maibach, E., Rosenthal, S., & Kotcher, J. (2019). *Climate change in the American mind: November, 2019*. New Haven, CT: Yale Project on Climate Change Communication. https://climatecommunication.yale.edu/wp-content/uploads/2019/12/Climate_Change_American_Mind_November_2019b.pdf

Lewandowsky, S., Gignac, G. E., & Vaughan, S. (2013). The pivotal role of perceived scientific consensus in acceptance of science. *Nature Climate Change*, *3*, 399–404. https://doi.org/10.1038/nclimate1720

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology*, *37*(11), 2098–2109. https://doi.org/10.1037/0022-3514.37.11.2098

Ma, Y., Dixon, G., & Hmielowski, J. D. (2019). Psychological reactance from reading basic facts on climate change: The role of prior views and political identification. *Environmental Communication*, *13*(1), 71–86. https://doi.org/10.1080/17524032.2018.1548369

McCright, A. M., Dunlap, R. E., & Xiao, C. (2013). Perceived scientific agreement and support for government action on climate change in the USA. *Climatic Change*, *119*, 511–518. https://doi.org/10.1007/s10584-013-0704-9

Mullinix, K. J., Leeper, T. J., Druckman, J. N., & Freese, J. (2015). The generalizability of survey experiments. *Journal of Experimental Political Science*, *2*(2), 109–138. https://doi.org/10.1017/XPS.2015.19

Myers, T. A., Maibach, E., Peters, E., & Leiserowitz, A. (2015). Simple messages help set the record straight about scientific agreement on human-caused climate change: The results of two experiments. *PLoS ONE, 10*(3), e0120985. https://doi.org/10.1371/journal.pone.0120985

Pew. (2020, February 13). As economic concerns recede, environmental protection rises on the public's policy agenda. *Pew Research Center*. https://www.people-press.org/2020/02/13/as-economic-concerns-recede-environmental-protection-rises-on-the-publics-policy-agenda/

Skurka, C., Niederdeppe, J., & Nabi, R. (2019). Kimmel on climate: Disentangling the emotional ingredients of a satirical monologue. *Science Communication*, *41*(4), 394–421. https://doi.org/10.1177/1075547019853837

Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science*, *50*(3), 755–769. https://doi.org/10.1111/j.1540-5907.2006.00214.x

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: Plain facts, pie charts or metaphors? *Climatic Change*, *126*, 255–262. https://doi.org/10.1007/s10584-014-1190-4

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS ONE*, *10*(2), e0118489. https://doi.org/10.1371/journal.pone.0118489

van der Linden, S., Leiserowitz, A., & Maibach, E. (2017). Gateway illusion or cultural cognition confusion? *Journal of Science Communication*, *16*(05). https://doi.org/10.22323/2.16050204

van der Linden, S., Leiserowitz, A., & Maibach, E. (2018). Perceptions of scientific consensus predict later beliefs about the reality of climate change using cross-lagged panel analysis: A response to Kerr and Wilson (2018). *Journal of Environmental Psychology*, *60*, 110–111. https://doi.org/10.1016/j.jenvp.2018.10.002

van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology*, *62*, 49–58. https://doi.org/10.1016/j.jenvp.2019.01.009

van der Linden, S., Maibach, E., & Leiserowitz, A. (2019). Exposure to scientific consensus does not cause psychological reactance. *Environmental Communication*, 1–8. https://doi.org/10.1080/17524032.2019.1617763

Wilkins, E. J., Miller, H. M., Tilak, E., & Schuster, R. M. (2018). Communicating information on nature-related topics: Preferred information channels and trust in sources. *PLoS ONE*, *13*(12), e0209013. https://doi.org/10.1371/journal.pone.0209013

Xie, W., Xiong, W., Pan, J., Ali, T., Cui, Q., Guan, D., Meng, J., Mueller, N. D., Lin, E., &

Davis, S. J. (2018). Decreases in global beer supply due to extreme drought and heat. *Nature Plants, 4*, 964–973. https://doi.org/10.1038/s41477-018-0263-1

Zhang, B., van der Linden, S., Mildenberger, M., Marlon, J. R., Howe, P. D., & Leiserowitz, A. (2018). Experimental effects of climate messages vary geographically. *Nature Climate Change, 8*, 370–374. https://doi.org/10.1038/s41558-018-0122-0

CHAPTER 3

Abstract

Researchers interested in communicating science about climate change to the public have conducted experimental studies to investigate how people respond to messages about climate change. Through meta-analysis, the current chapter synthesizes this multitude of experimental studies in an attempt to uncover which interventions are most effective at influencing attitudes. The meta-analysis focused on experimental studies that included a control condition and measured climate change attitudes from participants in the United States. After a large literature search, 387 effect sizes were retrieved from 73 independent experiments. Interventions had a small, statistically significant positive effect on attitudes, $g = 0.07$, 95% CI [0.05, 0.09], $p < .001$. Surprisingly, type of intervention was not a significant moderator of the effect, nor was political affiliation. However, type of attitude was a significant moderator: the treatment-control difference in attitudes was smaller for policy support than for belief in climate change, indicating that policy attitudes are more resistant to influence than belief in climate change. The meta-analysis also details and describes other moderators and publication bias. The chapter concludes with takeaways and recommendations for future research.

A Systematic Review and Meta-Analysis of Climate Change Attitudes After Experimental Interventions

Climate change looms as one of the most substantial threats to the natural and built environment, bringing increased droughts, floods, and severe weather to most of the world in the next 100 years (IPCC, 2018). Yet collective action to address and mitigate it has been slow to mobilize. There is continued theorizing about why human psychology is part of the reason climate change is such a difficult problem to address. Human perceptions of climate change are vulnerable to a broad range of biases and are impacted by complex processes. Weber and Stern (2011) argued that non-scientists rely too heavily on personal experience, use simple mental models of climate change that are inadequate (e.g., equating weather with climate), and base beliefs on worldviews and values rather than scientific evidence. Certain aspects of climate change are so widespread that it necessarily intersects with many aspects of human psychology. Climate change is a collective action problem (i.e., requires widespread group solutions rather than just individual actions), has differential causes and effects, has the potential to destabilize social systems, is spread out over both space and time, and has both short-term and long-term effects in most areas of the earth (Pearson et al., 2016). These features interact with psychology in many ways, including group-processes, identity, belief systems, status, and time orientation. Furthermore, climate change has certain aspects that make it difficult to be approached as a moral problem: it is abstract, it is hard to ascribe blame on one actor, it provokes defensiveness through guilt, it allows for optimism through uncertainty, it incites tribal and group thinking, and it involves long-term time frames or far-away places (Markowitz & Shariff, 2012).

All of these psychological processes are factors that lead to the difference between scientific consensus and public beliefs, as well as a gap between the emissions reductions needed

to mitigate the worst effects of global warming and the public's willingness to act. Specifically, whereas 97% of climate scientists agree that human-caused global warming is happening, a recent poll found that 59% of the American sample thinks that global warming is human-caused (and only 25% of conservative Republicans; Leiserowitz, Maibach, Rosenthal, & Kotcher, 2019; Leiserowitz, Maibach, Rosenthal, Kotcher, et al., 2019). Additionally, in a recent sample of registered voters, 66% said that they were worried about global warming—again, split along political lines with 94% of liberal Democrats and 26% of conservative Republicans worried (Leiserowitz, Maibach, Rosenthal, Kotcher, et al., 2019). To investigate opinions about action to combat the effects of global warming, the same poll asked about support for both specific policies and general attitudes about making global warming a political priority: global warming should be a high priority for the President and Congress (83% of Democrats, 53% of Independents, 22% of Republicans); support for a carbon fee for fossil fuel companies that would be redistributed to citizens (77% of Democrats, 51% of Independents, 40% of Republicans); support for a revenue-neutral carbon tax[10] (87% of Democrats, 58% of Independents, 48% of Republicans); oppose President Trump's decision to pull out of the Paris climate agreement (92% of Democrats, 66% of Independents, 31% of Republicans); and various other policies showing similar results (Leiserowitz, Maibach, Rosenthal, Kotcher, et al., 2019). Registered voters were also asked about the issues they consider very important when voting in the next presidential election; highlighting the political contrast, global warming was the 3rd most important issue for liberal Democrats, the 7th most important issue for moderate/conservative Democrats, the 23rd most important issue for liberal/moderate Republicans, and the 29th most important issue for conservative Republicans (Leiserowitz, Maibach, Rosenthal, Kotcher, et al.,

[10] A revenue-neutral carbon tax, as described to survey respondents, requires fossil fuel companies to pay a tax on carbon and the revenue would be used to lower other taxes (Leiserowitz, Maibach, Rosenthal, Kotcher, et al., 2019).

2019). In summary, Americans are divided politically—with Independent and Republican attitudes further away from scientific evidence than Democrat attitudes—and they vary in their attitudes about the cause of global warming, the effects it will have, the policies that should be enacted to stop it, and its priority as a voting issue. Therefore, social scientists have investigated ways of bridging the gap between public and scientific knowledge about climate change, as well as examining ways of inducing support for policies to mitigate its effects.

Interventions to Influence Climate Change Attitudes

When considering how to alter perceptions about climate change, researchers have proposed a number of interventions. Weber and Stern (2011) argued that improving public knowledge requires conceptual changes rather than an influx of information. For example, a conceptual adjustment would involve changing a person's mental model of how climate change works—thus promoting a deeper understanding of the phenomenon—instead of giving them more evidence about global temperature increases. The authors also advocated for using a frame of risk management, where climate change communication focuses on future risks and how people can manage those risks, drawing on analogies to health and managing retirement. Weber (2016) outlined research with potential to sway perceptions of climate change, including: making climate change more concrete and local, using numbers to denote uncertainty rather than vague words, increasing care for future generations and connecting a country's long past to a potentially long future, and increasing emotional responses in a carefully crafted way so as to reduce unintended side effects (e.g., inducing avoidance rather than action). In discussing social psychological interventions to increase concern for climate change, Fielding et al. (2014) highlight promising research in this area: effective interventions have used messages tailored to the audience's values, framed messages in a way that focuses on avoiding losses, aligned

messages with the policies in those messages, used messages designed to assuage defensive reactions, reduced the distance between the consequences of climate change and the audience, and induced a shared human identity.

There are many experimental studies designed to alter attitudes on climate change, and researchers have various perspectives about the types of interventions that will be the most effective. Despite numerous reviews discussing various interventions (e.g., Markowitz & Shariff, 2012; Pearson et al., 2016; Weber, 2016), a comprehensive quantitative synthesis has not yet been conducted. In non-quantitative reviews, each study cited is given relatively equal weight (or subjectively weighted) in the conclusions that the authors draw. Quantitatively combining studies can help determine which interventions are effective at influencing climate change attitudes—such as increasing belief in climate change or garnering more support for a climate policy—and for whom these interventions are effective (e.g., examining effectiveness by political group). A recent meta-analysis specifically examined the effect of message frames on various climate change attitudes and behavioral intentions, analyzing 27 effects from 9 published studies (Li & Su, 2018). The current meta-analysis takes a similar approach but expands the scope to include any type of experimental manipulation across a larger range of studies.

The current meta-analysis integrates and reconciles experimental interventions to influence climate change attitudes for people in the U.S. I will use "intervention" to refer to experimental studies where a researcher varied some aspect of the setting or provided something to participants that was not provided to those in the control condition. For example, an intervention might include giving participants in the experimental condition a climate change related news article, a video about climate change, or a map of the potential effects of climate change, while providing an unrelated task or simply withholding a task from those in the control

condition. Additionally, I will use the term "climate change attitudes" to represent various types of attitudes and beliefs about climate change, where higher attitudes represent more belief in, support for, concern for, and worry about climate change (to name a few). In other words, having higher attitudes means that someone has more belief in climate change (e.g., acknowledging its causes and effects) and increased support for measures to address it. The first section of this chapter will discuss theoretical and methodological moderators and why they might be expected to explain variation in intervention effect sizes. The second section discusses the methods, the third provides the results, and the fourth section contextualizes the results, discusses limitations, and suggests potential future directions for this work.

Moderators

Theoretical Moderator: Politics

Political ideology—liberal, conservative, and moderate—is a strong predictor of climate change beliefs, and there is evidence that political party in particular (Democrat, Republican, Independent) drives differences in support for measures to address climate change (Ehret et al., 2017; Hornsey et al., 2016). Therefore, many researchers have examined ways to communicate climate change in a way that increases support, especially among conservatives and those most skeptical of climate change. This moderator focuses on effect sizes between liberals, conservatives, and moderates: can variation in intervention effect sizes be explained by the political affiliation of people receiving an intervention?

Research on motivated reasoning provides certain predictions about how individuals may process information provided by climate change communication researchers. Motivated reasoning suggests that individuals have a desire to reach certain conclusions when forming attitudes and beliefs. Specifically, individuals can have directional goals (i.e., reach a preferred

conclusion) or accuracy goals (i.e., reach an accurate conclusion) and will employ strategies that are in line with those goals (Kunda, 1990). In addition, motivated reasoning can take place in the selection of information (e.g., news sources) and in the processing of information (i.e., how one changes beliefs in response to new information). Research on motivated reasoning tends to focus on directional goals, emphasizing situations where individuals selectively expose themselves to preferred information (via selective exposure; Garrett, 2009; W. Hart et al., 2009; Stroud, 2010) or are too easily accepting of preferred information (Ditto et al., 2019; Ditto & Lopez, 1992; Taber & Lodge, 2006). Within the realm of climate change, there is some evidence of directional motivated reasoning: research has found evidence that political partisanship is more predictive of attitudes than knowledge (Palm et al., 2017), and providing people with information about the effects of climate change may not only be ineffective but also has the potential to increase polarization (P. S. Hart & Nisbet, 2012; Kahan et al., 2017).

Other research, however, finds little evidence of directional motivated reasoning in climate change communication, suggesting that perhaps people may rely on accuracy goals when interpreting climate change information (Druckman & McGrath, 2019; van der Linden, Maibach, et al., 2019). Traditional research on motivated reasoning may be "too hot", assuming more directional political motivated reasoning than the evidence suggests (Hennes et al., 2020). Given information, people with accuracy goals are motivated to interpret information using strategies that will lead them to accurate conclusions. Accuracy goals (as well as Bayesian goals; see Druckman & McGrath, 2019 for a discussion) may explain the mixed evidence for motivated reasoning (Bolsen, Druckman, et al., 2014), particularly in the field of climate change communication (Druckman & McGrath, 2019). For example, recent research demonstrated that incentives reduced directionally motivated reasoning in learning (Khanna & Sood, 2018). While

motivated reasoning may predict that most interventions will not be effective among skeptics, there is still the possibility that individuals—even climate skeptics—may form accuracy goals and thus interpret new information as evidence for climate change.

Therefore, the expected direction of moderation based on political affiliation varies on two dimensions: first, whether individuals are expected to have accuracy or directional goals when encountering interventions; and second, the type of intervention employed. If individuals have accuracy goals, then their prior belief about climate change would not be expected to influence their processing of information, and all individuals should increase their belief in climate change when encountering an intervention (no matter the intervention type).[11] However, Druckman and McGrath (2019) point out that accuracy motivations do not always lead to belief updating in a linear fashion. For example, if an individual desires to have an accurate view of the world, then it is better to pay attention to more credible sources than less credible ones. Filtering by source credibility becomes problematic when people from different political groups have different sources they perceive to be credible. As Druckman and McGrath (2019) argue, accuracy motivations do not necessarily lead to converging beliefs in response to identical information because liberals and conservatives differentially perceive pieces of evidence as credible. This divergence in source credibility is highlighted by the partisan sorting of trust in scientists, where liberal and conservative differences in trust in science vary by topic (Pechar et al., 2018; Washburn & Skitka, 2018).

[11] Importantly, this discussion of the impacts of prior beliefs is in the context of an experimental study, where the information is given to participants by researchers. Outside of the lab, participants may form prior beliefs by seeking out information in a biased manner (Flynn et al., 2017; Stroud, 2010). Therefore, even if people process information in an unbiased way in the lab, they still might reach politically driven conclusions outside of the lab due to politically diverging information sources.

If, when encountering information on climate change, people are expected to have directional goals (i.e., a specific conclusion in mind), then motivated reasoning predicts that information about climate change would be processed in a directional manner: conservatives overly critical of pro-climate information and liberals overly accepting of it. A recent meta-analysis found evidence for bias within both liberals and conservatives: each ideology was prone to reject counter-attitudinal information and accept pro-attitudinal information (Ditto et al., 2019). Liberals and conservatives displayed nearly the exact same amount of bias, and studies with scientific information produced the same amount of bias as other studies. This result would suggest that interventions are interpreted in a biased manner, leading to rejection of the information rather than change in attitudes. However, there are ways to persuade individuals even when they are motivated by directional goals. For example, interventions that frame climate change in a way that affirms a group's values seem to be promising, although the evidence is still somewhat mixed (Dixon et al., 2017; Druckman & McGrath, 2019; Zhou, 2016).

Given that climate change is an issue much less supported by conservatives than by liberals, climate change interventions are expected to work or have no effect (e.g., ceiling effect) for liberals. More specifically, there is evidence that conservative climate change attitudes are more variable and unstable than liberals' attitudes, perhaps making them more prone to change (Jenkins-Smith et al., 2020). Given the aforementioned research on motivated reasoning, different interventions will be effective depending on whether conservative participants process information with accuracy or directional goals. If conservatives are motivated to form accurate conclusions, then interventions will be effective if they provide strong evidence for climate change—specifically, evidence perceived as strong by conservatives (e.g., from a conservative source). If conservatives are motivated to form directional conclusions, then interventions will be

effective if they affirm conservative values. Because of the specific nature of these two situations—interventions that provide strong evidence as perceived by conservatives or affirm conservative values—it seems unlikely that many interventions will fit either situation.

Hypothesis

Given the specific situations in which interventions are expected to be effective for conservatives, interventions overall will not be effective for conservatives. Due to the ceiling effect for liberals, interventions will not be effective for liberals, although there may be small positive effects due to liberals' trust of climate science. Interventions may be most effective for moderates (e.g., Feldman & Hart, 2016), although there is less research to rely on for a strong prediction.

Theoretical Moderator: Intervention Type

Key to the current meta-analysis is an examination of which types of interventions are most effective. This section will provide a brief background about various intervention types, as well as hypotheses for how effect sizes within each category are expected to differ.[12] In addition, each section will mention how the intervention type is expected to interact with political group.

General or Scientific Information About the Effects of Climate Change

The most straightforward way to influence beliefs about a natural phenomenon would be to give people facts; if they do not understand something, give them information. In other words, give the public scientific information then they will update their attitudes in line with that information. Within the field of climate change communication, the information-deficit model posits that increasing public knowledge will lead to an increase in public support to address

[12] In determining the feasibility for the current meta-analysis, an initial literature search was conducted to get a sense of the various types of interventions used. Interventions were grouped by types found through this initial search, and further categorized after independent coders provided descriptions about each study. More information on grouping can be found in the Method section.

climate change (for a review, see Suldovsky, 2017). Indeed, some evidence suggests that knowledge about climate change may be beneficial for generating action on global warming and correcting misperceptions (Bord et al., 2000; Guy et al., 2014; Ranney & Clark, 2016).

Responses to general information about climate change, however, may not be evenly distributed across the political spectrum. Some researchers and journalists would argue that conservatives are more likely to deny science or have less trust in it (Gauchat, 2012; Jost et al., 2003; Mooney, 2012). However, a recent experimental study revealed evidence that both liberals and conservatives engage in denying scientific information that is not in accordance with their attitudes (Washburn & Skitka, 2018). There is also evidence that the most quantitatively literate individuals are not immune to this bias; they may in fact be the most prone to it (Kahan et al., 2017). Individuals who are adept with numbers can use them in biased ways, and are able to sift through, discount, and critique data to conform to their beliefs. Furthermore, education is positively associated with global warming concern for liberals, but the same relation is weak or even negative for conservatives (McCright & Dunlap, 2011).

Because this category of interventions only captures general effects of climate change—rather than a targeted intervention for conservatives—it is not expected to be particularly effective for conservatives. Moreover, even if in an accuracy mindset, conservatives may not perceive general information about climate change as credible (Lewandowsky & Oberauer, 2016; Nisbet et al., 2015; Pechar et al., 2018). In addition, it is unclear whether providing more information to liberals will be effective. Liberals may already be familiar about the effects of climate change and exhibit a ceiling effect (McCright, 2009).

Hypothesis. For these reasons, interventions that only provide general information about the effects of climate change will not be effective for conservatives, liberals, or moderates.

Scientific Consensus

A related line of research has emerged in the past few years focused on messaging about agreement among climate scientists. Rather than providing people with general information about the effects of climate change, research using scientific consensus messaging provides people with the specific information that the overwhelming majority of climate scientists agree that climate change is human-caused. The research attempts to bridge the gap between science—where around 97% of published papers endorse anthropogenic climate change (Cook et al., 2013, 2016)—and the public. In 2014, researchers asked a nationally representative sample of Americans how many climate scientists believe in anthropogenic global warming (Leiserowitz et al., 2014). Only 12% of the sample correctly identified the consensus as over 90%; in fact, a greater percentage (16%) of the sample said that the consensus is 50-59%. Even in 2019 when the survey was repeated, only 22% of the sample said that scientific agreement was over 90% (Leiserowitz, Maibach, Rosenthal, & Kotcher, 2019). Centered around the Gateway Belief Model (GBM), research on this topic posits that belief about the scientific consensus is a gateway belief to other climate change attitudes, such as belief in human-caused climate change and support for action to address it (van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2015).

Multiple experimental studies have been conducted to examine the effectiveness of consensus messaging, with many providing support for the GBM (e.g., Brewer & McKnight, 2017; Goldberg, van der Linden, Ballew, Rosenthal, & Leiserowitz, 2019; Myers et al., 2015; van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2015). However, other studies provide evidence against the GBM and the overall effectiveness of consensus messaging—especially when looking at attitudes such as belief and support for policy—is heavily debated

(Dixon et al., 2017, 2019; Kahan, 2017; Kerr & Wilson, 2018; Ma et al., 2019; van der Linden et al., 2017, 2018; van der Linden, Maibach, et al., 2019). The experimental work on consensus messaging is mixed about whether effective consensus messages only increase participants' beliefs about the scientific consensus itself, or if they also increase climate change attitudes such as belief and policy support. While some studies suggest that this method of science communication is not as effective as expected (Dixon et al., 2017; Kahan, 2017; Kerr & Wilson, 2018) and other studies find that it may increase political polarization over climate (Cook & Lewandowsky, 2016; Ma et al., 2019), the majority of work using consensus messaging finds that—even when it does not effectively change attitudes—it is not politically polarizing.

Hypothesis. Given that the GBM predicts an indirect effect (rather than main effect) of message on climate change belief, and the mixed evidence from various studies, it is expected that consensus messaging will have only a minimal effect on attitudes for conservatives, moderates, and liberals.

Morality

Moralized attitudes—attitudes which are rooted in one's sense of moral right or wrong—are fundamentally different from non-moralized attitudes, which holds important implications for how they function (Clifford, 2019; Rozin, 1999; Ryan, 2017). For example, people report more intention to vote on moralized issues (Morgan et al., 2010), are more intolerant of groups who hold different opinions on moral attitudes (Wetherell et al., 2013), and are less susceptible to influence on moralized attitudes (Luttrell et al., 2016). Morality thus seems to play a unique role in attitudes and persuasion, especially for political attitudes that are constantly being challenged. Further complicating the fact that moralization entrenches attitudes, there is evidence that political conservatives and liberals have different moral values (Graham et al., 2009). Moral

Foundations Theory (MFT) suggests there are five moral domains, or foundations, in which people root their morality: harm, fairness, ingroup, authority, and purity (Graham et al., 2011). Whereas conservatives generally weigh each equally in their morality, liberals tend to emphasize harm and fairness (Graham et al., 2009). This distinction commonly arises as a focus on individualizing or binding foundations: liberals value the individualizing foundations—morality relating to the welfare of the individual—and conservatives value the binding foundations—morality relating to the welfare of groups. Moralized political attitudes paired with separate moral values sets the unsurprising scene of tenacious political polarization whenever there is a moral issue in the political realm.

Some evidence suggests that aligning a climate message with the moral values of its audience is an effective way to break through political polarization; specifically, reframing of climate change in terms of the binding foundations seems to be an effective way to engage conservatives in climate change (Feinberg & Willer, 2013; Wolsko, 2017; Wolsko et al., 2016). However, there are only a few studies that frame climate change messages with different moral foundations, so it is unlikely that analyses will be able to capture the nuance in interventions.

Hypothesis. Given the specifics of morality (e.g., people and groups rely on different moral foundations), combining morality interventions will wash out targeted distinctions and therefore will not be effective for conservatives, liberals, or moderates. However, isolating studies that reframe climate change in terms of binding morality will be effective at increasing support for climate change, especially among conservatives.[13] For that reason, effect sizes for

[13] After conducting the search, I found only three reports using a binding morality intervention, and furthermore I was only able to retrieve data from one experiment within those reports. Therefore, morality constituted just one category in the intervention type moderator (rather than being split by individualizing versus binding foundations).

conservatives are expected to be larger than those for liberals or moderates when climate change is reframed in terms of binding morality.

Emotion

Because of the potential catastrophic effects of climate change, discussion on the topic often creates panic, anxiety, and fear. Media members debate whether appeals to fear are better at compelling action than optimistic calls for hope (Mann et al., 2017; Wallace-Wells, 2017). Social science researchers also have debates on the same topic. Meta-analyses on fear appeals suggests that fear may be an effective motivator depending on other aspects of the message (Tannenbaum et al., 2015; Witte & Allen, 2000). Although fear-based messaging in general is somewhat effective, its success within the environmental domain is mixed (see Reser and Bradley, 2017, for a review). Researchers have also examined the link between positive emotions, like hope, and climate change attitudes. For example, Smith and Leiserowitz (2014) present correlational evidence of the relation between hope and interest with global warming policy support. In reviewing evidence about the role of emotion in climate change communication, Markowitz and Shariff (2012) advocate for positive emotional messages rather than negative ones. They summarize evidence that suggests evoking positive emotions in climate change messages not only can spur pro-environmental behavior in other domains, but it also can prevent a defensive or boomerang reaction by those most prone to it—specifically climate change skeptics and conservatives.

However, Chapman et al. (2017) heavily criticize emotional messages as an effective tool in climate change communication. They argue that emotions cannot be straightforwardly manipulated using a single message. Responses can include a mix of emotions: a message may induce fear along with hope, guilt along with disgust, etc. Mixed emotional responses make it

difficult to causally attribute a discrete emotion to a specific result, and emotions are too complex for communicators to manipulate messages and have confidence in the outcome. Additionally, there is little research on the effects of emotion over time, and few experimental studies in the domain of climate change test the role of emotions. Lastly, the authors argue that emotional messages have different effects on different people. Whereas some people respond to a message with fear, others will respond with defensiveness. The uncertain relation between messages and how they are perceived emotionally makes it risky for communicators to rely on emotions as drivers of climate change policy support. Because of the range of responses they can provoke, the effectiveness of emotions relies on the combination of the emotion used to influence attitudes and the audience receiving the message.

Hypothesis. Because the current meta-analysis will be combining all emotion interventions—and thus washing out the nuance of emotions matched with audiences—these interventions will not be effective for conservatives, moderates, or liberals.[14]

Psychological distance

Because climate change is an abstract, hard to grasp, and slow-moving (at least on a daily or monthly time scale) concept, it is difficult for people to feel urgency towards addressing it (e.g., Markowitz & Shariff, 2012; Moser, 2010). Researchers have proposed that one way to increase engagement with climate change is to make it feel closer and less abstract (Fielding et al., 2014; Weber, 2016). Relying on construal level theory (CLT), research using psychological distance manipulations attempt to make climate change feel closer psychologically (if not physically) for people; these manipulations include highlighting the geographically near effects

[14] Although the current meta-analysis was not able to find enough emotion-related studies to group them by emotion (e.g., fear, hope, etc.), future meta-analyses on the topic should continue to consider the differential effect of emotions.

of climate change, pointing out the short term effects of climate change, or illustrating the effects of climate change on people that are socially close (or perceived as close) to the audience of the experimental message (Chu & Yang, 2019; Fielding et al., 2014; Schuldt et al., 2018; Trope & Liberman, 2010). Some evidence suggests that people have stronger attitudes towards climate change the closer they feel to it (A. S. Singh et al., 2017). Similarly, the local weather effect posits that there is a link between people perceiving the weather as warmer and belief in climate change, although the evidence for this effect seems to be mixed (Howe et al., 2019). Although theoretically expected to increase climate change attitudes, the evidence for psychological distance is mixed (McDonald et al., 2015), perhaps because of the potential for reduced distance to increase fear (Spence & Pidgeon, 2010). This leaves some doubt as to whether these manipulations will be effective overall.

Hypothesis. For these theoretical reasons, interventions making climate change feel psychologically near will be effective for conservatives, moderates, and liberals, while those making it feel psychologically far will not be effective for any political group.

Other Interventions: National Security

Researchers have also used national security as a way to influence climate change attitudes. These manipulations highlight the benefits of addressing climate change for national security (e.g., increased energy independence, decreased war over drought, etc.). National security—although generally not explicitly framed as a moral issue—is related to the moral foundation of ingroup/loyalty. America can be conceived as the ingroup, with patriotism as a call for more loyalty to this ingroup (e.g., Wolsko, 2017; Wolsko et al., 2016). Therefore, it follows that national security may be seen as more relevant for conservatives than for liberals. Indeed, conservatism is associated with concerns related to security. In a meta-analysis of political

ideology and personality, Jost et al. (2003) found that conservatism was significantly associated with death anxiety, system instability, uncertainty tolerance, and fear of threat and loss—all constructs related to security. If increased national security is an outcome of addressing climate change, conservatives should be particularly motivated to support efforts to stop climate change.

Despite the theoretical promise of pairing national security with the environment for conservatives, the experimental research is mixed. Singh and Swanson (2017) gave participants information about the consequences of climate change and, in one of the conditions, they framed climate change as a threat to national security. The frame did not increase Republicans' or conservatives' support for stopping climate change. Feygina et al. (2010) also used an appeal to support the environment framed in terms of national security. They found the appeal increased high system-justifying individuals'—a construct closely related to conservatism—pro-environmental behavioral intentions. Aklin and Urpelainen (2013) used a national security frame in an attempt to increase support for clean energy and found limited evidence of the frame's effectiveness for the whole sample. They did not report interactions with politics, so it is unclear if the frame differentially persuaded liberals and conservatives. Although national security is generally considered a conservative value, it could also be seen as reframing climate change to appeal to the common ingroup—the nation—and therefore still appeal to U.S. liberals (Wolsko, 2017). Therefore, there is reason to expect that national security would be an effective strategy for liberals as well. Due to their broad nature, issues of national security tap into conservative morality while still appealing to liberals.

Hypothesis. For these reasons, national security interventions will be particularly effective for political conservatives, but also effective for moderates and liberals.

Economy

Economic interventions highlight the economic benefits of addressing climate change (e.g., the economic benefits of climate change policies) or the economic harms of failing to address climate change (e.g., economic costs of severe weather). These interventions rely on the widespread support among Americans for a healthy economy. For example, months before the previous election in 2016, a Pew Research Center poll showed that 90% of Trump supporters and 80% of Clinton supporters listed the economy as a "very important" issue in the election (Pew, 2016a). These high percentages suggest that this issue is important for both ideologies, even if they do not agree on the way to address it. If climate change can be connected to improving the economy, then it would be in most Americans' interest to mitigate it or at least acknowledge that it is a problem. It would seem that both conservatives and liberals would be motivated to address climate change if they are given information that it will impact the economy.

While Americans generally want a strong and healthy economy, conservatives may be particularly attuned to economic issues. Conservatism as an ideology generally favors small government and a free market economy (e.g., Crowson, 2009; Everett, 2013). In a 2016 poll, 58% of Republicans said that stricter environmental regulations cost too many jobs and hurt the economy, whereas only 17% of Democrats said the same thing (Pew, 2016c). A message that emphasizes the economic aspects of climate change impacts—whether economic benefits from mitigation or economic costs of impacts—speaks a conservative language by highlighting what they value.[15]

[15] 'Economy' may have some nuance as a category. Generally, conservatives support the free market whereas liberals favor government regulation. A manipulation that highlights the ability of the free market to stop climate change is slightly different than a manipulation that highlights the harm that climate change will have on the economy (or positive economic benefits of mitigation). Unfortunately, the small number of economic manipulations involved in the current meta-analysis limits my ability to distinguish between types of economic interventions.

Hypothesis. Providing people with information about the economic impacts of climate change will be an effective intervention for conservatives, moderates, and liberals.

Religion

The last intervention category involves manipulations that focus on the religious aspects of climate change. These interventions generally take on two forms: arguing for environmental action by relying on religious values or texts, or highlighting a religious figure's (e.g., Pope Francis) support for environmental causes. Most research on religion and climate change (and all of the studies included in the current meta-analysis) focuses on Christianity specifically, finding that some Christian denominations report low belief in climate change whereas others have relatively high belief, depending on political ideology (Ecklund et al., 2017; Leiserowitz et al., 2015; Smith & Leiserowitz, 2013). Experimental manipulations leverage religion by linking the environment to Christian values in order to target Christian participants' morality in hopes that this might be especially persuasive for climate skeptics who are also Christian. Additionally, research has investigated the effectiveness of informing people about the Catholic pope's environmentally focused encyclical, which has garnered much attention and support from Christians (Maibach et al., 2015). However, given the specific nature of religious interventions, it is unlikely that they would have an effect for an entire sample or across multiple studies in this meta-analysis.

Hypothesis. Religious interventions will not be effective for conservatives, moderates, or liberals, although they may be effective for Christians specifically.

Theoretical Moderator: Type of Climate Change Attitude

The third and final theoretical moderator is the type of climate change attitude. Attitudes can include measures of belief in natural climate change, belief in anthropogenic climate change,

concern about climate change, support for climate change mitigation policy, and many others. Public polling data reflects differences in opinions across these attitudes. For example, a recent poll found that around 72% of Americans believe in global warming, 59% belief it is human-caused, 66% are at least somewhat worried about it, and 46% have experienced its effects (Leiserowitz, Maibach, Rosenthal, & Kotcher, 2019). A similar recent poll found that 52% of respondents believed that climate change should be a top priority for the president and congress (Pew, 2020). Just as the polling numbers reflect slight differences in beliefs between these climate change attitudes, research suggests that there is somewhat of a hierarchical relation between these variables: belief in climate change leads to policy support, implying that policy support occurs only after one acknowledges climate change (Ding et al., 2011; McCright et al., 2013; van der Linden et al., 2015). In other words, there is belief in the phenomenon and cause, concern due to this belief, and support for action to be taken (e.g., policy support) due to concern; the direction ostensibly flows from belief to concern to support for action. In a meta-analysis discussed earlier, Hornsey, Harris, et al. (2016) provided evidence that the link between climate change belief and policy support is a weak one, suggesting distance between the two attitudes. Moreover, support for a policy to address climate change could require a cost (e.g., tax), making it more difficult to garner support for policy than belief. Research finds that policies framed as taxes are especially disliked, highlighting that cost may play a role in policy support (Hardisty et al., 2010, 2019). This could make it even harder for interventions to increase policy support.

In addition, there is evidence that liberals and conservatives respond differently across these dependent variable types. As public opinion polling has found, liberals show high belief in both natural and anthropogenic climate change, whereas many conservatives believe that the

earth is warming but it is not due to human activity (Pew, 2016b). This asymmetry would indicate that the divide between liberal and conservative attitudes is stronger with anthropogenic compared to natural climate change. Belief in anthropogenic climate change requires a stronger policy reaction—if one believes the earth is warming due to human activities, then it can be stopped by human activities. On the other hand, one can acknowledge the existence of natural climate change and admit that humans cannot stop it. If human activity does not affect the climate, then human solutions seem unlikely to mitigate negative consequences. It also makes sense that policy support flows from belief: if one does not believe climate change is happening, then there is no point in policy to stop it. Research suggests that support for climate change policy might be diminished within conservatives because of the regulatory nature of policy (Campbell & Kay, 2014). Because policies often involve government regulation, conservatives may be especially wary of a climate change policy that is not explicitly defined as free market friendly. This finding would imply that liberal and conservative differences in climate change policy support might be even more exacerbated than they are in climate change beliefs.

There is, however, other research that would suggest the opposite conclusion. Renewable energy legislation can garner conservative support (Gillis & Popovich, 2017), especially when it is framed in line with conservative ideology (Hess et al., 2016). Some recent polling suggests that Trump voters support policies such as increasing renewable energy, regulating pollutants that cause global warming, and funding more research in clean energy (Leiserowitz et al., 2017). This same poll found that policy endorsement was stronger among Trump voters than was belief in global warming. Corroborating these attitudes, a recent media article summarized data from the Energy Information Administration and noted that many of the country's top wind energy producing states were won by Trump in the most recent election (Gillis & Popovich, 2017).

Therefore, although there seems to be more evidence to suggest that liberals and conservatives would respond differently to different measures about climate change, it would not be surprising if politics did not interact with attitude type. Importantly, given that the current meta-analysis is focused on climate change policies, there may be less conservative support for the policies included in this meta-analysis than for other general environmental policies such as recycling policies.[16]

Hypothesis

Interventions will be more effective on belief in climate change than for support for climate change policy, particularly for conservatives.

Methodological Moderator: Sample

The type of samples that interventions use may play a part in how effective those interventions are. Many studies in the field of climate change communication recruit college students, Amazon Mechanical Turk (MTurk) workers, or a nationally representative sample. In comparing MTurk and nationally representative samples, one concern is that participants recruited through MTurk are more politically liberal (Berinsky et al., 2012; Levay et al., 2016). There is some evidence that the conservatives on MTurk are similar to conservatives in general, whereas the liberals are slightly more liberal (Clifford et al., 2015). This asymmetry in strength of political identity would imply that interventions that are particularly effective for liberals are

[16] Relatedly, there is a line of research that investigates how dependent variables are phrased and whether they use the term "global warming" or "climate change." Some evidence suggests that the phrasing is important for conservatives (Schuldt et al., 2011), such that conservatives are more likely to believe in climate change than in global warming. Other work shows that Independents are especially affected by the phrase choice (Benjamin et al., 2017). As this line of research involves the difference between "global warming" and "climate change", it is unclear as to whether interventions using one phrase or the other would be more effective. In the current meta-analysis, attitudes from experimental conditions are compared to those from control conditions; therefore, the analysis compares intervention effectiveness (treatment vs. control) between "global warming" and "climate change" rather than comparing just raw means between these phrases. I do not have a theoretical prediction as to whether interventions are more influential if they use the term "global warming" or "climate change."

also more effective for MTurk samples than those that are nationally representative. On the other hand, research generally finds that MTurk samples provide quality data and perform similarly to nationally representative samples in experiments (Buhrmester et al., 2011; Casler et al., 2013; Crump et al., 2013; Kees et al., 2017; Paolacci et al., 2010).

Historically, college student samples have not been representative of the general public in psychology studies (Sears, 1986). There is recent evidence that college students pay less attention to online studies than do MTurk workers (Hauser & Schwarz, 2016). Furthermore, Americans with a college degree (58%) and millennials (59%) are more likely to identify as Democrats (Pew, 2018). Some polling evidence suggests that young Republicans and young people in general are more supportive of action to curb emissions (Mooney et al., 2014). Another recent poll shows that, among American adults under 30, 77% say the environment should be a top governmental priority and 64% say climate change should be (Pew, 2020). These numbers reflect a 10% and 8% increase over adults aged 30-49 for the environment and climate change, respectively. This generation shift would imply that college student conservatives might be less conservative than the average American conservative. There may potentially be a ceiling effect for college students, such that interventions are not effective simply because college students already have extremely strong attitudes towards climate change. Indeed, if samples vary on important moderators of an effect (e.g., ideology), they may be prone to display differential treatment effects (Boas et al., 2020; Druckman & Kam, 2011).

Hypothesis

Sample will explain variation in effect sizes, such that interventions will be more effective (larger effect sizes) for studies using nationally representative and MTurk samples than for those using college students.

The Current Meta-Analysis

This meta-analysis quantitatively synthesizes interventions for influencing climate change attitudes. Based on the theoretical and methodological moderators in the previous section, I hypothesize that interventions will generally not be effective for conservatives, and may be especially effective for moderates due to their (probable) absence of a ceiling effect (which would be expected for liberals) along with lack of strong partisan identity (which would spur motivated reasoning, expected for conservatives). I hypothesize that effect sizes will vary based on intervention type. In particular, interventions that reduce the psychological distance of climate change are most promising across all political groups. For conservatives in particular, economic and national security interventions have potential to include higher effect sizes than other types. I also hypothesize that the type of attitude will explain variation in effect sizes, specifically that—for conservatives especially—effect sizes will be larger when attitudes are measured with belief in climate change than with policy support. Lastly, I hypothesize that studies that rely on college students will have smaller effect sizes than studies that use nationally representative or MTurk samples. As described below, I conducted a large literature search to identify eligible studies, coded the effect sizes and moderators for each study, and meta-analyzed the effect sizes, including moderator analyses to test if each moderator explained variation in effect sizes.

Method

Inclusion and Exclusion Criteria

Inclusion Criteria

Studies had to meet the following three main criteria to be included in the meta-analysis: 1) random assignment of participants into study conditions (i.e., experimental or control), 2) a control condition where participants did not receive an intervention related to climate change, and 3) a measure of climate change attitudes after the experimental manipulation. Studies qualified for inclusion regardless of their publication status and were not excluded based on publication type, publication year, or publication quality.

Climate Change Attitudes. Studies needed to include some measure of climate change attitudes to qualify for the meta-analysis. Because of the focus on attitudes, I limited the population of studies to those that measured attitudes rather than actual behaviors or behavioral intentions. Other meta-analyses have studied pro-environmental behavior (e.g., Maki et al., 2016; Maki et al., 2019), household energy use (Karlin et al., 2015), and the relation between climate change attitudes and behavior (Hornsey et al., 2016). The focus of the current analysis is specifically on attitudes.

Importantly, studies were also included if they measured attitudes towards a climate change policy. The attitude towards a policy can be synonymous with behavior intention (e.g., would you vote for a cap-and-trade policy), somewhat blurring the distinction between attitude and behavior. I included studies that measured support for a climate policy, but did not include studies that only measured willingness to pay for a policy or any other measure of willingness to pay. Along with distinguishing between behavior and attitudes, I also only included studies that measured attitudes towards climate change or policies directly related to climate change. For example, Xu et al. (2015) utilized an experimental manipulation to shift attitudes towards saving energy, but was framed as saving the environment rather than focusing on climate change.

Exclusion Criteria

Because of the focus of the meta-analysis on American polarization and climate change, studies were excluded if their samples were comprised of participants outside the United States. American politics are unique, as are those of any other country. Empirical evidence substantiates this point: a recent study by Hornsey et al. (2018) compared data from 25 countries and found that the link between conservative politics and climate change skepticism was the strongest in the United States. The authors suggested there is something unique about American politics that unites climate change skepticism and conservatism. Relations between politics and climate change attitudes may not only be different in other countries, but the makeup of political ideologies and parties in general is much different. Accordingly, studies were only included if they used U.S. participants.

Additionally, due to the focus on climate change, studies were excluded if they only measured general environmental attitudes or attitudes towards non-climate change related issues (e.g., fracking). Studies about recycling (too distant) or household energy use (actual behavior) were also excluded.

Abstract Screening

I conducted the abstract screening and removed abstracts that clearly were: 1) non-primary research, 2) non-English abstract, 3) non-random assignment, 4) not measuring environmental attitudes, 5) no experimental intervention to change climate change attitudes, or 6) a non-US sample. The abstract screening tool can be found in Appendix B. Abstracts were retained if they possibly measured environmental attitudes and passed all other abstract screening criteria (i.e., the distinction between environmental vs. climate change attitudes was not made until full-text screening).

Full-Text Screening

For any study without an abstract, any study for which all abstract screening criteria was met, or any study that was ambiguous about the criteria, I screened the full-text for exclusion and inclusion criteria.

Searching the Literature

The search was conducted using *Web of Science*, *PsycINFO*, and *Communication Abstracts* between early February and mid-November 2019. In early 2020, the search was updated by searching each database for all of 2019. As displayed in Table 3.1, the search terms keyed on three aspects of targeted experiments: measuring attitudes, using an experimental design, and investigating the topic of climate change. I also emailed six of the authors with multiple studies selected for inclusion if they knew of any unpublished data on the topic. I sent an email to the *Society for Personality and Social Psychology* listserv with a request for unpublished data on the topic. Table 3.1 presents an overview of the search terms used.

Table 3.1

Search Categories and Terms Used

Category	Search terms	Search parameters	Electronic database	Reports retrieved
Attitudes	attitude* or belief* or position* or opinion* or perception* or stance or judgement* or judgment* or skeptic* or accept*	“Topic”	Web of Science	11,311
	AND			
Experimental design	intervention* or manipulat* or experiment* or trial* or "control condition" or "control group" or assign* or random* or study or studies	Full-text	PsycINFO	1,574
		Full-text	Communication Abstracts	243
	AND			
Climate change	"climate change" or "global warming" or “greenhouse effect”			

Note. The search terms for climate change were adapted from those used by (Hornsey et al., 2016).

Coding Studies

The full coding protocol is shown in Appendix B. Studies were coded for general characteristics about the report (e.g., type of publication), the sample (e.g., proportion female, where the sample was recruited from), the intervention (e.g., category and description), and the effect size. Each effect was coded by me and 83% of the effects were coded by one other trained researcher (e.g., research assistant or graduate student).[17] Agreement was calculated for the coding of each moderator (see moderator section) as well as for all effect sizes. For categorical moderators, agreement was calculated using Cohen’s kappa (unweighted), and for *g* and *v* as

[17] For two of the moderators (intervention medium and direction), 100% of effects were double coded.

well as for continuous moderators, agreement was calculated using the intra-class correlation coefficient (ICC) with absolute agreement. Discrepancies were then resolved through discussion, therefore ultimately dropping the percentage of disagreement to zero after discussion (Dent & Koenka, 2016).

Moderators

Politics

For every study, effect sizes were calculated separately for the full sample, liberals or Democrats, conservatives or Republicans, and moderates or Independents. Studies tended to include a measure of political party (i.e., Democrat, Republican, Independent), political ideology (i.e., liberal, conservative, moderate), or both. If both were available, I requested data for and calculated effect sizes from the measure of political party, due to its strength of association with climate change belief (Hornsey et al., 2016). Otherwise, I requested and used the political measure that was available in the report. Sometimes, after asking an initial question to measure political party, studies included follow-up questions to probe if participants leaned towards one party or another. I calculated the effect size or requested data based on how the study grouped participants (i.e., if they included leaners then I did as well); if the study did not specify, then I did not include leaners.

If politics was not measured categorically, it was typically measured continuously with *Liberal* on one end of the scale, *Conservative* on the other, and *Moderate* at the midpoint. Whenever the author reported a continuous scale, I separated it into those below the midpoint, those at the midpoint, and those above the midpoint (moderates always at the midpoint, and liberals/conservatives below or above depending on the direction of the scale). If the authors included their own measure of ideology or party, I categorized it as they did in the paper. There

were two special cases of measuring politics. The first was a scale of support for the free market, used by the author of two reports as a measure of conservatism. Because the scale was an index of multiple items, it could not be easily separated into those scoring below the midpoint, at the midpoint, and above the midpoint of the scale (in other words, scores were often decimals rather than exactly at the midpoint, in contrast to the single-item measures of politics). To calculate and when requesting effect sizes for studies that used this 1 to 5 scale, I specified that those averaging below 2.5 be categorized as liberals, those between 2.5 and 3.5 (inclusive) as moderates, and those above 3.5 as conservatives. This method was used to best approximate how those individuals would be categorized on a single 5-point item (i.e., 1-2 liberal, 3 moderate, 4-5 conservative).

The second special case was used in one report where the authors measured cultural values by giving participants scales on hierarchy and individualism. As in Kahan et al. (2011), I categorized participants into hierarchical-individualists (scoring above the median on both hierarchy and individualism) and egalitarian-communalists (scoring below the median on both hierarchy and individualism). Similar to a left-right measure of politics, egalitarian-communalists support environmental causes while hierarchical-individualists tend to be dismissive of environmental risks (Kahan, 2010).

Intervention Category

In the coding protocol (Appendix B), I outlined seven categories that I anticipated finding in the included studies: Morality, Emotion, General or scientific information about the effects of climate change, Scientific consensus, Psychological distance (near), Psychological distance (far), and Other. Because many interventions included manipulations that fit into multiple categories (e.g., discussed the effects of climate change and emphasized how they are occurring nearby or

far away), coders selected each category that applied to an experimental condition. For the most part, this classification lead to mutually exclusive categories among the six expected intervention types (i.e., excluding the "Other" category). One exception was particularly problematic, specifically information about the effects of climate change: while 35% of manipulations included information about the effects of climate change, only 9% of manipulations exclusively contained this intervention. Therefore, I categorized interventions as effects of climate change if that was listed as the only category. Additionally, three studies included both consensus and emotion manipulations within one experimental condition; to separate these, I categorized them into their primary focus (one study was interested in emotions and the manipulation included consensus information, Skurka et al., 2019, while the other two were studying consensus and the manipulations included emotion as well, Brewer & McKnight, 2017; Clarke et al., 2019). All other interventions fell into only one of the remaining categories (excluding the "Other" category).

Additionally, a number of interventions in the "Other" category coalesced into a few themes: national security, religion, and economy or free market (smaller categories also emerged, but with very few studies). I tested the original categories as outlined above, then expanded the number of categories to include these additional three. This expanded categorization led to three new overlapping situations. First, one study included an intervention that was categorized as both morality and religion; since the study was clearly focused on religion, I grouped it into the religious category (Shin & Preston, 2019). The second two overlaps were much harder to disentangle: one included an equally moral and economic intervention (Albertson & Busby, 2015), and another included a scientific consensus manipulation crossed with separate moral and religious manipulations (Dixon et al., 2017). Because both of these

studies were focused on orthogonal manipulations, they did not clearly focus on one category or the other. Therefore—when categorizing experimental conditions that contained both manipulations—I classified them into whichever manipulation was more in depth. There was slightly more economic information than moral information (resulting in an economy classification), and both more moral and religious information than scientific consensus information (resulting in a moral or religious classification, respectively). I conducted moderator tests on the original coding of intervention type and the expanded types (with the three new categories). Both the original coding of the intervention type (k = .80) and the expanded types (k = .80) indicated substantial agreement between coders (Landis & Koch, 1977).

Intervention Direction. Although not originally planned as a moderator, intervention direction emerged as an important classification for experiments. As I was coding studies, I realized that some interventions were intended to lower participants' belief in climate change (or at least would be expected to lower belief). Many of these interventions included misinformation as part of a manipulation, usually to compare it with a corresponding correction condition (i.e., a condition that includes both the misinformation and a debunking of the misinformation). For example, one study presented participants with a misstatement that sea-ice levels are at record highs; in another condition, participants in this study also received a correction to the misstatement (Porter et al., 2019). To avoid confounding effect size estimates by combining data from interventions designed to increase belief in climate change with those intended to decrease it, I coded whether interventions were positive (i.e., presenting information to increase belief in climate change), balanced (i.e., presenting information to increase belief in climate change along with a skeptic's viewpoint or counterarguments), or negative (i.e., presenting only a skeptic's viewpoint or information to decrease belief in climate change). Manipulations that humorously

presented a skeptic's viewpoint as a way to reveal the weakness of the skeptic's argument were coded as positive (e.g., Anderson & Becker, 2018). Intervention direction was treated as a categorical variable with positive interventions as the reference group (coded 0) and dummy variables to represent balanced and negative interventions (coded 1 for each). There was moderate agreement between coders on intervention direction (k = .58).[18]

Intervention Medium. Another category that emerged after I began my search was the type of medium in which interventions were delivered. Some were short text blurbs, others were videos, and others included images or maps of climate change effects. I coded this moderator into five categories: Text, Video, Image or map, Text plus image or map, and Other. I grouped the categories into three groups: Text, Video, Image or map, and Other. Studies with both images or maps and text were grouped into the image or map category. One study included both a table and text and was grouped into the Text category. Coders had substantial agreement for this moderator (k = .79).

Control Type. As a methodological moderator, I coded the type of control condition within each experiment. Coders sorted control conditions into five categories (list of options in the coding protocol, Appendix B), ranging from no information at all to a brief definition of climate change. Because most of the interventions used either no information or an unrelated task, I grouped this moderator into three categories: no intervention, a task unrelated to the environment or climate change, and other (k = .91).

[18] The low agreement for this variable might be driven by two factors. First, the variable as a potential moderator emerged during the coding process and therefore coders spent less time training with this variable than they did with other moderators. For example, removing disagreements where the coders did not actually disagree but rather there were coding mistakes, the agreement increases to substantial (k = .64). Second, this variable is hard to define, and coders had detailed discussions about the nature of interventions and specific hypotheses within studies. However, the coders agreed on all of the coding at the end and there were only a few interventions that were difficult to confidently categorize.

Dependent Variable Category

Before coding, I specified eight potential categories, including an "Other" option (see coding protocol in Appendix B). Upon collecting data from the included studies, two themes emerged. First, coders often had disagreements between dependent variables classified as risk and those classified as predicted impacts of climate change. Disentangling the risk of climate change from its expected impacts was not always clear; therefore, I combined these two categories together (similar to how risk was grouped in Leiserowitz, Maibach, Rosenthal, & Kotcher, 2019). Second, a few new categories of variables developed from within the "Other" category: personal responsibility for addressing climate change, harm of climate change, negative affect towards climate change, government responsibility to address climate change, and support for action to address climate change. Given the similarities of some of these categories to the initial coding protocol categories, I combined some of them. Similar to the grouping used in Leiserowitz, Maibach, Rosenthal, and Kotcher (2019), I added harm of climate change into the risk category and negative affect into the worry category. Additionally, I categorized both government responsibility and support for action as part of climate change policy. As the coders discussed discrepancies, there was an agreement that any government involvement most likely involved policy, linking the two constructs. Support for action, similarly, has been used to represent policy support and capture people's desire for public action to address climate change (van der Linden, Leiserowitz, et al., 2019; van der Linden et al., 2015). After making the aforementioned combinations, I analyzed dependent variable type with its updated five categories: belief in natural climate change (20% of dependent variables), belief in human-caused climate change (20%), concern or worry about climate change (9%), risk of

climate change (14%), support for climate change policy (22%), and other (14%).[19] Coding agreement calculated with the original coding categories (k = .80) and the updated categories (k = .86) showed substantial and nearly perfect agreement, respectively.

Phrasing: Climate Change or Global Warming. In addition to coding the type of dependent variable, we also coded whether the variable asked about participants' beliefs towards climate change, global warming, both, or neither. In moderator analyses, I only compared the effect sizes coded as global warming and climate change (k = .81) and tested the interaction with political group.

Sample Type

Coders selected from six options to categorize samples: College students, Amazon Mechanical Turk (MTurk), YouGov, Qualtrics Panel, GfK, and Other. Most studies used MTurk (22 samples, 30%), college students (14 samples, 19%), Other: Survey Sampling International (SSI; 8 samples, 11%), and Other: Qualtrics Panels (6 samples, 8%). The rest of the sample types were widely distributed and none were used by more than 2 independent experiments. Additionally, I categorized samples as being nationally representative and used this as a separate moderator. Coders showed nearly perfect agreement for both sample type (no discrepancies, k = 1) and whether a sample was nationally representative (k = .83).

Sample Demographics

To examine the effect of demographic variables, I coded the average age (or median when mean was not available) for each experiment (k = .77),[20] the percent of the sample that was female (k > .99), and the percent of the sample that was white (k > .99). The number of reports

[19] I also analyzed this variable using the original categories listed in Appendix B, and the pattern of results remained.
[20] After removing a typo (where .478 was changed to 47.8 for average age), the kappa for age increased to nearly perfect agreement (k > .99).

and effect sizes vary for each because these data were not available for every study. Although polling data suggests that climate change attitudes vary by demographics, I did not have theoretically driven predictions about how intervention effectiveness would vary by these demographic moderators (Pew, 2020).

Report Characteristics

Coders noted the year that the data were collected (if not available, then the year the manuscript was submitted) and the type of publication (e.g., journal article, dissertation, unpublished data). Publication type was grouped as published compared to unpublished and tested as a moderator.

Effect Size Calculation

Standardized Difference Between Means (SMD)

The SMD between each treatment and control was calculated using Hedges' *g* (Hedges, 1981). Because Cohen's *d* tends to overestimate the population mean difference in small samples (Borenstein et al., 2009), Hedges' *g* is seen as preferable in psychology when working with small samples (Lakens, 2013). Because I split effect sizes by condition and political group (i.e., an effect size for each political group within each treatment condition), the samples tended to be small. Therefore, I calculated Cohen's *d* and *v* for each effect size and applied the correction for small samples used by Hedges' *g*:

$$J = 1 - \frac{3}{4df - 1}$$

$$g = J \times d$$

where *df* is $n_1 + n_2 - 2$. The correction factor, *J*, ranges from 0 to 1. Therefore, the absolute value of *g* is always less than the absolute value of *d*, although the difference between the two becomes extremely small as sample size increases (Borenstein et al., 2009). The variance of *g* is:

$$V_g = J^2 \times V_d$$

I calculated all effect sizes using the effect size calculator from the Campbell Collaboration (Wilson, n.d.), and 83% of effect sizes were also coded by another trained researcher (ICC for d = .88; ICC for v = .90). Discrepancies (where differences in d were greater than 0.01 and for v greater than 0.001) were then resolved by discussion. For studies with continuous dependent variables, I calculated effect sizes from the sample sizes, means, and standard deviations reported in the article. If those were not reported, I emailed the author and requested the sample sizes, means, and standard deviations for each dependent variable separated by condition and political group (I also accepted raw data). For one study, the author reported the unstandardized regression coefficient for the difference between treatment and control (no covariates in the model), as well as the sample sizes. I emailed the author (and received) the full sample standard deviation, calculating the effect size using sample sizes, the full sample standard deviation, and the unstandardized coefficients. For dichotomous dependent variables, I calculated effect sizes using the proportion of participants scoring 1 in each condition. All effect sizes were calculated such that larger effects corresponded to higher levels of climate change attitudes (e.g., more belief, more concern, more worry, more policy support). If studies included dependent variables in the opposition direction (e.g., climate change skepticism), I flipped the sign of the calculated effect size.

Analytical Plan

Dependent Effect Sizes

Two key aspects of the meta-analytical design resulted in a large number of dependent effect sizes. First, I compared each treatment to a control condition; in experiments with more than one treatment, participants in the control condition contributed to multiple effect sizes.

Some experiments included numerous treatments (up to 8 different experimental conditions), and therefore contributed multiple effect sizes with control condition participants supplying data to each of those effect sizes. The second origin of dependency was due to multiple dependent variables per experiment (e.g., belief in climate change, worry about its effects, support for a climate policy). The same participants in an experiment contribute to each dependent variable, but I calculated a separate effect size for each dependent variable, leading to non-independent effect sizes.

Because many experiments contained multiple treatments and multiple dependent variables, I had many more effect sizes than independent experiments or samples (Scammacca et al., 2014). Traditional meta-analysis assumes that each effect size is independent (Borenstein et al., 2009), requiring me to deal with the dependencies in the data. Traditionally, meta-analysists have dealt with dependent effect sizes by aggregating across multiple measures and comparing the aggregated effect sizes, which are independent (Scammacca et al., 2014; Tipton, 2015). For example, if participants in a study contribute to multiple outcome measures, the meta-analyst could run a separate meta-analysis for each outcome measure. If the meta-analysist desires to use all of the information available (rather than aggregating effect sizes), they can use multivariate meta-analytical techniques, but these methods require abundant information about the covariance structure of estimates which is often hard to acquire (Tipton, 2015). A third option is robust variance estimation (RVE), which is a random-effects meta-regression technique that accounts for dependent effect sizes within each experiment (Hedges et al., 2010). RVE does not make distributional assumptions about effect sizes (Hedges et al., 2010), provides valid estimates about meta-regression coefficients even in small samples (with a small sample adjustment, Hedges et al., 2010; Tipton, 2015), includes meta-regression moderator tests (Tipton & Pustejovsky, 2015),

and is easy to implement with current statistical software (Fisher & Tipton, 2015; Tanner-Smith et al., 2016). Relying on the *robumeta* package (Fisher & Tipton, 2015) in R, I used RVE in the current meta-analysis because it allowed me to utilize the maximum amount of information from the included studies (e.g., using all dependent variables) while still being straightforward to implement.

Weighting

In traditional meta-analysis, each effect size is given a weight of the inverse of its variance. RVE uses a slightly different weighting scheme, where weights are determined by the number of effect sizes per study, the average variance (across effect sizes) in a study, and the estimate of the between-study variability, Tau-squared (τ^2). The weighting scheme used by RVE is slightly different for a correlated effects model—one in which dependent effect sizes arise from multiple outcomes per sample or a shared control group for multiple treatment conditions—than for a hierarchical model—where dependent effect sizes arise from studies nested within larger units (e.g., multiple experiments in one study or multiple studies within the same lab). Because most of the dependencies in the dataset were due to multiple measures and a shared control group, I used a correlated effects model and the corresponding weighting scheme (Hedges et al., 2010; Tanner-Smith & Tipton, 2014).

Quantifying Heterogeneity

Traditionally, heterogeneity is quantified and moderators are tested using the test statistic *Q*, given by the formula:

$$Q = \sum_{I=1}^{k} W_{\mathrm{i}}(Y_{\mathrm{i}} - M)^2$$

where W_i is the weight of each study, $1/V_i$ (V_i is the variance of the effect size of a study), Y_i is the study effect size, M is the summary effect size, and k is the number of studies (Borenstein et al., 2009). Q is effectively a weighed sum of squares, taking every experiment's deviation from the mean effect size, squaring it, and weighting it by the inverse of its within-study variance. The expected amount of variation in a collection of studies is given by:

$$df = k - 1$$

where k is the number of studies. The following formula measures the excess variation in a set of studies:

$$Q - df$$

This formula tells us how much variation is observed in the set of studies compared to how much variation one would expect simply based on the number of studies. Under the null hypothesis, Q is distributed on the chi-squared distribution with $df = k - 1$ (Borenstein et al., 2009). Locating Q on a chi-square distribution allows researchers to calculate a p-value for Q and determine if there is a significant amount of heterogeneity among the studies (beyond chance alone).

To determine the best test for heterogeneity using RVE, Tipton and Pustejovsky (2015) conducted a simulation study using a modification of the traditional Q measure, as well as other measures of heterogeneity with small-sample adjustments. The researchers found that an Approximate Hotelling-Zhang (AHZ) test outperformed all other tests, especially with small-samples, in controlling the Type I error rate. Therefore, I used the AHZ test for moderator analysis, implemented with the *clubSandwich* package (Pustejovsky, 2020) in R as recommended by Tanner-Smith et al. (2016). I^2 and T^2 were also calculated to quantify overall heterogeneity. I^2 captures the ratio of the excess variation (reflecting true differences between effect sizes) to total variation among studies. The statistic is not an estimate of a population

parameter but rather a descriptive statistic (Borenstein et al., 2009). As the sample estimate of the population parameter Tau-squared (τ^2), T^2 measures the variance that can be attributed to real differences between effect sizes. The bigger T^2, the greater the true differences are between effect sizes. A smaller T^2 and therefore a narrower distribution of effect sizes suggests less variation between true effect sizes. In RVE, T^2 represents an estimate of the variance between-studies after averaging dependent effect sizes within-study. The calculation of T^2 relies in part on the value of a common correlation; the most conservative estimate of this correlation is 1, which would mean that studies do not receive extra weight for having more effect sizes (Fisher & Tipton, 2015; Hedges et al., 2010). I will use the default assumed correlation of .80, but test correlations of 0 and 1 and report whenever the pattern of results changes between these assumptions (although results tend to be robust to this correlation assumption; Hedges et al., 2010; Tipton, 2015).

Results

Retrieving Effect Sizes

Shown in Figure 3.1, we identified 74 reports that fit the inclusion criteria, including one unpublished dissertation, one dependent variable and condition that were not originally reported in an article, and three unpublished reports. Out of the 74 reports selected for inclusion, 16 reported the necessary information to calculate effect sizes.[21] I emailed the corresponding author of the other 58 reports and received 44 responses that included the necessary data to calculate effect sizes, resulting in a final sample of 60 reports. Because some of the reports included multiple experiments using independent samples, the total number of independent experiments was 73. I calculated k = 387 effect sizes from these 73 experiments, with the average

[21] For one study included in this count of 16, the data were available for the full sample but I was unable to retrieve the effect sizes broken down by political group.

independent sample contributing 5.3 effect sizes. For each experiment, I calculated an effect size for the whole sample, as well as an effect size for liberals, conservatives, and moderates separately. When politics is not included as a moderator in the following analyses, the meta-analytic calculations are based on the effect sizes for the full sample.

Summary Effect

Overall, interventions did not have a statistically significant impact on climate change attitudes, $g = 0.03$, 95% CI [-0.01, 0.07], $p = .16$. Importantly, however, there was a large amount of heterogeneity between studies, $I^2 = 80.46$, as expected due to the varied nature of interventions. I first tested for moderation by intervention direction in order to exclude interventions that were intentionally aiming to lower climate change attitudes (e.g., providing misinformation about climate change). As expected, intervention direction was a significant moderator of effect size, $F(11.89) = 23.74$, $p < .001$, with negative interventions having significantly more negative effects on climate change attitudes compared with positive interventions, $b = -0.44$, 95% CI [-0.58, -0.30], $t(9.10) = -7.03$, $p < .001$. Balanced interventions were not significantly different than positive interventions, $b = -0.07$, 95% CI [-0.14, 0.004], $t(10.25) = -2.11$, $p = .06$. The quantitative evaluation of negative interventions—their drastically negative effect on attitudes—reflects the theoretical reasoning behind coding them as negative and separating them from other interventions. For the remaining analyses, I excluded the negative interventions (23 effect sizes from 12 studies) to evaluate the effect of positive and balanced interventions on attitudes.

After this exclusion of negative experimental conditions, interventions had a very small but significant positive effect on attitudes, $g = 0.07$, 95% CI [0.05, 0.09], $t(47.23) = 6.56$, $p < .001$, $I^2 = 28.40$, $T^2 = 0.003$. Table 3.2 describes the different characteristics of every study

included in the analysis, including the values for the sample level moderators. Additionally, a full table with every effect size and moderator value is shown in Appendix C. The effect size for interventions—excluding negative interventions—suggests that interventions tend to exert only very small influences on climate change attitudes. It is worth noting the discrepancy in effect sizes between negative and non-negative interventions: it seems that it is much easier to increase skepticism than it is to increase support for various climate change attitudes.

Figure 3.1

Flow Chart of Abstract and Full-Text Screening Process

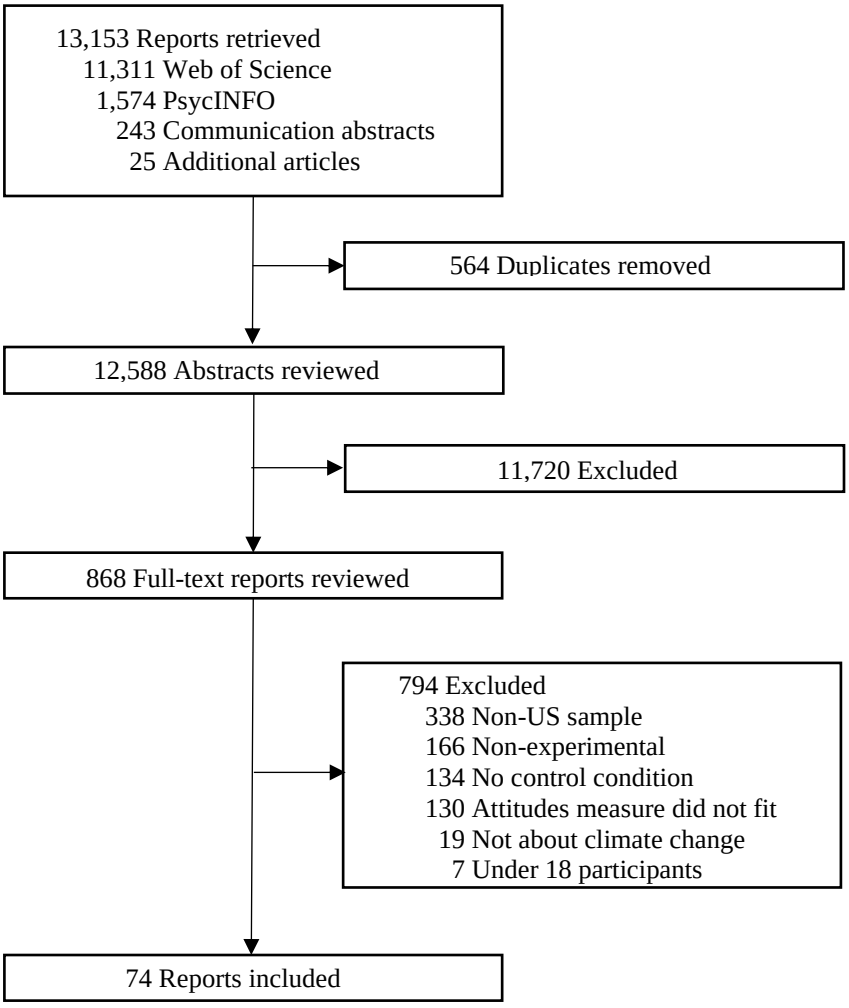


Table 3.2

Sample Level Moderator Scores

Paper	Study	Sample type	Control type	Age	White	Female	Year	Publication status
Ma et al. (2019)	Study 1	SSI	No info	44.59	68.4%	59.3%	2017	Published
Brewer & McKnight, (2015)	Study 1	Students	Unrelated	19.95	90%	64%	2013	Published
Chu & Yang (2018)	Study 1	MTurk	No info	36.97		54.5%	2017	Published
Hu et al. (2018)	Study 1	MTurk	Unrelated	35.02	83%	54.18%	2016	Published
Anderson & Becker (2018)	Study 1	Students	Unrelated	19.51		61.3%	2017	Published
Wong-Parodi & Fischhoff (2015)	Study 1	MTurk	No info	30.8	76.5%	45.8%	2014	Published
Bolsen & Druckman (2018)	Study 1	Other	Other		82.34%	53.57%	2014	Published
Bolsen et al. (2018)	Study 1	MTurk	No info	37	75%	48.3%	2017	Published
Skurka et al. (2018)	Study 1	Other	Unrelated	25.7	77.4%	55.3%	2016	Published
Manning et al. (2018)	Study 1	Other	No info	35.25	83.33%	69.32%	2018	Published
Tesler (2018)	Study 1	Other	No info				2010	Published
Dixon et al. (2017)	Study 1	SSI	No info	45.37	61.8%	43%	2016	Published
Singh & Swanson (2017)	Study 1	MTurk	No info	38.96		35%	2015	Published
Guisinger & Saunders (2017)	Study 1	Other	Other	51.68	73.85%	54%	2012	Published
Cook et al. (2017)	Study 1	Qualtrics Panel	No info	48		49%	2016	Published
	Study 2	Qualtrics Panel	No info	43		49.2%	2016	Published
Schuldt et al. (2017)	Study 1	Other	No info	49	61.1%	48.3%	2016	Published
Brewer & McKnight (2017)	Study 1	Students	Unrelated	21.59	77%	53%	2014	Published
Baumer et al. (2017)	Study 1	MTurk	Other	33.76		38.71%	2015	Published
Hardy & Jamieson (2017)	Study 1	Other	Unrelated	56.7		47.8%	2014	Published
Drummond et al. (2016)	Study 1	Other	Unrelated				2016	Published
Deryugina & Shurchkov (2016)	Study 1	Other	No info	46.99	85.13%	45.53%	2013	Published
Zhou (2016)	Study 1	SSI	Other	50	87.6%	49.3%	2014	Published

Cook & Lewandowsky (2016)	Study 1	Qualtrics Panel	No info			50.5%	2013	Published
Carrico et al. (2015)	Study 1	MTurk	Other	31.5	84%	49.5%	2014	Published
	Study 2	MTurk	Other	34.2	79%	49.5%	2014	Published
Zaval et al. (2015)	Study 1	MTurk	No info	34.3	80%	46%	2014	Published
Albertson & Busby (2015)	Study 2	Other	No info	43	77.88%	58%	2015	Published
van der Linden et al. (2014)	Study 1	SSI	No info			52%	2013	Published
Schuldt & Roh (2014)	Study 2	Students	Unrelated	19.62		76.56%	2014	Published
Bolsen et al. (2014)	Study 1	Students	No info	20		64%	2010	Published
Bolsen	Study 2	Students	No info	20.66		60.54%	2011	Published
Jang (2013)	Study 1	Qualtrics Panel	No info	45.33		53%	2012	Published
Feinberg & Willer (2013)	Study 3	Other	Unrelated			71.43%	2011	Published
Risen & Critcher (2011)	Study 2	Students	No info				2010	Published
	Study 3	Students	No info				2010	Published
	Study 4	Students	Unrelated				2010	Published
Joireman et al. (2010)	Study 2	Students	Unrelated	21	88%	54.76%	2010	Published
Bakaki & Bernauer (2017)	Study 1	MTurk	No info			45.72%	2014	Published
Clayton et al. (2013)	Study 2	MTurk	No info			53.97%	2011	Published
Budescu et al. (2012)	Study 1	Other	No info	47.8	71.04%	58.88%	2010	Published
van der Linden et al. (2019)	Study 1	Qualtrics Panel	Unrelated		73%	54%	2015	Published
Goldberg et al. (2019)	Study 1	MTurk	Unrelated	34	60.42%	41%	2018	Published
	Study 2	Other	Unrelated	41	72.74%	59%	2018	Published
	Study 3	Other	Unrelated	57	86.78%	44%	2018	Published
	Study 4	Other	Unrelated	37.17	84%	38.76%	2018	Published
Shin & Preston (2019)	Study 2	MTurk	Unrelated	38.65	79.73%	61.31%	2018	Published
	Study 3	MTurk	Unrelated	34.64	75.5%	51.2%	2018	Published
Gehlbach et al. (2019)	Study 1	MTurk	No info	38.2	79%	57%	2017	Published
Sparks (2017)	Study 2	MTurk	Unrelated	35.9	54.6%	48%	2017	Unpublished
Skurka et al. (2019)	Study 1	Other	Unrelated	24.8	75.6%	82.4%	2019	Published
Goldberg, Gustafson, et al. (2019)	Study 2	Other	Unrelated	44	74%	64%	2019	Published

Bolsen et al. (2019)	Study 1	MTurk	No info	37.49	76%	49%	2018	Published
Truelove et al. (2016)	Study 1	Students	No info	24.4	71.9%	78.35%	2015	Published
Wolske et al. (2019)	Study 1	SSI	No info	45		48%	2017	Published
Myers et al. (2015)	Study 1	SSI	Unrelated			50.27%	2014	Published
Watkins & Goodwin (2019)	Study 1	MTurk	Unrelated	36.5		42.64%	2019	Published
Stroik et al. (2019)	Study 1	SSI	No info	44.3	79.1%	50.7%	2015	Published
	Study 2	Students	No info	19.5	77.8%	51.1%	2015	Published
Cruz (2019)	Study 1	MTurk	No info	34.96	75.4%	47.6%	2017	Published
Porter et al. (2019)	Study 1	MTurk	No info		73.86%	45.24%	2018	Published
	Study 2	Other	No info		71.51%	55.53%	2018	Published
Motta et al. (2019)	Study 1	Other	No info	46	71%	51%	2018	Published
Mildenberger et al. (2019)	Study 1	Qualtrics Panel	No info		66%	53.9%	2017	Published
Halperin & Walton (2018)	Study 1	MTurk	No info	34.5		52%	2015	Published
Schoenefeld & McCauley (2016)	Study 1	Other	No info	36		64%	2015	Published
Kotcher et al. (2018)	Study 1	Other	No info		80.15%	52.5%	2017	Published
Rode et al. (2019)	Study 1	Students	No info		14%	78%	2019	Unpublished
	Study 2	Other	No info	35.09		25%	2019	Unpublished
Goldberg, van der Linden, Ballew, Rosenthal, Gustafson, et al. (2019)	Study 1	Other	Unrelated	43.26		52%	2019	Published
Stroik & Jamelske (2017)	Study 1	SSI	No info				2017	Unpublished
	Study 2	Students	No info				2017	Unpublished
Clarke et al. (2019)	Study 1	MTurk	Unrelated	51.07		59.1%	2019	Unpublished

Note. SSI = Survey Sampling International. In Sparks (2017), the study used was Study 2 from Chapter 4. "Study" refers to the independent experiment used in the paper. If a paper had one experiment, then it is listed in the table as "Study 1". If a paper had multiple experiments, then the table lists the name of the study that was used. If a paper had multiple samples (but not labeled as separate experiments in the paper, like "Study 1" or "Study 2"), then they are listed in the table as "Study 1", "Study 2", etc. to denote independent samples.

Moderators

Politics

To test political beliefs as a moderator of intervention effectiveness, I separated effect sizes by political group—liberals, conservatives, and moderates—resulting in g = 1,001 effect sizes across n = 68 studies.[22] Table 3.3 displays the results of all moderator analyses. As implied by the non-significant F test and no significant meta-regression coefficients, political group was not a significant moderator of intervention effectiveness. Surprisingly, intervention effectiveness was not statistically different across the three groups.

Intervention Category

As seen in Table 3.3, intervention type was not a significant moderator of effect size using the expanded categories.[23] Because of the number of coefficients required to test the interaction with politics (i.e., 10 conditions by 3 political groups), I investigated political effects by conducting separate models for liberals and conservatives. Effect sizes for liberals were not significantly moderated by intervention type, $F(1.54) = 0.28$, $p = .92$, suggesting that all interventions were similarly effective. Likewise, intervention type was not a significant moderator of effect size for conservatives, $F(3.40) = 0.60$, $p = .76$ nor for moderates, $F(0.83) = 0.23$, $p = .93$. Importantly to note, however, for both the whole sample model and the models within political group, the number of independent studies contributing to each category was very

[22] Even though I included measures of both political ideology and political party, I will refer to political groups as liberals, conservatives, and moderates for the sake of clarity (rather than always repeating both ideologies and parties).

[23] Using the original seven categories, intervention type was a significant moderator, $F(6.14) = 4.33$, $p = .047$. However, none of the individual meta-regression coefficients were significantly different from 0, with psychological distance (near) being marginally significant, $b = 0.05$, 95% CI [-0.01, 0.12], $t(4.20) = 2.18$, $p = .09$. All of the coefficients using the original categories were similar to those when using the expanded categories, both suggesting that psychological distance (near) was marginally significantly different from 0, such that those interventions were had marginally significantly higher effect sizes than those using scientific information. Similar to the expanded categories, the original seven categories were not a significant moderator for liberals, conservatives, or moderates.

low and the categories were unbalanced, resulting in degrees of freedom below 4 which means the estimates are not valid for those *t*-tests (Tipton, 2015). The results for any category with fewer than 4 degrees of freedom should be disregarded.

In contrast to the other categories, scientific consensus interventions were used in a large number of studies. Because of the abundance of research using consensus messaging, I calculated an effect size for studies using consensus messages (including those that overlapped with other categories, as discussed in the Methods section). The effect size was statistically significant and positive, $g = 0.08$, 95% CI [0.04, 0.13], $p = .004$, and was not significantly moderated by political group, $F(5.53) = 0.28$, $p = .77$. Researchers conducting experiments using consensus manipulations should expect an effect around $g = 0.08$ for climate change attitudes (not including perceived consensus).

Dependent Variable Category and Phrasing

The type of dependent variable was a significant moderator of effect size (Table 3.3). Specifically, interventions were much less effective for swaying support for policy than belief in natural climate change. As expected, all coefficients were negative (i.e., smaller effect sizes than those for belief in natural climate change), although only policy support was significantly different. Contrary to hypotheses, dependent variable category did not significantly interact with politics, $F(17.26) = 0.66$, $p = .75$, indicating that liberals, conservatives, and moderates had similar effect sizes across the various dependent variables. In addition, effect sizes did not significantly vary by dependent variable phrasing, climate change or global warming (Table 3.3). Moreover, political group did not significantly interact with phrasing, $F(28.20) = 2.96$, $p = .07$.

Sample Type

As seen in Table 3.3, sample type was not a significant moderator of effect sizes, nor did it interact with political group, $F(6.50) = 0.45$, $p = .85$. When using the original coding of sample type (e.g., including YouGov and GfK), sample was still not a significant moderator of effect sizes, $F(5.17) = 1.07$, $p = .47$. Additionally, I tested if effect sizes from samples that were coded as representative of the U.S. population were more or less effective than others. Representative samples did not have statistically different effect sizes than non-representative samples, $b = -0.01$, 95% CI [-0.05, 0.04], $t(12.48) = -0.34$, $p = .74$. Neither sample type nor representativeness of samples explained variation in intervention effect sizes.

Other Moderators

Lastly, I investigated a few exploratory and report-level moderators, seen in Table 3.3. The only significant moderator was percentage female, where effect sizes were larger in studies with a higher percentage of females in the sample. As seen by the regression coefficient of $b = 0.003$, for every one percentage increase in a sample's female composition, the predicted effect size increased by 0.003. In other words, each 10 percent increase in females was associated with an increase in Hedges' g of around 0.03.

Table 3.3

Moderator Analyses

Moderator	*F*	*df*	*b*	*df*	95% CI	*k*	*n*	I^2	T^2
Politics	0.30	34.05				1,001	68	13.89	0.004
Conservatives[a]			0.07**	34.96	[0.02, 0.11]	342	68		
Moderates			0.02	35.42	[-0.03, 0.07]	325	66		
Liberals			0.02	34.79	[-0.04, 0.08]	334	67		
Intervention category	1.45	3.10				364	71	29.64	0.003
Effects of climate change[a]			0.07*	4.20	[0.01, 0.14]	38	11		
Morality			-0.07	1.60	[-0.60, 0.45]	8	3		
Emotion			0.07	3.89	[-0.08, 0.23]	10	4		
Scientific consensus			-0.002	8.01	[-0.06, 0.06]	111	20		
Psych. distance -- near			0.05	4.30	[-0.01, 0.12]	18	6		
Psych. distance -- far			-0.04	3.85	[-0.14, 0.06]	16	5		
National security			-0.01	1.69	[-0.34, 0.31]	7	3		
Economy			-0.05	2.16	[-0.33, 0.23]	13	4		
Religion			0.05	6.03	[-0.05, 0.15]	16	5		
Other			-0.03	6.93	[-0.10, 0.04]	127	36		
DV category	4.09**	26.03				364	71	21.88	0.002
Belief in natural CC[a]			0.11***	21.73	[0.07, 0.16]	65	32		
Belief in ACC			-0.02	24.97	[-0.06, 0.02]	76	31		
Concern or worry			-0.03	14.62	[-0.08, 0.02]	29	16		
Risk			-0.05	23.15	[-0.15, 0.05]	60	18		
Policy support			-0.11***	30.02	[-0.16, -0.05]	82	33		

Other			-0.03	22.62	[-0.08, 0.02]	52	19		
DV phrasing						278	60	25.82	0.003
Climate change[a]			0.06**	24.68	[0.03, 0.10]	174	32		
Global warming			0.01	43.15	[-0.03, 0.06]	104	33		
Sample type	0.95	12.35				364	71	29.65	0.003
MTurk[a]			0.08**	18.50	[0.03, 0.12]	112	22		
Students			0.04	10.33	[-0.09, 0.16]	39	13		
SSI			-0.03	7.68	[-0.11, 0.05]	52	7		
Qualtrics Panel			0.02	5.23	[-0.05, 0.09]	43	6		
Other			-0.02	35.05	[-0.08, 0.04]	118	23		
Intervention medium	1.18	9.76				364	71	28.97	0.003
Text[a]			0.06***	32.74	[0.04, 0.08]	285	50		
Video			0.06	6.60	[-0.02, 0.14]	33	8		
Image or map			0.01	6.85	[-0.11, 0.13]	34	9		
Other			0.06	5.19	[-0.10, 0.23]	12	9		
Control type	0.79	12.01				364	71	29.28	0.003
No information[a]			0.07***	26.62	[0.05, 0.10]	239	40		
Unrelated task			-0.004	32.65	[-0.06, 0.05]	85	25		
Other			-0.04	5.65	[-0.11, 0.03]	40	6		
Age			-0.003	14.02	[-0.01, 0.001]	270	53	29.88	0.003
Percent white			-0.001	3.78	[-0.01, 0.002]	200	42	27.05	0.002
Percent female			0.003**	10.01	[0.001, 0.01]	358	66	22.54	0.002
Year			0.002	19.63	[-0.01, 0.01]	364	71	29.32	0.003
Publication status						364	71	29.09	0.003
Unpublished[a]			0.06	2.55	[-0.21, 0.32]	20	4		

Published	0.02	2.80	[-0.23, 0.27]	344	67

Note. *F* = Wald-type test statistic using the AHZ test (Tipton & Pustejovsky, 2015); *df* = degrees of freedom; *b* = unstandardized meta-regression coefficient; *k* = number of effect sizes; *n* = number of independent samples. Any coefficient associated with degrees of freedom less than 4 should be ignored because the corresponding *t* test is not valid and the Type I error rate is inflated (Tipton, 2015). AHZ tests, shown in the column labeled *F*, can be interpreted even with *df* close to 0 (Tipton & Pustejovsky, 2015).
[a]Represents the reference group, or intercept of the model. The meta-regression coefficient for the intercept is compared to 0, while all other coefficients are compared to the intercept.
***$p < .001$. **$p < .01$. *$p < .05$.

Publication bias

To examine the possibility of publication bias in the observed effect sizes, I calculated fail-safe *N*s, tested for asymmetry around funnel plots, and imputed missing effect sizes using trim-and-fill methods. Because there are no methods currently available for assessing publication bias for dependent effect sizes (i.e., current methods assume independent effect sizes), I tested for bias using two datasets: one dataset that aggregated dependent effect sizes using the *MAd* package in R (Del Re & Hoyt, 2014) to calculate one effect size per independent experiment, assuming a within-study correlation of .50; and another dataset that ignored dependencies in the dataset and used all effect sizes (but not separated by political group), treating them as if they were independent.[24] This method is similar to those used in other RVE meta-analyses (Agadullina & Lovakov, 2018; Liu et al., 2017).

Fail-Safe N

Rosenthal's fail-safe *N* calculates the number of missing studies that would be needed to add to the meta-analysis to make the effect size estimate non-significant, assuming the effect size in the missing studies was zero (Borenstein et al., 2009; Rosenthal, 1979). Similarly, Orwin's fail-safe *N* determines the number of studies needed to reach a specified effect size, typically one that would be trivial; in other words, if only a few studies with null results were needed to add to a meta-analysis to make the effect size trivial, then that would suggest that the true effect size is most likely trivial (Orwin, 1983). For the current aggregated dataset, 1,447 studies with null effect sizes would need to be added to make the summary effect non-significant (Rosenthal's

[24] Similarly to earlier analyses, I excluded interventions that were coded as intending to negatively affect climate change attitudes. Because those manipulations were expected to have negative effect sizes, they would pull the effect size down and mask potential publication bias. In other words, if there was strong publication bias for positive and balanced interventions then I would expect missing studies below the estimated effect size; however, including negative interventions would fill the left side of the funnel plot (i.e., negative effects) and make the plot more symmetric.

method), and 81 studies (Orwin's method) needed to cut the summary effect to $g = 0.035$ (half of the original effect size). Both analyses suggest that a large amount of missing studies would be required to substantially reduce the observed effect size, suggesting that there is not a lot of publication bias.[25]

Funnel Plots

Funnel plots test for publication bias by plotting effect sizes on the x-axis and the standard error of each effect size on the y-axis (Egger et al., 1997). Studies with more variance are expected to be more widespread towards the bottom, with more precise effect sizes clustered around the effect size estimate at the top of the y-axis. This displays (or hints at) publication bias because if the graph is asymmetric—for example, more studies on the bottom right than bottom left—then it suggests that there are missing studies and therefore publication bias, although there are alternative reasons for asymmetry (Borenstein et al., 2009). Figure 3.2 displays the funnel plot for the aggregated dataset, and Figure 3.3 shows the plot for the full dataset. Both plots visually seem symmetrical, although there appear to be a few more effect sizes in the bottom right of Figure 3.2 than in the bottom left. To inferentially test for asymmetry, I conducted an Egger regression test of asymmetry, using standard errors to predict observed effect sizes (Egger et al., 1997). Using the *metafor* package in R (Viechtbauer, 2010), I first conducted a random-

[25] The lack of publication bias may seem unusual or unexpected for a meta-analysis on interventions, especially because one would expect "failed" interventions to stay in the file drawer (i.e., unpublished). Furthermore, the current meta-analysis only included a small number of unpublished studies. One reason for this unexpected absence of publication bias may be that this meta-analysis conceptualized interventions differently than many of the primary studies contributing effect sizes (see the Discussion section for more on this discrepancy). For example, a study may have manipulated X1 and X2 with a specific interaction prediction in mind. If neither X1 nor X2 is significant but the interaction is, then it is highly likely for that study to be published. In this meta-analysis, X1 and X2 would be treated as independent interventions and contribute small effect sizes (given their nonsignificance in the primary study). Similar differences between primary studies and interventions as defined by this meta-analysis may occur with mediating variables (e.g., the effect of X1 was not significant, but hypothesized mediator M significantly mediated the relation between X1 and Y). However, even though the current meta-analysis contains studies that were published yet did not find a significant intervention effect, the reverse is highly unlikely to be true: if a study finds a significant intervention effect of X1 or X2, it is likely to be published.

effects meta-analysis with both datasets separately, and then conducted a random-effects version of the Egger test (default in *metafor*; Sterne & Egger, 2005). Confirming the visual inspection of the funnel plot, the test for asymmetry was non-significant in the aggregated dataset, $z = -0.27$, $p = .78$. The test was significant using the full dataset, $z = -3.00$, $p = .003$, although the test statistic was negative, indicating that studies with increased standard error had smaller effect sizes.

Trim-and-Fill

The last method to assess publication bias was the trim-and-fill method (Duval & Tweedie, 2000a, 2000b). This correction for publication bias corrects for asymmetry by imputing effect sizes (i.e., on the less populated side of the plot) until the distribution is symmetric, recalculating an unbiased measure of effect size from this new distribution (Borenstein et al., 2009; Duval & Tweedie, 2000a, 2000b). However, because the trim-and-fill test statistic was negative for both the aggregated and the full dataset, effect sizes were actually imputed on the right side of the plot to make the dataset more symmetric.[26] The trim-and-fill unbiased estimate of the effect size ($g = 0.071$, 1 effect size imputed) was larger than the estimate using the original aggregated dataset ($g = 0.070$). Similarly, the trim-and-fill unbiased estimate was larger ($g = 0.08$, 51 effect sizes imputed) than the original full dataset effect size ($g = 0.06$).[27] Considering all three methods of estimating publication bias together, there is little evidence of publication bias in the selected studies.

[26] Forcing the trim-and-fill function to impute only to the lower side of the effect size resulted in zero imputed effects for either dataset because none were needed below the estimate to make the distribution more symmetric.
[27] Original estimates—used as input for the trim-and-fill models—were random-effects meta-analyses that assumed independent effect sizes (a condition that was met for the aggregated dataset but not for the full dataset).

Figure 3.2

Funnel Plot of Aggregated Effect Sizes

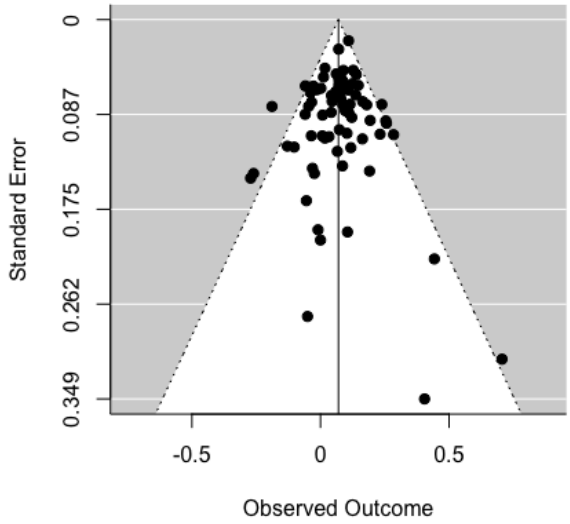
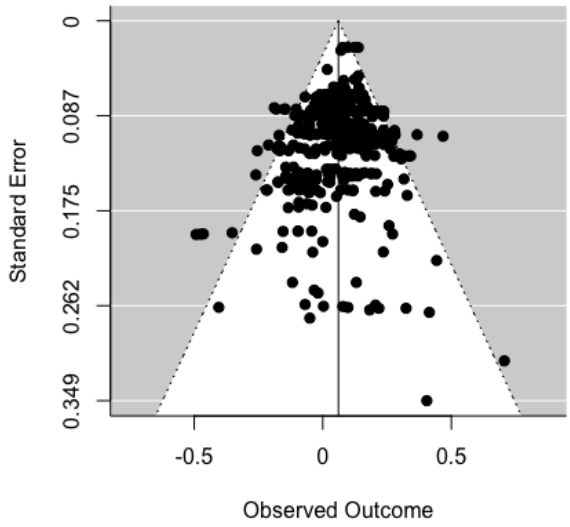


Figure 3.3

Funnel Plot of All Effect Sizes, Ignoring Dependencies



Discussion

The current meta-analysis quantitatively synthesized experimental studies that applied interventions to influence climate change attitudes. Limited to studies that included a control group, the synthesis brought together 73 independent experiments with 387 total effect sizes. Because of the nature and goals of the included studies, some experimental manipulations were meant to reduce belief in climate change (for various theoretical or methodological reasons). The direction of manipulation—positive, negative, or balanced—was a strong moderator of effect sizes, with negative manipulations resulting in significantly stronger negative effect sizes than positive conditions.

Focusing only on positive and balanced manipulations, there was a very small but statistically significant positive effect of intervention on climate change attitudes. Although the category of intervention was not a significant moderator, the type of dependent variable was: attitudes about climate change policy were significantly less influenced by experimental manipulation than were attitudes about belief in climate change. Unsurprisingly, the current results suggest that it is harder to influence people's attitudes about supporting a climate change policy than to persuade them that climate change exists. The other statistically significant moderator was the percentage of the sample that was female, where samples that had a higher percentage of females displayed stronger experimental effects. None of the other moderators were significant, and none significantly interacted with political group.

Takeaways

Small Summary Effect

The results of the current study provide a number of relevant implications for researchers and policymakers interested in climate change communication and related fields. First and

foremost, the results point to the limited effectiveness of the interventions included in this synthesis. The summary effect was very small with few significant moderators of the effect. The summary effect was smaller than that from a more specific meta-analysis on framing and climate change attitudes (*SMD* = 0.17; Li & Su, 2018), and it was much smaller than a meta-analysis that examined the effect of experimental interventions on pro-environmental behaviors (*g* = 0.45; Osbaldiston & Schott, 2012). Although some meta-analytic work finds that political attitudes can be shifted (e.g., manipulating mortality salience shifts people towards political conservatism, *r* = .22; Burke et al., 2013), others find that climate change attitudes are politically charged (Hornsey et al., 2016) and that people process political information in a biased manner such that they discount information that contradicts their prior beliefs (Ditto et al., 2019). Therefore, the small effect in the current meta-analysis could be due to both the stability of political attitudes like climate change beliefs and the disparate nature of the interventions used.

Exemplifying the disparate nature of interventions in the current meta-analysis, several of the included studies did not employ interventions focused on the main effect of experimental condition on attitudes, but rather mediation, moderation, or a related focal dependent variable. The authors of those studies would likely not hypothesize that there would be a main effect of condition on attitudes. For example, studies using consensus manipulations rely on the GBM, a two-step model where a consensus message increases perceived consensus which increases climate beliefs, finally leading to policy support (van der Linden et al., 2015). The model predicts that perceived consensus is a key mediator between a consensus message and climate change attitudes, but does not predict a main effect of consensus message on attitudes. Similarly, Chu and Yang (2018) manipulated psychological distance, but also orthogonally manipulated the type of climate change effect (novel or familiar) in the stimulus materials. Their hypotheses

involved the relation between psychological distance, type of effect, and political ideology. When effect sizes from their study were combined in the current meta-analysis, I could test for the effect of psychological distance as well as its interaction with political ideology, but the type of effect was included as an "Other" category of intervention. In other words, the current meta-analysis grouped interventions together as much as possible, but the wide variety of interventions made it impossible to investigate each specific combination of interventions as intended by the original study authors. Several original studies also conceptualized dependent variables differently than the current study. For example, Motta, et al. (2019) were interested in how beliefs about climate change vary depending on the response options (e.g., categorical responses, Likert scale, a "Don't know" option, etc.). Important to the current meta-analysis, half of their experimental conditions included a few sentences explaining climate change and global warming and their causes, resulting in an experimental manipulation that fit the inclusion criteria. While I was not interested in responses on different scales, the original authors were entirely focused on differential responses based on scales. Therefore, as I collapsed their different scales into one dependent variable to investigate the effect of experimental manipulation, I may have lost an important source of effect size variation—response scale. Only looking at the main effects of interventions limits the ability of the current meta-analysis to examine how fine-grained intervention characteristics (e.g., combinations of interventions, different response scales) explain variation in effect sizes.

These various examples of differences between original study design and the current meta-analytic design highlight that "intervention effectiveness" is different depending on context. Although the overall effect size was small, indicating that manipulations had limited effects on climate change attitudes when not taking potential moderators into account, there are a

variety of factors that contribute to intervention effectiveness and many of those factors were unable to be analyzed in the current meta-analysis. The variety of interventions and scope of inclusion criteria limit the specific conclusions that can be drawn from the summary effect of the synthesis.

Moderation by Intervention Direction

Another takeaway is the strong moderation of intervention direction. Although not originally intended to be a moderator, intervention direction emerged as an important factor to consider when combining interventions. For example, one study provided a news article that used misleading information to argue that global warming is exaggerated; the authors also included an experimental condition where this information was paired with better scientific information to help correct perceptions (Hardy & Jamieson, 2017). Considering both of these experimental conditions to be interventions would be misleading because the first condition was not intended to increase climate change attitudes. Unsurprisingly, the moderator of intervention direction was a strong significant negative predictor of effect size direction. Furthermore, experimental conditions coded as negative had a much stronger effect on attitudes than positive manipulations, illustrating the ease at which skepticism is to induce. Given that climate change is an uncertain, large event with potentially devastatingly negative consequences, people may be quick to hold on to information that gives them hope—even if that hope is grounded in downplaying the consequences. Future research should continue to examine these negative manipulations of climate change attitudes and examine ways of mitigating the jump to skepticism or reduced concern (for examples of this type of research, see Bolsen & Druckman, 2018b, 2018a; Cook et al., 2017).

Policy Support is Difficult to Influence

Similarly, climate change belief was much easier for interventions to influence than was support for climate change policy. This was in line with hypotheses and previous research (Hornsey et al., 2016), given that support for policy would be expected to occur after one accepts climate change and that support for policy may imply costs more than accepting climate change would. Unfortunately, policy support is arguably more important than belief—a main reason belief is important is to drive support for climate policies. Even if interventions were extremely effective for beliefs, if they were not effective for policy support then there would still be limits to the policy implications for those interventions. Conversely, even if interventions were not effective at all for beliefs, if they were effective for policy support then there would be direct policy implications and policymakers could focus on those effective interventions. For example, P. S. Hart and Feldman (2018) found that people were more receptive to policy when it was framed around air pollution rather than climate change, suggesting that there may be ways to garner policy support among climate skeptics without changing their minds about the existence of climate change. Although it is difficult to sway policy attitudes, there may be ways to influence policy support without first changing belief.

The current meta-analysis was unable to test specific policies due to the limited number of studies measuring support for specific policies, but this finding would suggest that more research should investigate ways of making climate policy more palatable. For example, current work shows that avoiding the term "tax" is useful for garnering policy support (Hardisty et al., 2010, 2019). Additionally, framing policy as being supported by the ingroup may be a way to increase support, although findings using this method are somewhat mixed (Bolsen et al., 2019b; Fielding et al., 2019; Zhou, 2016). Relatedly, Campbell and Kay (2014) experimentally manipulated a potential solution to climate change to be either free market friendly or

government regulation; conservative participants exhibited more belief in climate change when the solution was framed in terms of the free market. Future research should continue to focus on policy support as a dependent variable (for a review, see Kyselá et al., 2019), and consider testing different types of policy support (e.g., word framing, types of policy, etc.).

Need for a Control Group

Lastly, the current meta-analysis demonstrates the benefits of experimental designs that include control conditions. By including a condition that involves no experimental manipulation, these studies allow comparable effect sizes to be calculated between treatment and control. In the current literature search, over 130 additional independent studies could have been selected for inclusion in the meta-analysis if they had included a control condition. This would have allowed for both more robust claims and more fine-grained analyses, such as examining intervention category subtypes. Although it may not make theoretical sense for all experimental designs to include a control condition—and indeed, many studies might not be focused on interventions per se but rather comparing experimental manipulations to each other (e.g., a 2x2 factorial design)—researchers should at least consider the benefits of randomly assigning some participants to an additional condition where there is no manipulation involving climate change. When a control condition is included as a comparison for treatments, it allows for claims to be made about the absolute effect of treatments. For example, an experimental study might manipulate the source of a climate change policy to be from the Republican or Democratic party. Although informative, a design without a control condition would be limited to making relative claims about the effectiveness of a Republican source compared to a Democratic one; on the other hand, a control condition would allow the researcher to determine how each source increased or decreased support compared to a generic version of the policy. Future research should include a control

condition when possible, and future meta-analysts may consider alternative ways of calculating effect sizes that do not require a control group (e.g., comparing liberal and conservative attitudes within experimental conditions).

Limitations

The current meta-analysis has several limitations, some of which are more obvious than others. First and most obviously, the synthesis combined a wide range of experimental studies together, each with its own goals and focus. As discussed earlier, only some studies were specifically interested in the main effect of an experimental condition on climate change attitudes; many focused on mediation with another variable, moderation with a variable or other condition, or different dependent variables besides climate change attitudes. Although combining all of these studies can be informative, the result is unable to present a conclusive answer as to whether interventions work—individual experimental manipulations may have been effective in their specific process through a mediating or moderating variable, even if they do not seem effective when looking at the main effect of manipulation as this current analysis does. For example, a study may have manipulated a variable with the intent that it would only impact attitudes for participants with high scores on a moderating variable. Even if that study found a significant interaction, such that participants with high scores on the moderating variable had significant increases in climate change attitudes compared to a control condition, the current meta-analysis only examined the impact of experimental condition. Given that the meta-analytic focus on interventions necessitates collapsing across moderating variables (other than those specifically examined at the meta-analytic level), it may have washed out the moderating effect in the primary study and resulted in a nonsignificant main effect. This (and any) meta-analysis is

unable to offer that nuanced picture when comparing across studies, something that future experimental studies can consider when crafting their designs.

The second limitation involves generalizability: not all studies were included in the analysis. Although I tried to find every possible study that fit the inclusion criteria, I was unable to retrieve data from 16 of the selected reports and have inevitably missed some reports (including many unpublished ones). If reports were randomly omitted, then the current results would not be affected; however, it is likely that unpublished reports were more likely to be missed than published ones. At face value, this would seem to suggest that the current meta-analysis overestimates the true effect. However, the effect size was extremely small, most likely due to the aforementioned variety in types and goals of the included experiments. Tests assessing publication bias provided little evidence that there was strong publication bias. Given the small effect in this meta-analysis, reports that were not published still could have had larger effects than the one found in this meta-analysis and been non-statistically significant. It may not be surprising to find little evidence of publication bias because of the unique nature of this synthesis: many studies were not focused on the main effect of intervention on climate change attitudes and therefore did not even report or test the relation (most authors were emailed for data). Related to generalizability, the current meta-analysis excluded non-U.S. participants and behavioral outcome measures.[28] While this was a known limitation at the outset of designing this

[28] Although behavioral outcomes would have been interesting and important to investigate, including them would have substantially broadened the scope of the meta-analysis. For example, many environmental behaviors are indirectly related to climate change (e.g., recycling, energy efficiency). Creating a distinction between climate change and the environment in general seemed to be easier for attitudes—with many involving face-valid questions about one's perceptions of climate change—than for behaviors, where the interconnected nature of climate systems means that many behaviors can be eventually linked to climate. The current meta-analysis therefore focuses on climate change and excludes behavioral outcomes. Future research, however, should investigate intervention effectiveness for behavior and behavioral intentions.

analysis, it still is worth mentioning that the results are only generalizable to experiments that use U.S. participants and measure climate change attitudes.

The third limitation relates to the nuance in dependent variables. I focused on attitudes specific to climate change, excluding attitudes towards the environment in general or related environmental topics. However, attitudes towards climate change still includes a very broad range of measures and constructs. For example, dependent variables ranged from predicted levels of sea-ice to the personal importance of climate change to foreign countries' responsibility for addressing climate change. Combining these has the potential to convolute what the calculated summary effect size actually estimates. While including dependent variable type as a moderator helped to demonstrate how effect size estimates varied by attitude type, the overall summary effect still estimates a general measure of climate change attitudes rather than any one specific attitude.

Conclusion and Future Directions

The current meta-analysis provides some information about the effectiveness of experimental interventions on climate change attitudes. Despite the limitations of the meta-analysis, it still provides valuable information for climate change communications researchers: experimental manipulations tend to have very small effects; it is easier for people to become more skeptical of climate change than more supportive; and attitudes towards climate change policy are much more difficult to change than belief in climate change. Researchers using experiments to influence climate change attitudes should expect a very small effect on average, depending on the other factors and variables used in their experiments. Furthermore, given the importance of policy in addressing climate change, researchers should particularly key in on policy support as a dependent variable. This meta-analysis also highlights that there is not a one-

size-fits-all approach to influencing climate change attitudes. Individual experiments will vary, and whether specific interventions are effective or not depends on both the type of intervention and audience who is receiving it. Future research should continue investigating the best ways to engage the public in climate change and policies that will garner the most public support.

References

References marked with an asterisk indicate studies included in the meta-analysis.

Agadullina, E. R., & Lovakov, A. V. (2018). Are people more prejudiced towards groups that are perceived as coherent? A meta-analysis of the relationship between out-group entitativity and prejudice. *British Journal of Social Psychology*, *57*(4), 703–731. https://doi.org/10.1111/bjso.12256

Aklin, M., & Urpelainen, J. (2013). Debating clean energy: Frames, counter frames, and audiences. *Global Environmental Change*, *23*(5), 1225–1232. https://doi.org/10.1016/j.gloenvcha.2013.03.007

*Albertson, B., & Busby, J. W. (2015). Hearts or minds? Identifying persuasive messages on climate change. *Research & Politics*, *2*(1), 1–9. https://doi.org/10.1177/2053168015577712

*Anderson, A. A., & Becker, A. B. (2018). Not just funny after all: Sarcasm as a catalyst for public engagement with climate change. *Science Communication*, *40*(4), 524–540. https://doi.org/10.1177/1075547018786560

*Bakaki, Z., & Bernauer, T. (2017). Do global climate summits influence public awareness and policy preferences concerning climate change? *Environmental Politics*, *26*(1), 1–26. https://doi.org/10.1080/09644016.2016.1244964

*Baumer, E. P. S., Polletta, F., Pierski, N., & Gay, G. K. (2017). A simple intervention to reduce framing effects in perceptions of global climate change. *Environmental Communication*, *11*(3), 289–310. https://doi.org/10.1080/17524032.2015.1084015

Benjamin, D., Por, H.-H., & Budescu, D. (2017). Climate change versus global warming: Who is susceptible to the framing of climate change? *Environment and Behavior*, *49*(7), 745–

770. https://doi.org/10.1177/0013916516664382

Berinsky, A. J., Huber, G. A., & Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon.com's Mechanical Turk. *Political Analysis*, *20*(3), 351–368. https://doi.org/10.1093/pan/mpr057

Boas, T. C., Christenson, D. P., & Glick, D. M. (2020). Recruiting large online samples in the United States and India: Facebook, Mechanical Turk, and Qualtrics. *Political Science Research and Methods*, *8*(2), 232–250. https://doi.org/10.1017/psrm.2018.28

*Bolsen, T., & Druckman, J. N. (2018a). Do partisanship and politicization undermine the impact of a scientific consensus message about climate change? *Group Processes & Intergroup Relations*, *21*(3), 389–402. https://doi.org/10.1177/1368430217737855

Bolsen, T., & Druckman, J. N. (2018b). Validating conspiracy beliefs and effectively communicating scientific consensus. *Weather, Climate, and Society*, *10*, 453–458. https://doi.org/10.1175/WCAS-D-17-0096.1

Bolsen, T., Druckman, J. N., & Cook, F. L. (2014). The influence of partisan motivated reasoning on public opinion. *Political Behavior*, *36*(2), 235–262. https://doi.org/10.1007/s11109-013-9238-0

*Bolsen, T., Kingsland, J., & Palm, R. (2018). The impact of frames highlighting coastal flooding in the USA on climate change beliefs. *Climatic Change*, *147*, 359–368. https://doi.org/10.1007/s10584-018-2143-0

*Bolsen, T., Leeper, T. J., & Shapiro, M. A. (2014). Doing what others do: Norms, science, and collective action on global warming. *American Politics Research*, *42*(1), 65–89. https://doi.org/10.1177/1532673X13484173

*Bolsen, T., Palm, R., & Kingsland, J. T. (2019a). Counteracting climate science politicization

with effective frames and imagery. *Science Communication*, *41*(2), 147–171. https://doi.org/10.1177/1075547019834565

Bolsen, T., Palm, R., & Kingsland, J. T. (2019b). The impact of message source on the effectiveness of communications about climate change. *Science Communication*, *41*(4), 464–487. https://doi.org/10.1177/1075547019863154

Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change? *Public Understanding of Science*, *9*(3), 205–218. https://doi.org/10.1088/0963-6625/9/3/301

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Wiley.

*Brewer, P. R., & McKnight, J. (2015). Climate as comedy: The effects of satirical television news on climate change perceptions. *Science Communication*, *37*(5), 635–657. https://doi.org/10.1177/1075547015597911

*Brewer, P. R., & McKnight, J. (2017). "A statistically representative climate change debate": Satirical television news, scientific consensus, and public perceptions of global warming. *Atlantic Journal of Communication*, *25*(3), 166–180. https://doi.org/10.1080/15456870.2017.1324453

*Budescu, D. V., Por, H.-H., & Broomell, S. B. (2012). Effective communication of uncertainty in the IPCC reports. *Climatic Change*, *113*, 181–200. https://doi.org/10.1007/s10584-011-0330-3

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, *6*(1), 3–5. https://doi.org/10.1177/1745691610393980

Burke, B. L., Kosloff, S., & Landau, M. J. (2013). Death goes to the polls: A meta-analysis of mortality salience effects on political attitudes. *Political Psychology*, *34*(2), 183–200. https://doi.org/10.1111/pops.12005

Campbell, T. H., & Kay, A. C. (2014). Solution aversion: On the relation between ideology and motivated disbelief. *Journal of Personality and Social Psychology*, *107*(5), 809–824. https://doi.org/10.1037/a0037963

*Carrico, A. R., Truelove, H. B., Vandenbergh, M. P., & Dana, D. (2015). Does learning about climate change adaptation change support for mitigation? *Journal of Environmental Psychology*, *41*, 19–29. https://doi.org/10.1016/j.jenvp.2014.10.009

Casler, K., Bickel, L., & Hackett, E. (2013). Separate but equal? A comparison of participants and data gathered via Amazon's MTurk, social media, and face-to-face behavioral testing. *Computers in Human Behavior*, *29*(6), 2156–2160. https://doi.org/10.1016/j.chb.2013.05.009

Chapman, D. A., Lickel, B., & Markowitz, E. M. (2017). Reassessing emotion in climate change communication. *Nature Climate Change*, *7*, 850–852. https://doi.org/10.1038/s41558-017-0021-9

*Chu, H., & Yang, J. Z. (2018). Taking climate change here and now – mitigating ideological polarization with psychological distance. *Global Environmental Change*, *53*, 174–181. https://doi.org/10.1016/j.gloenvcha.2018.09.013

Chu, H., & Yang, J. Z. (2019). Emotion and the psychological distance of climate change. *Science Communication*, *41*(6), 761–789. https://doi.org/10.1177/1075547019889637

*Clarke, E. J. R., Klas, A., Stevenson, J., & Kothe, E. J. (2019). The role of late-night infotainment comedy in communicating climate change consensus. *PsyArXiv*.

https://doi.org/10.31234/osf.io/ufg9r

*Clayton, S., Koehn, A., & Grover, E. (2013). Making sense of the senseless: Identity, justice, and the framing of environmental crises. *Social Justice Research*, *26*, 301–319. https://doi.org/10.1007/s11211-013-0185-z

Clifford, S. (2019). How emotional frames moralize and polarize political attitudes. *Political Psychology*, *40*(1), 75–91. https://doi.org/10.1111/pops.12507

Clifford, S., Jewell, R. M., & Waggoner, P. D. (2015). Are samples drawn from Mechanical Turk valid for research on political ideology? *Research & Politics*, *2*(4), 1–9. https://doi.org/10.1177/2053168015622072

*Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using bayesian networks. *Topics in Cognitive Science*, *8*(1), 160–179. https://doi.org/10.1111/tops.12186

*Cook, J., Lewandowsky, S., & Ecker, U. K. H. (2017). Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLoS ONE*, *12*(5), e0175799. https://doi.org/10.1371/journal.pone.0175799

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., Way, R., Jacobs, P., & Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*(2), 024024. https://doi.org/10.1088/1748-9326/8/2/024024

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

Research Letters, *11*(4), 048002. https://doi.org/10.1088/1748-9326/11/4/048002

Crowson, H. M. (2009). Are all conservatives alike? A study of the psychological correlates of cultural and economic conservatism. *The Journal of Psychology*, *143*(5), 449–463. https://doi.org/10.3200/JRL.143.5.449-463

Crump, M. J. C., McDonnell, J. V., & Gureckis, T. M. (2013). Evaluating Amazon's Mechanical Turk as a tool for experimental behavioral research. *PLoS ONE*, *8*(3), e57410. https://doi.org/10.1371/journal.pone.0057410

*Cruz, S. M. (2019). Lateral attitude change on environmental issues: Implications for the climate change debate. *Climatic Change*, *156*, 151–169. https://doi.org/10.1007/s10584-019-02474-x

Del Re, A. C., & Hoyt, W. T. (2014). *MAd: Meta-analysis with mean differences* (R package version 0.8-2). https://cran.r-project.org/package=MAd

Dent, A. L., & Koenka, A. C. (2016). The relation between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. *Educational Psychology Review*, *28*(3), 425–474. https://doi.org/10.1007/s10648-015-9320-8

*Deryugina, T., & Shurchkov, O. (2016). The effect of information provision on public consensus about climate change. *PLoS ONE*, *11*(4), e0151469. https://doi.org/10.1371/journal.pone.0151469

Ding, D., Maibach, E. W., Zhao, X., Roser-Renouf, C., & Leiserowitz, A. (2011). Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nature Climate Change*, *1*, 462–466. https://doi.org/10.1038/nclimate1295

Ditto, P. H., Liu, B. S., Clark, C. J., Wojcik, S. P., Chen, E. E., Grady, R. H., Celniker, J. B., & Zinger, J. F. (2019). At least bias is bipartisan: A meta-analytic comparison of partisan

bias in liberals and conservatives. *Perspectives on Psychological Science*, *14*(2), 273–291. https://doi.org/10.1177/1745691617746796

Ditto, P. H., & Lopez, D. F. (1992). Motivated skepticism: Use of differential decision criteria for preferred and nonpreferred conclusions. *Journal of Personality and Social Psychology*, *63*(4), 568–584. https://doi.org/10.1037/0022-3514.63.4.568

*Dixon, G., Hmielowski, J., & Ma, Y. (2017). Improving climate change acceptance among U.S. conservatives through value-based message targeting. *Science Communication*, *39*(4), 520–534. https://doi.org/10.1177/1075547017715473

Dixon, G., Hmielowski, J., & Ma, Y. (2019). More evidence of psychological reactance to consensus messaging: A response to van der Linden, Maibach, and Leiserowitz (2019). *Environmental Communication*, 1–7. https://doi.org/10.1080/17524032.2019.1671472

Druckman, J. N., & Kam, C. D. (2011). Students as experimental participants: A defense of the "narrow data base." In J. N. Druckman, D. P. Green, J. H. Kuklinski, & A. Lupia (Eds.), *Cambridge handbook of experimental political science*. Cambridge University Press.

Druckman, J. N., & McGrath, M. C. (2019). The evidence for motivated reasoning in climate change preference formation. *Nature Climate Change*, *9*, 111–119. https://doi.org/10.1038/s41558-018-0360-1

*Drummond, A., Palmer, M. A., & Sauer, J. D. (2016). Enhancing endorsement of scientific inquiry increases support for pro-environment policies. *Royal Society Open Science*, *3*(9), 160360. https://doi.org/10.1098/rsos.160360

Duval, S., & Tweedie, R. (2000a). A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. *Journal of the American Statistical Association*, *95*(449), 89–98. https://doi.org/10.1080/01621459.2000.10473905

Duval, S., & Tweedie, R. (2000b). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics, 56*(2), 455–463. https://doi.org/10.1111/j.0006-341X.2000.00455.x

Ecklund, E. H., Scheitle, C. P., Peifer, J., & Bolger, D. (2017). Examining links between religion, evolution views, and climate change skepticism. *Environment and Behavior, 49*(9), 985–1006. https://doi.org/10.1177/0013916516674246

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ, 315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Ehret, P. J., Sparks, A. C., & Sherman, D. K. (2017). Support for environmental protection: an integration of ideological-consistency and information-deficit models. *Environmental Politics, 26*(2), 253–277. https://doi.org/10.1080/09644016.2016.1256960

Everett, J. A. C. (2013). The 12 item social and economic conservatism scale (SECS). *PLoS ONE, 8*(12), e82131. https://doi.org/10.1371/journal.pone.0082131

*Feinberg, M., & Willer, R. (2013). The moral roots of environmental attitudes. *Psychological Science, 24*(1), 56–62. https://doi.org/10.1177/0956797612449177

Feldman, L., & Hart, P. S. (2016). Using political efficacy messages to increase climate activism: The mediating role of emotions. *Science Communication, 38*(1), 99–127. https://doi.org/10.1177/1075547015617941

Feygina, I., Jost, J. T., & Goldsmith, R. E. (2010). System justification, the denial of global warming, and the possibility of "system-sanctioned change". *Personality and Social Psychology Bulletin, 36*(3), 326–338. https://doi.org/10.1177/0146167209351435

Fielding, K. S., Hornsey, M. J., & Swim, J. K. (2014). Developing a social psychology of climate

change. *European Journal of Social Psychology*, *44*(5), 413–420. https://doi.org/10.1002/ejsp.2058

Fielding, K. S., Hornsey, M. J., Thai, H. A., & Toh, L. L. (2019). Using ingroup messengers and ingroup values to promote climate change policy. *Climatic Change*. Advance online publication. https://doi.org/10.1007/s10584-019-02561-z

Fisher, Z., & Tipton, E. (2015). *robumeta: An R-package for robust variance estimation in meta-analysis*. http://arxiv.org/abs/1503.02220

Flynn, D. J., Nyhan, B., & Reifler, J. (2017). The nature and origins of misperceptions: Understanding false and unsupported beliefs about politics. *Political Psychology*, *38*, 127–150. https://doi.org/10.1111/pops.12394

Garrett, R. K. (2009). Echo chambers online?: Politically motivated selective exposure among Internet news users. *Journal of Computer-Mediated Communication*, *14*(2), 265–285. https://doi.org/10.1111/j.1083-6101.2009.01440.x

Gauchat, G. (2012). Politicization of science in the public sphere. *American Sociological Review*, *77*(2), 167–187. https://doi.org/10.1177/0003122412438225

*Gehlbach, H., Robinson, C. D., & Vriesema, C. C. (2019). Leveraging cognitive consistency to nudge conservative climate change beliefs. *Journal of Environmental Psychology, 61*, 134–137. https://doi.org/10.1016/j.jenvp.2018.12.004

Gillis, J., & Popovich, N. (2017, June 6). In Trump country, renewable energy is thriving. *The New York Times*. https://www.nytimes.com/2017/06/06/climate/renewable-energy-push-is-strongest-in-the-reddest-states.html

*Goldberg, M. H., Gustafson, A., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). A social identity approach to engaging Christians in the issue of climate change. *Science*

Communication, *41*(4), 442–463. https://doi.org/10.1177/1075547019860847

*Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., Gustafson, A., & Leiserowitz, A. (2019). The experience of consensus: Video as an effective medium to communicate scientific agreement on climate change. *Science Communication*, *41*(5), 659–673. https://doi.org/10.1177/1075547019874361

*Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). The role of anchoring in judgments about expert consensus. *Journal of Applied Social Psychology*, *49*(3), 192–200. https://doi.org/10.1111/jasp.12576

Graham, J., Haidt, J., & Nosek, B. a. (2009). Liberals and conservatives rely on different sets of moral foundations. *Journal of Personality and Social Psychology*, *96*(5), 1029–1046. https://doi.org/10.1037/a0015141

Graham, J., Nosek, B. a, Haidt, J., Iyer, R., Koleva, S., & Ditto, P. H. (2011). Mapping the moral domain. *Journal of Personality and Social Psychology*, *101*(2), 366–385. https://doi.org/10.1097/00005053-199107000-00016

*Guisinger, A., & Saunders, E. N. (2017). Mapping the boundaries of elite cues: How elites shape mass opinion across international issues. *International Studies Quarterly*, *61*(2), 425–441. https://doi.org/10.1093/isq/sqx022

Guy, S., Kashima, Y., Walker, I., & O'Neill, S. (2014). Investigating the effects of knowledge and ideology on climate change beliefs. *European Journal of Social Psychology*, *44*(5), 421–429. https://doi.org/10.1002/ejsp.2039

*Halperin, A., & Walton, P. (2018). The importance of place in communicating climate change to different facets of the American public. *Weather, Climate, and Society*, *10*, 291–305. https://doi.org/10.1175/WCAS-D-16-0119.1

Hardisty, D. J., Beall, A. T., Lubowski, R., Petsonk, A., & Romero-Canyas, R. (2019). A carbon price by another name may seem sweeter: Consumers prefer upstream offsets to downstream taxes. *Journal of Environmental Psychology*, *66*, 101342. https://doi.org/10.1016/j.jenvp.2019.101342

Hardisty, D. J., Johnson, E. J., & Weber, E. U. (2010). A dirty word or a dirty world?: Attribute framing, political affiliation, and query theory. *Psychological Science*, *21*(1), 86–92. https://doi.org/10.1177/0956797609355572

*Hardy, B. W., & Jamieson, K. H. (2017). Overcoming endpoint bias in climate change communication: The case of Arctic sea ice trends. *Environmental Communication*, *11*(2), 205–217. https://doi.org/10.1080/17524032.2016.1241814

Hart, P. S., & Feldman, L. (2018). Would it be better to not talk about climate change? The impact of climate change and air pollution frames on support for regulating power plant emissions. *Journal of Environmental Psychology*, *60*, 1–8. https://doi.org/10.1016/j.jenvp.2018.08.013

Hart, P. S., & Nisbet, E. C. (2012). Boomerang effects in science communication. *Communication Research*, *39*(6), 701–723. https://doi.org/10.1177/0093650211416646

Hart, W., Albarracín, D., Eagly, A. H., Brechan, I., Lindberg, M. J., & Merrill, L. (2009). Feeling validated versus being correct: A meta-analysis of selective exposure to information. *Psychological Bulletin*, *135*(4), 555–588. https://doi.org/10.1037/a0015701

Hauser, D. J., & Schwarz, N. (2016). Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants. *Behavior Research Methods*, *48*(1), 400–407. https://doi.org/10.3758/s13428-015-0578-z

Hedges, L. V. (1981). Distribution theory for Glass's estimator of effect size and related

estimators. *Journal of Educational Statistics*, *6*(2), 107. https://doi.org/10.2307/1164588

Hedges, L. V., Tipton, E., & Johnson, M. C. (2010). Robust variance estimation in meta-regression with dependent effect size estimates. *Research Synthesis Methods*, *1*(1), 39–65. https://doi.org/10.1002/jrsm.5

Hennes, E. P., Kim, T., & Remache, L. J. (2020). A goldilocks critique of the hot cognition perspective on climate change skepticism. *Current Opinion in Behavioral Sciences*, *34*, 142–147. https://doi.org/10.1016/j.cobeha.2020.03.009

Hess, D. J., Mai, Q. D., & Brown, K. P. (2016). Red states, green laws: Ideology and renewable energy legislation in the United States. *Energy Research & Social Science*, *11*, 19–28. https://doi.org/10.1016/j.erss.2015.08.007

Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change*, *6*, 622–626. https://doi.org/10.1038/nclimate2943

Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). Relationships among conspiratorial beliefs, conservatism and climate scepticism across nations. *Nature Climate Change*, *8*, 614–620. https://doi.org/10.1038/s41558-018-0157-2

Howe, P. D., Marlon, J. R., Mildenberger, M., & Shield, B. S. (2019). How will climate change shape climate opinion? *Environmental Research Letters*, *14*(11), 113001. https://doi.org/10.1088/1748-9326/ab466a

*Hu, S., Zheng, X., Zhang, N., & Zhu, J. (2018). The impact of mortality salience on intergenerational altruism and the perceived importance of sustainable development goals. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01399

IPCC. (2018). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D.

Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*. World Meteorological Organization.

*Jang, S. M. (2013). Framing responsibility in climate change discourse: Ethnocentric attribution bias, perceived causes, and policy attitudes. *Journal of Environmental Psychology, 36,* 27–36. https://doi.org/10.1016/j.jenvp.2013.07.003

Jenkins-Smith, H. C., Ripberger, J. T., Silva, C. L., Carlson, D. E., Gupta, K., Carlson, N., Ter-Mkrtchyan, A., & Dunlap, R. E. (2020). Partisan asymmetry in temporal stability of climate change beliefs. *Nature Climate Change*, *10,* 322–328. https://doi.org/10.1038/s41558-020-0719-y

*Joireman, J., Barnes Truelove, H., & Duell, B. (2010). Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *Journal of Environmental Psychology, 30*(4), 358–367. https://doi.org/10.1016/j.jenvp.2010.03.004

Jost, J. T., Glaser, J., Kruglanski, A. W., & Sulloway, F. J. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin*, *129*(3), 339–375. https://doi.org/10.1037/0033-2909.129.3.339

Kahan, D. (2010). Fixing the communications failure. *Nature*, *463*, 296–297. https://doi.org/10.1038/463296a

Kahan, D. (2017). The "Gateway Belief" illusion: reanalyzing the results of a scientific-consensus messaging study. *Journal of Science Communication*, *16*(05).

https://doi.org/10.22323/2.16050203

Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research*, *14*(2), 147–174. https://doi.org/10.1080/13669877.2010.511246

Kahan, D. M., Peters, E., Dawson, E. C., & Slovic, P. (2017). Motivated numeracy and enlightened self-government. *Behavioural Public Policy*, *1*(1), 54–86. https://doi.org/10.1017/bpp.2016.2

Karlin, B., Zinger, J. F., & Ford, R. (2015). The effects of feedback on energy conservation: A meta-analysis. *Psychological Bulletin*, *141*(6), 1205–1227. https://doi.org/10.1037/a0039650

Kees, J., Berry, C., Burton, S., & Sheehan, K. (2017). An analysis of data quality: Professional panels, student subject pools, and Amazon's Mechanical Turk. *Journal of Advertising*, *46*(1), 141–155. https://doi.org/10.1080/00913367.2016.1269304

Kerr, J. R., & Wilson, M. S. (2018). Perceptions of scientific consensus do not predict later beliefs about the reality of climate change: A test of the gateway belief model using cross-lagged panel analysis. *Journal of Environmental Psychology*, *59*, 107–110. https://doi.org/10.1016/j.jenvp.2018.08.012

Khanna, K., & Sood, G. (2018). Motivated responding in studies of factual learning. *Political Behavior*, *40*, 79–101. https://doi.org/10.1007/s11109-017-9395-7

*Kotcher, J., Maibach, E., Montoro, M., & Hassol, S. J. (2018). How Americans respond to information about global warming's health impacts: Evidence from a national survey experiment. *GeoHealth*, *2*(9), 262–275. https://doi.org/10.1029/2018GH000154

Kunda, Z. (1990). The case for motivated reasoning. *Psychological Bulletin*, *108*(3), 480–498.

https://doi.org/10.1037/0033-2909.108.3.480

Kyselá, E., Ščasný, M., & Zvěřinová, I. (2019). Attitudes toward climate change mitigation policies: A review of measures and a construct of policy attitudes. *Climate Policy*, *19*(7), 878–892. https://doi.org/10.1080/14693062.2019.1611534

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00863

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174. https://doi.org/10.2307/2529310

Leiserowitz, A., Maibach, E., Rosenthal, S., & Kotcher, J. (2019). *Climate change in the American mind: November, 2019*. New Haven, CT: Yale Project on Climate Change Communication. https://climatecommunication.yale.edu/wp-content/uploads/2019/12/Climate_Change_American_Mind_November_2019b.pdf

Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Bergquist, P., Gustafson, A., Ballew, M., & Goldberg, M. (2019). *Politics & global warming, November 2019*. New Haven, CT: Yale Project on Climate Change Communication. https://climatecommunication.yale.edu/wp-content/uploads/2020/01/politics-global-warming-november-2019b.pdf

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Cutler, M., & Rosenthal, S. (2017). *Trump voters & global warming*. New Haven, CT: Yale Project on Climate Change Communication. https://climatecommunication.yale.edu/publications/trump-voters-global-warming/

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Rosenthal, S. (2014). *Climate*

change in the American mind: April, 2014. New Haven, CT: Yale Project on Climate Change Communication. https://environment.yale.edu/climate-communication-OFF/files/Climate-Change-American-Mind-April-2014.pdf

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Rosenthal, S. (2015). *Climate change in the American Christian mind: March, 2015*. New Haven, CT: Yale Project on Climate Change Communication. https://environment.yale.edu/climate-communication-OFF/files/Global-Warming-Religion-March-2015.pdf

Levay, K. E., Freese, J., & Druckman, J. N. (2016). The demographic and political composition of Mechanical Turk samples. *SAGE Open*, *6*(1), 1–17. https://doi.org/10.1177/2158244016636433

Lewandowsky, S., & Oberauer, K. (2016). Motivated rejection of science. *Current Directions in Psychological Science*, *25*(4), 217–222. https://doi.org/10.1177/0963721416654436

Li, N., & Su, L. Y.-F. (2018). Message framing and climate change communication: A meta-analytical review. *Journal of Applied Communications, 102*(3). https://doi.org/10.4148/1051-0834.2189

Liu, J., Zhao, S., Chen, X., Falk, E., & Albarracín, D. (2017). The influence of peer behavior as a function of social and cultural closeness: A meta-analysis of normative influence on adolescent smoking initiation and continuation. *Psychological Bulletin*, *143*(10), 1082–1115. https://doi.org/10.1037/bul0000113

Luttrell, A., Petty, R. E., Briñol, P., & Wagner, B. C. (2016). Making it moral: Merely labeling an attitude as moral increases its strength. *Journal of Experimental Social Psychology, 65*, 82–93. https://doi.org/10.1016/j.jesp.2016.04.003

*Ma, Y., Dixon, G., & Hmielowski, J. D. (2019). Psychological reactance from reading basic

facts on climate change: The role of prior views and political identification. *Environmental Communication*, *13*(1), 71–86. https://doi.org/10.1080/17524032.2018.1548369

Maibach, E., Leiserowitz, A., Roser-Renouf, C., Myers, T., Rosenthal, S., & Feinberg, G. (2015). *The Francis effect: How Pope Francis changed the conversation about global warming*. https://doi.org/10.2139/ssrn.2695199

Maki, A., Burns, R. J., Ha, L., & Rothman, A. J. (2016). Paying people to protect the environment: A meta-analysis of financial incentive interventions to promote proenvironmental behaviors. *Journal of Environmental Psychology*, *47*, 242–255. https://doi.org/10.1016/j.jenvp.2016.07.006

Maki, A., Carrico, A. R., Raimi, K. T., Truelove, H. B., Araujo, B., & Yeung, K. L. (2019). Meta-analysis of pro-environmental behaviour spillover. *Nature Sustainability*, *2*, 307–315. https://doi.org/10.1038/s41893-019-0263-9

Mann, M. E., Hassol, S. J., & Toles, T. (2017, July 12). Doomsday scenarios are as harmful as climate change denial. *The Washington Post*. https://www.washingtonpost.com/opinions/doomsday-scenarios-are-as-harmful-as-climate-change-denial/2017/07/12/880ed002-6714-11e7-a1d7-9a32c91c6f40_story.html

*Manning, C., Mangas, H., Amel, E., Tang, H., Humes, L., Foo, R., Sidlova, V., & Cargos, K. (2018). Psychological distance and response to human versus non-human victims of climate change. In W. Leal Filho, R. W. Marans, & J. Callewaert (Eds.), *Handbook of Sustainability and Social Science Research* (pp. 143–161). Springer. https://doi.org/10.1007/978-3-319-67122-2_8

Markowitz, E. M., & Shariff, A. F. (2012). Climate change and moral judgement. *Nature*

Climate Change, *2*, 243–247. https://doi.org/10.1038/nclimate1378

McCright, A. M. (2009). The social bases of climate change knowledge, concern, and policy support in the U.S. general public. *Hofstra Law Review*, *37*(4), 1017–1048.

McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly*, *52*(2), 155–194. https://doi.org/10.1111/j.1533-8525.2011.01198.x

McCright, A. M., Dunlap, R. E., & Xiao, C. (2013). Perceived scientific agreement and support for government action on climate change in the USA. *Climatic Change*, *119*, 511–518. https://doi.org/10.1007/s10584-013-0704-9

McDonald, R. I., Chai, H. Y., & Newell, B. R. (2015). Personal experience and the 'psychological distance' of climate change: An integrative review. *Journal of Environmental Psychology*, *44*, 109–118. https://doi.org/10.1016/j.jenvp.2015.10.003

*Mildenberger, M., Lubell, M., & Hummel, M. (2019). Personalized risk messaging can reduce climate concerns. *Global Environmental Change*, *55*, 15–24. https://doi.org/10.1016/j.gloenvcha.2019.01.002

Mooney, C., Clement, S., & Mufson, S. (2014, November 19). There's a global warming generation gap in the GOP, like on the issue of gay marriage. *The Washington Post*. https://www.washingtonpost.com/news/wonk/wp/2014/11/19/the-polls-are-clear-younger-republicans-support-action-on-climate-change/?noredirect=on&utm_term=.74075e6ad005

Morgan, G. S., Skitka, L. J., & Wisneski, D. C. (2010). Moral and religious convictions and intentions to vote in the 2008 presidential election. *Analyses of Social Issues and Public Policy*, *10*(1), 307–320. https://doi.org/10.1111/j.1530-2415.2010.01204.x

Moser, S. C. (2010). Communicating climate change: History, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change*, *1*(1), 31–53. https://doi.org/10.1002/wcc.11

*Motta, M., Chapman, D., Stecula, D., & Haglin, K. (2019). An experimental examination of measurement disparities in public climate change beliefs. *Climatic Change*, *154*, 37–47. https://doi.org/10.1007/s10584-019-02406-9

*Myers, T. A., Maibach, E., Peters, E., & Leiserowitz, A. (2015). Simple messages help set the record straight about scientific agreement on human-caused climate change: The results of two experiments. *PLoS ONE*, *10*(3), e0120985. https://doi.org/10.1371/journal.pone.0120985

Nisbet, E. C., Cooper, K. E., & Garrett, R. K. (2015). The partisan brain: How dissonant science messages lead conservatives and liberals to (dis)trust science. *The ANNALS of the American Academy of Political and Social Science*, *658*(1), 36–66. https://doi.org/10.1177/0002716214555474

Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics*, *8*(2), 157. https://doi.org/10.2307/1164923

Osbaldiston, R., & Schott, J. P. (2012). Environmental sustainability and behavioral science: Meta-analysis of proenvironmental behavior experiments. *Environment and Behavior*, *44*(2), 257–299. https://doi.org/10.1177/0013916511402673

Palm, R., Lewis, G. B., & Feng, B. (2017). What causes people to change their opinion about climate change? *Annals of the American Association of Geographers*, *107*(4), 883–896. https://doi.org/10.1080/24694452.2016.1270193

Pearson, A. R., Schuldt, J. P., & Romero-Canyas, R. (2016). Social climate science: A new vista

for psychological science. *Perspectives on Psychological Science*, *11*(5), 632–650. https://doi.org/10.1177/1745691616639726

Pechar, E., Bernauer, T., & Mayer, F. (2018). Beyond political ideology: The impact of attitudes towards government and corporations on trust in science. *Science Communication*, *40*(3), 291–313. https://doi.org/10.1177/1075547018763970

Pew. (2016a, July 17). 2016 campaign: Strong interest, widespread dissatisfaction. *Pew Research Center*. https://www.people-press.org/2016/07/07/2016-campaign-strong-interest-widespread-dissatisfaction/

Pew. (2016b, October 4). The politics of climate. *Pew Research Center*. https://www.pewresearch.org/science/2016/10/04/the-politics-of-climate/

Pew. (2016c, December 8). Low approval of Trump's transition but outlook for his presidency improves. *Pew Research Center*. https://www.people-press.org/2016/12/08/low-approval-of-trumps-transition-but-outlook-for-his-presidency-improves/

Pew. (2018, March 20). Wide gender gap, growing educational divide in voters' party identification. *Pew Research Center*. https://www.people-press.org/2018/03/20/wide-gender-gap-growing-educational-divide-in-voters-party-identification/

Pew. (2020, February 13). As economic concerns recede, environmental protection rises on the public's policy agenda. *Pew Research Center*. https://www.people-press.org/2020/02/13/as-economic-concerns-recede-environmental-protection-rises-on-the-publics-policy-agenda/

*Porter, E., Wood, T. J., & Bahador, B. (2019). Can presidential misinformation on climate change be corrected? Evidence from Internet and phone experiments. *Research & Politics*, *6*(3), 1–10. https://doi.org/10.1177/2053168019864784

Pustejovsky, J. E. (2020). *clubSandwich: Cluster-robust (sandwich) variance estimators with small-sample corrections* (R package version 0.4.1). https://cran.r-project.org/package=clubSandwich

Ranney, M. A., & Clark, D. (2016). Climate change conceptual change: Scientific information can transform attitudes. *Topics in Cognitive Science*, *8*(1), 49–75. https://doi.org/10.1111/tops.12187

Reser, J. P., & Bradley, G. L. (2017). *Fear Appeals in Climate Change Communication* (Vol. 1). Oxford University Press. https://doi.org/10.1093/acrefore/9780190228620.013.386

*Risen, J. L., & Critcher, C. R. (2011). Visceral fit: While in a visceral state, associated states of the world seem more likely. *Journal of Personality and Social Psychology*, *100*(5), 777–793. https://doi.org/10.1037/a0022460

*Rode, J. B., Iqbal, S., & Ditto, P. H. (2019). [Unpublished data]. University of California, Irvine.

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, *86*(3), 638–641. https://doi.org/10.1037/0033-2909.86.3.638

Rozin, P. (1999). The process of moralization. *Psychological Science*, *10*(3), 218–221. https://doi.org/10.1111/1467-9280.00139

Ryan, T. J. (2017). No compromise: Political consequences of moralized attitudes. *American Journal of Political Science*, *61*(2), 409–423. https://doi.org/10.1111/ajps.12248

Scammacca, N., Roberts, G., & Stuebing, K. K. (2014). Meta-analysis with complex research designs: Dealing with dependence from multiple measures and multiple group comparisons. *Review of Educational Research*, *84*(3), 328–364. https://doi.org/10.3102/0034654313500826

*Schoenefeld, J. J., & McCauley, M. R. (2016). Local is not always better: The impact of climate information on values, behavior and policy support. *Journal of Environmental Studies and Sciences, 6*, 724–732. https://doi.org/10.1007/s13412-015-0288-y

Schuldt, J. P., Konrath, S. H., & Schwarz, N. (2011). "Global warming" or "climate change"?: Whether the planet is warming depends on question wording. *Public Opinion Quarterly, 75*(1), 115–124. https://doi.org/10.1093/poq/nfq073

*Schuldt, J. P., Pearson, A. R., Romero-Canyas, R., & Larson-Konar, D. (2017). Brief exposure to Pope Francis heightens moral beliefs about climate change. *Climatic Change, 141*, 167–177. https://doi.org/10.1007/s10584-016-1893-9

Schuldt, J. P., Rickard, L. N., & Yang, Z. J. (2018). Does reduced psychological distance increase climate engagement? On the limits of localizing climate change. *Journal of Environmental Psychology, 55*, 147–153. https://doi.org/10.1016/j.jenvp.2018.02.001

*Schuldt, J. P., & Roh, S. (2014). Of accessibility and applicability: How heat-related cues affect belief in "global warming" versus "climate change." *Social Cognition, 32*(3), 217–238. https://doi.org/10.1521/soco.2014.32.3.217

Sears, D. O. (1986). College sophomores in the laboratory: Influences of a narrow data base on social psychology's view of human nature. *Journal of Personality and Social Psychology, 51*(3), 515–530. https://doi.org/10.1037/0022-3514.51.3.515

*Shin, F., & Preston, J. L. (2019). Green as the gospel: The power of stewardship messages to improve climate change attitudes. *Psychology of Religion and Spirituality*. Advance online publication. https://doi.org/10.1037/rel0000249

Singh, A. S., Zwickle, A., Bruskotter, J. T., & Wilson, R. (2017). The perceived psychological distance of climate change impacts and its influence on support for adaptation policy.

Environmental Science & Policy, *73*, 93–99. https://doi.org/10.1016/j.envsci.2017.04.011

*Singh, S. P., & Swanson, M. (2017). How issue frames shape beliefs about the importance of climate change policy across ideological and partisan groups. *PLoS ONE*, *12*(7), e0181401. https://doi.org/10.1371/journal.pone.0181401

*Skurka, Chris, Niederdeppe, J., & Nabi, R. (2019). Kimmel on climate: Disentangling the emotional ingredients of a satirical monologue. *Science Communication*, *41*(4), 394–421. https://doi.org/10.1177/1075547019853837

*Skurka, Christofer, Niederdeppe, J., Romero-Canyas, R., & Acup, D. (2018). Pathways of influence in emotional appeals: Benefits and tradeoffs of using fear or humor to promote climate change-related intentions and risk perceptions. *Journal of Communication*, *68*(1), 169–193. https://doi.org/10.1093/joc/jqx008

Smith, N., & Leiserowitz, A. (2013). American evangelicals and global warming. *Global Environmental Change*, *23*(5), 1009–1017. https://doi.org/10.1016/j.gloenvcha.2013.04.001

Smith, N., & Leiserowitz, A. (2014). The role of emotion in global warming policy support and opposition. *Risk Analysis*, *34*(5), 937–948. https://doi.org/10.1111/risa.12140

*Sparks, A. (2017). *Reducing distance to increase action: How psychological proximity drives activism* [Doctoral dissertation, University of California, Santa Barbara]. https://escholarship.org/uc/item/7nq534jf

Spence, A., & Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change*, *20*(4), 656–667. https://doi.org/10.1016/j.gloenvcha.2010.07.002

Sterne, J. A. C., & Egger, M. (2005). Regression methods to detect publication and other bias in

meta-analysis. In H. R. Rothstein, A. J. Sutton, & M. Borenstein (Eds.), *Publication bias in meta-analysis: Prevention, assessment, and adjustments* (pp. 99–110). Wiley.

*Stroik, P., Chakraborty, D., Ge, W., Boulter, J., & Jamelske, E. (2019). Effect of reciprocity on public opinion of international climate treaties: Experimental evidence from the US and China. *Climate Policy*, *19*(8), 959–973. https://doi.org/10.1080/14693062.2019.1617666

*Stroik, P., & Jamelske, E. (2017). [Unpublished data]. University of Wisconsin-Eau Claire.

Stroud, N. J. (2010). Polarization and partisan selective exposure. *Journal of Communication*, *60*(3), 556–576. https://doi.org/10.1111/j.1460-2466.2010.01497.x

Suldovsky, B. (2017). The information deficit model and climate change communication. In *Oxford Research Encyclopedia of Climate Science*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190228620.013.301

Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science*, *50*(3), 755–769. https://doi.org/10.1111/j.1540-5907.2006.00214.x

Tannenbaum, M. B., Hepler, J., Zimmerman, R. S., Saul, L., Jacobs, S., Wilson, K., & Albarracín, D. (2015). Appealing to fear: A meta-analysis of fear appeal effectiveness and theories. *Psychological Bulletin*, *141*(6), 1178–1204. https://doi.org/10.1037/a0039729

Tanner-Smith, E. E., & Tipton, E. (2014). Robust variance estimation with dependent effect sizes: Practical considerations including a software tutorial in Stata and SPSS. *Research Synthesis Methods*, *5*(1), 13–30. https://doi.org/10.1002/jrsm.1091

Tanner-Smith, E. E., Tipton, E., & Polanin, J. R. (2016). Handling complex meta-analytic data structures using robust variance estimates: A tutorial in R. *Journal of Developmental and*

Life-Course Criminology, *2*, 85–112. https://doi.org/10.1007/s40865-016-0026-5

*Tesler, M. (2018). Elite domination of public doubts about climate change (not evolution). *Political Communication*, *35*(2), 306–326. https://doi.org/10.1080/10584609.2017.1380092

Tipton, E. (2015). Small sample adjustments for robust variance estimation with meta-regression. *Psychological Methods*, *20*(3), 375–393. https://doi.org/10.1037/met0000011

Tipton, E., & Pustejovsky, J. E. (2015). Small-sample adjustments for tests of moderators and model fit using robust variance estimation in meta-regression. *Journal of Educational and Behavioral Statistics*, *40*(6), 604–634. https://doi.org/10.3102/1076998615606099

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, *117*(2), 440–463. https://doi.org/10.1037/a0018963

*Truelove, H. B., Yeung, K. L., Carrico, A. R., Gillis, A. J., & Raimi, K. T. (2016). From plastic bottle recycling to policy support: An experimental test of pro-environmental spillover. *Journal of Environmental Psychology*, *46*, 55–66. https://doi.org/10.1016/j.jenvp.2016.03.004

*van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: Plain facts, pie charts or metaphors? *Climatic Change*, *126*, 255–262. https://doi.org/10.1007/s10584-014-1190-4

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS ONE*, *10*(2), e0118489. https://doi.org/10.1371/journal.pone.0118489

van der Linden, S., Leiserowitz, A., & Maibach, E. (2017). Gateway illusion or cultural cognition confusion? *Journal of Science Communication*, *16*(05).

https://doi.org/10.22323/2.16050204

van der Linden, S., Leiserowitz, A., & Maibach, E. (2018). Perceptions of scientific consensus predict later beliefs about the reality of climate change using cross-lagged panel analysis: A response to Kerr and Wilson (2018). *Journal of Environmental Psychology, 60*, 110–111. https://doi.org/10.1016/j.jenvp.2018.10.002

*van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology*, *62*, 49–58. https://doi.org/10.1016/j.jenvp.2019.01.009

van der Linden, S., Maibach, E., & Leiserowitz, A. (2019). Exposure to scientific consensus does not cause psychological reactance. *Environmental Communication*, 1–8. https://doi.org/10.1080/17524032.2019.1617763

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*(3). https://doi.org/10.18637/jss.v036.i03

Wallace-Wells, D. (2017, July). The uninhabitable Earth. *New York Magazine*. https://nymag.com/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html

Washburn, A. N., & Skitka, L. J. (2018). Science denial across the political divide: Liberals and conservatives are similarly motivated to deny attitude-inconsistent science. *Social Psychological and Personality Science*, *9*(8), 972–980. https://doi.org/10.1177/1948550617731500

*Watkins, H. M., & Goodwin, G. P. (2019). Reflecting on sacrifices made by past generations increases a sense of obligation towards future generations. *Personality and Social Psychology Bulletin*. Advance online publication. https://doi.org/10.1177/0146167219883610

Weber, E. U. (2016). What shapes perceptions of climate change? New research since 2010. *Wiley Interdisciplinary Reviews: Climate Change*, *7*(1), 125–134. https://doi.org/10.1002/wcc.377

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist*, *66*(4), 315–328. https://doi.org/10.1037/a0023253

Wetherell, G. A., Brandt, M. J., & Reyna, C. (2013). Discrimination across the ideological divide: The role of value violations and abstract values in discrimination by liberals and conservatives. *Social Psychological and Personality Science*, *4*(6), 658–667. https://doi.org/10.1177/1948550613476096

Wilson, D. B. (n.d.). *Practical meta-analysis effect size calculator* [Online calculator].

Witte, K., & Allen, M. (2000). A Meta-Analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior*, *27*(5), 591–615. https://doi.org/10.1177/109019810002700506

*Wolske, K. S., Raimi, K. T., Campbell-Arvai, V., & Hart, P. S. (2019). Public support for carbon dioxide removal strategies: The role of tampering with nature perceptions. *Climatic Change*, *152*, 345–361. https://doi.org/10.1007/s10584-019-02375-z

Wolsko, C. (2017). Expanding the range of environmental values: Political orientation, moral foundations, and the common ingroup. *Journal of Environmental Psychology*, *51*, 284–294. https://doi.org/10.1016/j.jenvp.2017.04.005

Wolsko, C., Ariceaga, H., & Seiden, J. (2016). Red, white, and blue enough to be green: Effects of moral framing on climate change attitudes and conservation behaviors. *Journal of Experimental Social Psychology*, *65*, 7–19. https://doi.org/10.1016/j.jesp.2016.02.005

*Wong-Parodi, G., & Fischhoff, B. (2015). The impacts of political cues and practical

information on climate change decisions. *Environmental Research Letters*, *10*(3), 034004. https://doi.org/10.1088/1748-9326/10/3/034004

Xu, X., Arpan, L. M., & Chen, C. (2015). The moderating role of individual differences in responses to benefit and temporal framing of messages promoting residential energy saving. *Journal of Environmental Psychology*, *44*, 95–108. https://doi.org/10.1016/j.jenvp.2015.09.004

*Zaval, L., Markowitz, E. M., & Weber, E. U. (2015). How will I be remembered? Conserving the environment for the sake of one's legacy. *Psychological Science*, *26*(2), 231–236. https://doi.org/10.1177/0956797614561266

*Zhou, J. (2016). Boomerangs versus javelins: How polarization constrains communication on climate change. *Environmental Politics*, *25*(5), 788–811. https://doi.org/10.1080/09644016.2016.1166602

APPENDIX A

Initial study

We conducted a related study with the intention of manipulating article interest in order to influence climate change attitudes. Participants were randomly assigned to read an article about the effects of beer or bread on climate change, and both articles contained consensus information at the end. A few days after taking the initial survey (which included beliefs about climate change and global warming) and reading the article, participants responded to the same items and answered questions to test their memory of the initial article. Unexpectedly, participants reported similar amounts of interest in the beer (M = 5.51) and bread (M = 5.12) articles, $t(345) = 1.58$, $p = .12$, $d = 0.17$. We also found that participants' interest in the article was significantly correlated with global warming at time 2 ($r = .30$, $p < .001$) and memory score ($r = .35$, $p < .001$). We switched the focus of our investigation away from memory and towards manipulating the consensus information in the articles, leading to the first study of the main text.

Study 1 Results with All Conditions

Table A1

Linear regressions using all experimental conditions

	Perceived consensus *b* (95% CI)	Belief *b* (95% CI)	Risk *b* (95% CI)	Impact *b* (95% CI)	Support for action *b* (95% CI)
Intercept	79.54*** (76.65, 82.43)	5.83*** (5.67, 5.99)	5.47*** (5.25, 5.69)	5.73*** (5.57, 5.90)	6.43*** (6.24, 6.62)
Beer article with consensus	7.35*** (3.21, 11.50)	0.24* (0.02, 0.47)	0.31 (-0.01, 0.62)	0.24* (0.003, 0.47)	0.18 (-0.09, 0.45)
Beer article no consensus	1.34 (-2.81, 5.49)	0.11 (-0.11, 0.34)	0.23 (-0.09, 0.55)	0.25* (0.01, 0.49)	0.06 (-0.21, 0.33)
Tree article with consensus	8.31*** (4.13, 12.48)	0.28* (0.06, 0.51)	0.40* (0.08, 0.72)	0.32** (0.09, 0.56)	0.20 (-0.07, 0.48)
Tree article no consensus	5.33* (1.13, 9.53)	0.18 (-0.05, 0.40)	0.42* (0.10, 0.74)	0.31* (0.07, 0.55)	0.09 (-0.18, 0.37)
N	471	472	472	472	472
R_2	0.05	0.02	0.02	0.02	0.01
F	5.89***	1.91	2.16	2.38	0.74

Note. Because the condition variables were dummy coded, the intercept represents the mean of the control condition and the unstandardized coefficients represent the differences between each experimental group and the control condition.
*$p < .05$. **$p < .01$. ***$p < .001$.

Regressions with Robust Standard Errors

We employed heteroskedasticity-consistent estimators to compute standard errors using the *sandwich* package (Zeileis, 2004) in R.[29] For each study, the following regression tables show the main effects (experimental condition only) and the interaction effects (experimental condition moderated by conservatism) with robust standard errors.

Study 1

Table A2

Linear regressions using robust standard errors, Study 1

	Perceived consensus	Belief	Risk	Impact	Support for action
	b (SE)	*b* (SE)	*b* (SE)	*b* (SE)	*b* (SE)
Intercept	79.54***	5.83***	5.47***	5.73***	6.43***
	(1.59)	(0.09)	(0.12)	(0.10)	(0.11)
Article without consensus	3.29	0.14	0.32*	0.28*	0.08
	(1.96)	(0.11)	(0.14)	(0.11)	(0.13)
Article with consensus	7.82***	0.26**	0.35*	0.28*	0.19
	(1.87)	(0.10)	(0.14)	(0.11)	(0.13)
N	471	472	472	472	472
R^2	0.04	0.02	0.01	0.02	0.01

Note. Because the condition variables were dummy coded, the intercept represents the mean of the control condition and the unstandardized coefficients represent the differences between each experimental group and the control condition.
*$p < .05$. **$p < .01$. ***$p < .001$.

[29] This is different than in our Study 3 preregistration, where we inadvertently said we would use the *clubSandwich* package (Pustejovsky, 2020) to compute robust standard errors.

Table A3

Linear regressions for the interaction between condition and ideology using robust standard errors, Study 1

	Perceived consensus *b* (SE)	Belief *b* (SE)	Risk *b* (SE)	Impact *b* (SE)	Support for action *b* (SE)
Intercept	80.36***	5.89***	5.51***	5.81***	6.53***

	(1.64)	(0.08)	(0.12)	(0.09)	(0.10)
Article without consensus	2.58	0.09	0.30*	0.21	-0.02
	(1.98)	(0.10)	(0.15)	(0.11)	(0.12)
Article with consensus	6.76***	0.17	0.28	0.18	0.08
	(1.93)	(0.10)	(0.15)	(0.11)	(0.12)
Conservatism	-1.60	-0.15*	-0.16	-0.19*	-0.19*
	(1.27)	(0.07)	(0.10)	(0.08)	(0.09)
Conservatism*No consensus	-1.61	-0.04	-0.19	-0.02	-0.04
	(1.54)	(0.09)	(0.12)	(0.09)	(0.11)
Conservatism*Consensus	0.25	-0.09	-0.17	-0.04	0.04
	(1.53)	(0.09)	(0.12)	(0.10)	(0.10)
N	461	462	462	462	462
R_2	0.08	0.12	0.14	0.13	0.08

Note. Because the condition variables were dummy coded and conservatism was mean centered, the intercept represents the mean of the control condition for those with average conservatism.
*$p < .05$. **$p < .01$. ***$p < .001$.

Study 2

Table A4

Linear regressions using robust standard errors, Study 2

	Perceived consensus *b* (SE)	Belief *b* (SE)	Risk *b* (SE)	Impact *b* (SE)	Support for action *b* (SE)
Intercept	88.87***	6.06***	5.15***	5.01***	6.10***
	(1.13)	(0.07)	(0.10)	(0.10)	(0.08)
Article without consensus	-1.41	-0.18	-0.18	-0.26	-0.29*
	(1.65)	(0.10)	(0.14)	(0.14)	(0.13)
Article with consensus	4.76***	0.08	0.08	0.01	-0.02
	(1.34)	(0.10)	(0.14)	(0.14)	(0.12)
N	926	902	912	906	912

R_2	0.02	0.01	0.004	0.01	0.01

Note. Because the condition variables were dummy coded, the intercept represents the mean of the control condition and the unstandardized coefficients represent the differences between each experimental group and the control condition.
*p < .05. **p < .01. ***p < .001.

Table A5

Linear regressions for the interaction between condition and ideology using robust standard errors, Study 2

	Perceived consensus *b* (SE)	Belief *b* (SE)	Risk *b* (SE)	Impact *b* (SE)	Support for action *b* (SE)
Intercept	90.14***	6.17***	5.27***	5.14***	6.22***
	(1.05)	(0.05)	(0.08)	(0.08)	(0.07)
Article without consensus	0.36	-0.01	0.08	0.01	-0.08
	(1.39)	(0.07)	(0.11)	(0.11)	(0.09)
Article with consensus	3.45**	0.11	0.10	0.04	0.04
	(1.33)	(0.08)	(0.11)	(0.12)	(0.10)
Conservatism	-4.56***	-0.49***	-0.65***	-0.64***	-0.58***
	(0.97)	(0.05)	(0.06)	(0.06)	(0.06)
Conservatism*No consensus	-1.24	-0.08	-0.11	-0.07	-0.11
	(1.33)	(0.06)	(0.08)	(0.08)	(0.09)
Conservatism*Consensus	2.59*	0.08	0.05	0.07	0.11
	(1.13)	(0.07)	(0.08)	(0.08)	(0.08)
N	741	720	730	724	730

R^2	0.20	0.51	0.46	0.40	0.46

Note. Because the condition variables were dummy coded and conservatism was mean centered, the intercept represents the mean of the control condition for those with average conservatism.
*$p < .05$. **$p < .01$. ***$p < .001$.

Study 3

Table A6

Linear regressions using robust standard errors, Study 3

	Perceived consensus *b* (SE)	Perceived consensus Likert *b* (SE)	Belief *b* (SE)	Impact *b* (SE)	Support for action *b* (SE)
Intercept	80.92***	5.87***	5.04***	5.16***	5.34***
	(1.02)	(0.06)	(0.07)	(0.07)	(0.10)
Article without consensus	-0.06	-0.04	0.09	0.04	0.18
	(1.44)	(0.09)	(0.11)	(0.10)	(0.14)
Article with consensus	3.65**	0.11	0.12	-0.05	0.18
	(1.40)	(0.09)	(0.11)	(0.11)	(0.14)
Statement only	5.18***	0.15	0.04	-0.07	0.03
	(1.41)	(0.10)	(0.11)	(0.11)	(0.15)
N	1,047	1,048	1,048	1,047	1,047
R^2	0.02	0.005	0.001	0.001	0.003

Note. Because the condition variables were dummy coded, the intercept represents the mean of the control condition and the unstandardized coefficients represent the differences between each experimental group and the control condition.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table A7

Linear regressions for the interaction between condition and ideology using robust standard errors, Study 3

	Perceived consensus *b* (SE)	Perceived consensus Likert *b* (SE)	Belief *b* (SE)	Impact *b* (SE)	Support for action *b* (SE)
Intercept	81.05***	5.88***	5.06***	5.16***	5.37***

	(0.99)	(0.06)	(0.06)	(0.07)	(0.09)
Article without consensus	-0.02	-0.04	0.09	0.04	0.16
	(1.41)	(0.09)	(0.10)	(0.10)	(0.13)
Article with consensus	3.25*	0.08	0.05	-0.08	0.11
	(1.37)	(0.09)	(0.09)	(0.11)	(0.13)
Statement only	5.10***	0.14	0.03	-0.07	0.01
	(1.37)	(0.09)	(0.09)	(0.10)	(0.13)
Conservatism	-2.14***	-0.18***	-0.31***	-0.17***	-0.35***
	(0.53)	(0.03)	(0.03)	(0.04)	(0.04)
Conserv.*No consensus	0.68	0.03	0.06	0.04	0.10
	(0.73)	(0.05)	(0.05)	(0.05)	(0.06)
Conserv.*Consensus	-0.20	-0.01	-0.09	-0.06	-0.05
	(0.68)	(0.04)	(0.05)	(0.06)	(0.06)
Conserv.*Statement	0.10	0.02	-0.04	-0.004	0.01
	(0.66)	(0.05)	(0.05)	(0.05)	(0.07)
N	1,044	1,045	1,045	1,045	1,045
R^2	0.08	0.09	0.27	0.08	0.17

Note. Because the condition variables were dummy coded and conservatism was mean centered, the intercept represents the mean of the control condition for those with average conservatism.
*$p < .05$. **$p < .01$. ***$p < .001$.

Moderation by Political Party

Study 2

Table A8

Linear regressions for the interaction between condition and political party, Study 2

	Perceived consensus *b* (95% CI)	Belief *b* (95% CI)	Risk *b* (95% CI)	Impact *b* (95% CI)	Support for action *b* (95% CI)
Intercept	94.71*** (91.75, 97.68)	6.67*** (6.52, 6.82)	5.83*** (5.61, 6.04)	5.77*** (5.55, 5.98)	6.78*** (6.58, 6.97)
Article without consensus	0.04 (-4.44, 4.51)	0.02 (-0.20, 0.25)	0.19 (-0.13, 0.52)	-0.03 (-0.35, 0.30)	0.05 (-0.24, 0.34)
Article with consensus	1.14 (-3.10, 5.38)	0.01 (-0.20, 0.22)	0.22 (-0.09, 0.53)	0.11 (-0.20, 0.42)	0.02 (-0.25, 0.30)
Republican	-21.17***	-2.15***	-2.55***	-2.70***	-2.49***

	(-26.40, -15.95)	(-2.41, -1.89)	(-2.93, -2.17)	(-3.08, -2.31)	(-2.83, -2.15)
Rep.*No consensus	3.06	-0.04	-0.30	-0.07	-0.30
	(-4.31, 10.43)	(-0.41, 0.33)	(-0.83, 0.23)	(-0.61, 0.47)	(-0.78, 0.18)
Rep.*Consensus	13.07***	0.27	-0.25	-0.24	-0.05
	(5.66, 20.47)	(-0.10, 0.65)	(-0.79, 0.28)	(-0.78, 0.30)	(-0.53, 0.44)
N	565	551	557	555	557
R_2	0.19	0.57	0.52	0.53	0.55
F	26.38***	145.83***	121.29***	125.87***	136.74***

Note. Because the condition variables and political party (Democrats as base) were dummy coded, the intercept represents the mean of the control condition for Democrats.
*$p < .05$. **$p < .01$. ***$p < .001$.

Study 3

Table A9

Linear regressions for the interaction between condition and political party, Study 3

	Perceived consensus *b* (95% CI)	Perceived consensus Likert *b* (95% CI)	Belief *b* (95% CI)	Impact *b* (95% CI)	Support for action *b* (95% CI)
Intercept	83.29*** (80.55, 86.03)	6.09*** (5.90, 6.27)	5.57*** (5.37, 5.78)	5.53*** (5.33, 5.74)	5.84*** (5.57, 6.11)
Article without consensus	-0.68 (-4.41, 3.04)	-0.08 (-0.33, 0.18)	-0.21 (-0.48, 0.07)	-0.09 (-0.38, 0.19)	-0.06 (-0.43, 0.30)
Article with consensus	3.72 (-0.03, 7.48)	0.14 (-0.12, 0.40)	0.01 (-0.27, 0.29)	-0.05 (-0.33, 0.24)	0.07 (-0.30, 0.44)
Statement only	2.81 (-0.88, 6.51)	0.04 (-0.22, 0.29)	-0.12 (-0.40, 0.16)	-0.15 (-0.43, 0.13)	-0.22 (-0.59, 0.14)
Republican	-5.59** (-9.56, -1.62)	-0.49*** (-0.76, -0.22)	-1.09*** (-1.39, -0.80)	-0.67*** (-0.97, -0.37)	-1.00*** (-1.39, -0.61)
Rep.*No consensus	1.31 (-4.38, 7.00)	0.02 (-0.37, 0.41)	0.39 (-0.03, 0.82)	0.12 (-0.31, 0.55)	0.28 (-0.28, 0.84)
Rep.*Consensus	-0.38 (-6.06, 5.30)	-0.09 (-0.47, 0.30)	0.005 (-0.42, 0.43)	-0.24 (-0.67, 0.19)	0.02 (-0.54, 0.58)
Rep.*Statement	4.65 (-1.05, 10.36)	0.14 (-0.26, 0.53)	0.03 (-0.39, 0.46)	-0.16 (-0.59, 0.27)	0.23 (-0.33, 0.79)

N	977	977	977	977	977
R_2	0.04	0.05	0.15	0.09	0.07
F	5.72***	7.34***	24.13***	13.52***	10.98***

Note. Because the condition variables and political party (Democrats as base) were dummy coded, the intercept represents the mean of the control condition for Democrats.
*$p < .05$. **$p < .01$. ***$p < .001$.

Mediation Via Perceived Consensus

Study 1

Central to the GBM is the pathway by which perceived consensus leads to increased belief in climate change and other climate change attitudes. Although we cannot directly test the GBM—which requires pre-post data—we tested for mediation between consensus message and climate change attitudes through perceived consensus. To do so, we used the *mediation* package in R (Tingley et al., 2014) and calculated the indirect effect of consensus message (article with consensus compared to control) on climate change attitudes via perceived consensus, running 10,000 simulations with bias-corrected and accelerated (BCa) bootstrapped 95% confidence intervals. Through perceived consensus, the consensus article had a significant, positive indirect effect on climate change belief (0.14, [0.07, 0.24], $p < .001$), risk (0.18, [0.09, 0.30], $p < .001$), impact (0.11, [0.05, 0.19], $p < .001$), and support for action (0.10, [0.04, 0.22], $p < .001$). The results suggest that perceived consensus is a key mechanism by which the consensus article increased downstream climate change attitudes; without a pre-post design, however, the mediation is only suggestive, rather than direct, evidence for the GBM.

Study 2

Mediated Moderation Via Perceived Consensus

Because of the significant moderation of political ideology on the relation between condition and perceived consensus, we ran a series of moderated mediation models (using the *mediation* package; Tingley et al., 2014). We calculated the indirect effect of consensus message (article with consensus compared to control) on climate change attitudes via perceived consensus separately for liberals (score of 2 on ideology) and conservatives (score of 6 on ideology), running 10,000 simulations with BCa bootstrapped 95% confidence intervals. For conservative

participants, there was a significant indirect effect of consensus message on climate change attitudes through perceived consensus for belief in climate change (0.28, [0.07, 0.51], p = .01), risk (0.31, [0.09, 0.59], p = .01), impact (0.24, [0.07, 0.47], p = .01), and support for action (0.30, [0.09, 0.58], p = .01). For liberals, none of the indirect effects were significant: belief (0.03, [-0.01, 0.07], p = .14), risk (0.02, [-0.02, 0.07], p = .26), impact (0.02, [-0.01, 0.05], p = 0.26), and support for action (0.02, [-0.02, 0.06], p = .26).

Study 3

We ran the same mediation models in Study 3, although we ran models for both the 0 to 100 and Likert scale perceived consensus variables. For the 0 to 100 variable, perceived consensus was a significant mediator for belief (0.15, [0.04, 0.26], p = .01), impact (0.10, [0.02, 0.18], p = .01), and support for action (0.15, [0.04, 0.27], p = .01). For the Likert variable, perceived consensus was not a significant mediator for belief (0.08, [-0.05, 0.20], p = .23), impact (0.06, [-0.04, 0.15], p = .23), or support for action (0.08, [-0.05, 0.19], p = .23).

References

Pustejovsky, J. E. (2020). *clubSandwich: Cluster-robust (sandwich) variance estimators with small-sample corrections* (R package version 0.4.1). https://cran.r-project.org/package=clubSandwich

Tingley, D., Yamamoto, T., Hirose, K., Keele, L., & Imai, K. (2014). mediation: R package for causal mediation analysis. *Journal of Statistical Software*, *59*(5), 1–38.

Zeileis, A. (2004). Econometric computing with HC and HAC covariance matrix estimators. *Journal of Statistical Software, 11*(10). https://doi.org/10.18637/jss.v011.i10

APPENDIX B

Abstract screening tool

For all questions below, answer “yes”, “no”, or “maybe/unsure”.

Any question answered “no” is excluded.
Do not answer any further questions after the first “no”.

Primary Research:
Is the abstract an original study (e.g., not a review, meta-analysis, or secondary data analysis)?

2. **Language**:
Is the abstract written in English?

3. **Location***:
Does the study use participants from the United States?

4. **Participant age**:
Are the participants adults (i.e., over 18 years old)?

5. **True experiment**:
Does the study use random assignment to different conditions?

6. **Outcome**:
Does the study seem to measure something related to climate change attitudes (error on the side of unsure if there’s any doubt)?

Keep (all “yes” or “maybe/unsure” answers) or Drop (at least one “no” answer)

*For non-US samples, mark the title and authors for future reference if the meta is expanded

Coding protocol

Q1. What is the article ID number? (from list of included studies) (id)

Q2. What is the first author’s last name? (author)

Q3. What is the experiment ID number? (exp.id)

Q4. What is the dependent variable ID number? (dv.id)

Q5. What is the effect size ID number? (es.id)

Q6. What was the year of appearance of the report or publication? (year)

Q7. If the authors reported the exact dates of data collection, what year did they collect them in? (year.collected)

Q8. What type of report? (pubtype)
journal article
book chapter
dissertation
MA thesis
private report
government report
conference paper
other (specify_____)

Q9. Describe each condition (including the control condition) in the experiment. What did participants do in each condition? (conditions.open)

Q10. What information was presented in the control condition? (control.type)
No information
Information or a task unrelated to climate change/global warming
Information or a task related to the environment but not climate change/global warming
A statement about climate change/global warming
Other (specify_____)

Q11. How was politics measured? Select all that apply (separate by semi-colons). (politics)
Liberal/Conservative – categorical
Liberal/Conservative – continuous
Democrat/Republican – categorical
Democrat/Republican – continuous
Other (specify_____)

Q12. How was the sample collected? (setting)
In-person
Online
Unclear/not reported

Q13. Was it a simple random sample (or a probability sample)? (random) *Note: this will nearly always be "No". If it's yes, the authors will usually be pretty clear about it.*
Yes
No
Unclear (describe_____)

Q14. Was the sample nationally representative? (representative). *Note: they will usually mention this in the methods section if it is representative.*
Yes
No
Unclear/not reported

Q15. What type of sample was it? (sample.type)
College student
Amazon Mechanical Turk (Mturk)
YouGov
Qualtrics panel
Other (specify _____)

Q16. What proportion of the sample was female (in decimals)? (prop.female)

Q17. What was the average age of the sample? (age)

Q18. What proportion of the sample was white (in decimals)? (prop.white)

Q19. What category is this treatment condition? Select all that apply. (condition)
Morality
Emotion
General information about the effects of climate change/global warming
Scientific information
Scientific consensus
Psychological distance
Other (specify_____)

Q19. Describe more about the type of condition (e.g., morality was framed in terms of purity, a fear emotion was evoked, etc.) (condition.subtype)

Q20. What specifically did the participants do in this condition? (condition.desc)

Q21. What is the dependent variable? (dv.type)
Belief in natural climate change/global warming
Belief in anthropogenic (human-caused) climate change/global warming
Concern/worry about climate change/global warming
Risk/threat of climate change/global warming
Predicted impacts of climate change/global warming
Support for a climate change policy (specify_____)
Support for renewable energy
Other (specify_____)

Q22. Was the dependent variable about climate change or global warming? (cc.gw)
Climate change
Global warming
Phrasing included both
Neither

Q23. What is the Cohen's *d* (treatment condition – control)? (d)

Q24. What is the variance of Cohen's *d*? (v)

Q25. How did you calculate this effect size? (calc.method)

Q26. On which page(s) did you find the numbers for the effect size? (pages)

Q27. If you could not calculate the effect size, why couldn't you? Did you have partial information about it? (missing.info)

Q28. Do we need to email the authors? (email)
Yes
No

Q29. If we need to email the authors, what do we need to ask for to calculate this effect size? (email.open)

Q30. Whether the intervention was aiming to positively influence climate change attitudes. (intervention.direction)
Positive (1)
Balanced (0)
Negative (-1)

Q31. How was the intervention carried out/manipulated? Select all that apply. (medium.type)
Video
Text
Image or map
Other (Specify_____)

APPENDIX C

Table C1

Effect sizes and Moderator Scores for All Studies

Paper	Study	*g*	*v*	Intervention direction	Condition category	DV category	DV phrasing	Medium
Ma et al. (2019)	Study 1	0.13	0.01	Positive	General CC Info	Belief in ACC	Climate change	Text
	Study 1	0.02	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.12	0.01	Positive	General CC Info	Risk	Climate change	Text
	Study 1	0.11	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	0.01	0.01	Positive	General CC Info	Policy Support	Climate change	Text
	Study 1	0.08	0.01	Positive	Consensus	Policy Support	Climate change	Text
Brewer & McKnight, (2015)	Study 1	0.31	0.02	Positive	Emotion	Belief in natural CC	Global warming	Video
	Study 1	0.26	0.01	Positive	Emotion	Belief in natural CC	Global warming	Video
Chu & Yang (2018)	Study 1	0.08	0.01	Positive	Psych. Dist. Near	Risk	Climate change	Video
	Study 1	0.10	0.01	Positive	Psych. Dist. Near	Risk	Climate change	Video
	Study 1	0.04	0.01	Positive	Psych. Dist. Far	Risk	Climate change	Video
	Study 1	-0.09	0.01	Positive	Psych. Dist. Far	Risk	Climate change	Video
	Study 1	0.08	0.01	Positive	Psych. Dist. Near	Policy Support	Climate change	Video
	Study 1	0.16	0.01	Positive	Psych. Dist. Near	Policy Support	Climate change	Video
	Study 1	0.00	0.01	Positive	Psych. Dist. Far	Policy Support	Climate change	Video
	Study 1	-0.05	0.01	Positive	Psych. Dist. Far	Policy Support	Climate change	Video
	Study 1	0.07	0.01	Positive	Psych. Dist. Near	Concern	Climate change	Video
	Study 1	0.09	0.01	Positive	Psych. Dist. Near	Concern	Climate change	Video
	Study 1	0.10	0.01	Positive	Psych. Dist. Far	Concern	Climate change	Video
	Study 1	-0.05	0.01	Positive	Psych. Dist. Far	Concern	Climate change	Video
Hu et al. (2018)	Study 1	-0.26	0.02	Positive	Other	Policy Support	Climate change	Other
Anderson & Becker (2018)	Study 1	0.24	0.05	Positive	Emotion	Risk	Global warming	Video
	Study 1	-0.16	0.04	Balanced	Emotion	Risk	Global warming	Video
	Study 1	-0.04	0.05	Positive	Emotion	Belief in natural CC	Global warming	Video
	Study 1	-0.26	0.04	Balanced	Emotion	Belief in natural CC	Global warming	Video
Wong-Parodi & Fischhoff (2015)	Study 1	0.15	0.03	Positive	Other	Belief in natural CC	Global warming	Image/Map
	Study 1	0.12	0.03	Positive	General CC Info	Belief in natural CC	Global warming	Text
	Study 1	0.26	0.04	Positive	Other	Belief in natural CC	Global warming	Image/Map

	Study 1	-0.09	0.03	Positive	General CC Info	Belief in natural CC	Global warming	Image/Map
	Study 1	-0.04	0.03	Positive	Other	Belief in natural CC	Global warming	Image/Map
	Study 1	-0.06	0.03	Positive	General CC Info	Belief in natural CC	Global warming	Image/Map
	Study 1	0.27	0.04	Positive	Other	Belief in natural CC	Global warming	Image/Map
Bolsen & Druckman (2018)	Study 1	-0.08	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	-0.01	0.01	Balanced	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.02	0.01	Balanced	Consensus	Belief in natural CC	Climate change	Text
	Study 1	-0.03	0.01	Balanced	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.14	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	-0.11	0.01	Balanced	Consensus	Belief in ACC	Climate change	Text
	Study 1	-0.07	0.01	Balanced	Consensus	Belief in ACC	Climate change	Text
	Study 1	-0.1	0.01	Balanced	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.07	0.01	Positive	Consensus	Policy Support	Climate change	Text
	Study 1	0.05	0.01	Balanced	Consensus	Policy Support	Climate change	Text
	Study 1	-0.04	0.01	Balanced	Consensus	Policy Support	Climate change	Text
	Study 1	0.00	0.01	Balanced	Consensus	Policy Support	Climate change	Text
Bolsen et al. (2018)	Study 1	0.47	0.01	Positive	General CC Info	Risk	Neither	Text
	Study 1	0.37	0.01	Positive	Other	Risk	Neither	Image/Map
	Study 1	0.26	0.01	Positive	Other	Risk	Neither	Image/Map
	Study 1	0.20	0.01	Positive	General CC Info	Concern	Neither	Text
	Study 1	0.28	0.01	Positive	Other	Concern	Neither	Image/Map
	Study 1	0.09	0.01	Positive	Other	Concern	Neither	Image/Map
	Study 1	0.22	0.01	Positive	General CC Info	Belief in ACC	Global warming	Text
	Study 1	0.25	0.01	Positive	Other	Belief in ACC	Global warming	Image/Map
	Study 1	0.01	0.01	Positive	Other	Belief in ACC	Global warming	Image/Map
Skurka et al. (2018)	Study 1	0.11	0.01	Positive	General CC Info	Risk	Climate change	Video
	Study 1	0.16	0.01	Positive	Emotion	Risk	Climate change	Video
	Study 1	0.10	0.01	Positive	Emotion	Risk	Climate change	Video
Manning et al. (2018)	Study 1	0.18	0.07	Positive	Psych. Dist. Near	Belief in natural CC	Climate change	Text
	Study 1	0.22	0.07	Positive	Psych. Dist. Far	Belief in natural CC	Climate change	Text
	Study 1	0.32	0.07	Positive	Psych. Dist. Near	Risk	Climate change	Text
	Study 1	0.2	0.07	Positive	Psych. Dist. Far	Risk	Climate change	Text
	Study 1	0.41	0.07	Positive	Psych. Dist. Near	Concern	Climate change	Text
	Study 1	0.10	0.07	Positive	Psych. Dist. Far	Concern	Climate change	Text
	Study 1	0.00	0.07	Positive	Psych. Dist. Near	Other	Climate change	Text
	Study 1	-0.07	0.07	Positive	Psych. Dist. Far	Other	Climate change	Text
	Study 1	0.08	0.07	Positive	Psych. Dist. Near	Other	Climate change	Text
	Study 1	-0.40	0.07	Positive	Psych. Dist. Far	Other	Climate change	Text
Tesler (2018)	Study 1	0.14	0.003	Positive	Other	Belief in ACC	Global warming	Text

Dixon et al. (2017)	Study 1	0.12	0.02	Positive	Other	Belief in ACC	Climate change	Text
	Study 1	-0.02	0.02	Positive	Religion	Belief in ACC	Climate change	Text
	Study 1	0.12	0.02	Positive	Economy	Belief in ACC	Climate change	Text
	Study 1	0.10	0.02	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.21	0.02	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.24	0.02	Positive	Religion	Belief in ACC	Climate change	Text
	Study 1	0.07	0.02	Positive	Economy	Belief in ACC	Climate change	Text
Singh & Swanson (2017)	Study 1	-0.21	0.01	Positive	General CC Info	Policy Support	Climate change	Text
	Study 1	-0.11	0.01	Positive	General CC Info	Policy Support	Climate change	Text
	Study 1	0.02	0.01	Positive	Other	Policy Support	Climate change	Text
	Study 1	-0.17	0.01	Positive	Other	Policy Support	Climate change	Text
	Study 1	0.06	0.01	Positive	Nat. Security	Policy Support	Climate change	Text
	Study 1	0.05	0.01	Positive	Nat. Security	Policy Support	Climate change	Text
Guisinger & Saunders (2017)	Study 1	0.15	0.01	Positive	Nat. Security	Other	Neither	Text
	Study 1	0.03	0.01	Positive	Nat. Security	Other	Neither	Text
	Study 1	0.09	0.01	Positive	Nat. Security	Other	Neither	Text
Cook et al. (2017)	Study 1	0.14	0.01	Balanced	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.06	0.01	Balanced	Other	Belief in ACC	Climate change	Text
	Study 1	0.16	0.01	Balanced	Consensus	Belief in ACC	Climate change	Text
	Study 1	-0.16	0.01	Balanced	Other	Belief in ACC	Climate change	Text
	Study 1	0.13	0.01	Balanced	Consensus	Policy Support	Neither	Text
	Study 1	-0.03	0.01	Balanced	Other	Policy Support	Neither	Text
	Study 1	0.06	0.01	Balanced	Consensus	Policy Support	Neither	Text
	Study 1	-0.07	0.01	Balanced	Other	Policy Support	Neither	Text
	Study 1	0.01	0.01	Balanced	Consensus	Other	Neither	Text
	Study 1	0.15	0.01	Balanced	Other	Other	Neither	Text
	Study 1	0.17	0.01	Balanced	Consensus	Other	Neither	Text
	Study 1	-0.09	0.01	Balanced	Other	Other	Neither	Text
	Study 1	0.12	0.01	Balanced	Consensus	Belief in ACC	Neither	Text
	Study 1	0.08	0.01	Balanced	Other	Belief in ACC	Neither	Text
	Study 1	0.11	0.01	Balanced	Consensus	Belief in ACC	Neither	Text
	Study 1	-0.18	0.01	Balanced	Other	Belief in ACC	Neither	Text
	Study 2	-0.04	0.02	Positive	Other	Belief in ACC	Climate change	Text
	Study 2	-0.12	0.02	Negative	Other	Belief in ACC	Climate change	Text
	Study 2	0.12	0.02	Balanced	Other	Belief in ACC	Climate change	Text
	Study 2	-0.06	0.02	Positive	Other	Policy Support	Neither	Text
	Study 2	-0.19	0.02	Negative	Other	Policy Support	Neither	Text
	Study 2	0.11	0.02	Balanced	Other	Policy Support	Neither	Text
	Study 2	0.14	0.02	Positive	Other	Other	Neither	Text
	Study 2	-0.11	0.02	Negative	Other	Other	Neither	Text

	Study 2	-0.14	0.02	Balanced	Other	Other	Neither	Text
	Study 2	0.08	0.02	Positive	Other	Belief in ACC	Neither	Text
	Study 2	-0.16	0.02	Negative	Other	Belief in ACC	Neither	Text
	Study 2	-0.14	0.02	Balanced	Other	Belief in ACC	Neither	Text
Schuldt et al. (2017)	Study 1	0.09	0.004	Positive	Religion	Other	Climate change	Image/Map
	Study 1	0.05	0.004	Positive	Religion	Other	Climate change	Image/Map
Brewer & McKnight (2017)	Study 1	0.30	0.01	Positive	Consensus	Belief in natural CC	Global warming	Video
	Study 1	0.16	0.01	Positive	Consensus	Belief in ACC	Neither	Video
Baumer et al. (2017)	Study 1	0.17	0.01	Positive	Other	Belief in natural CC	Both	Text
	Study 1	0.07	0.01	Positive	Other	Policy Support	Climate change	Text
	Study 1	0.12	0.01	Positive	Other	Other	Climate change	Text
Hardy & Jamieson (2017)	Study 1	-0.80	0.01	Negative	Other	Risk	Neither	Text
	Study 1	-0.19	0.01	Balanced	Other	Risk	Neither	Image/Map
Drummond et al. (2016)	Study 1	-0.14	0.02	Positive	Other	Policy Support	Climate change	Text
	Study 1	-0.11	0.02	Positive	Other	Other	Neither	Text
Deryugina & Shurchkov (2016)	Study 1	0.16	0.005	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 1	-0.01	0.005	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 1	0.11	0.005	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 1	0.01	0.005	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 1	0.03	0.005	Positive	Consensus	Policy Support	Both	Text
	Study 1	0.02	0.005	Positive	Consensus	Policy Support	Both	Text
	Study 1	0.14	0.005	Positive	Consensus	Risk	Neither	Text
	Study 1	0.05	0.005	Positive	Consensus	Risk	Neither	Text
	Study 1	0.15	0.005	Positive	Consensus	Risk	Neither	Text
	Study 1	0.06	0.005	Positive	Consensus	Risk	Neither	Text
	Study 1	0.01	0.005	Positive	Consensus	Risk	Neither	Text
	Study 1	0.02	0.005	Positive	Consensus	Risk	Neither	Text
Zhou (2016)	Study 1	-0.15	0.04	Positive	Economy	Policy Support	Climate change	Text
	Study 1	-0.35	0.04	Positive	Economy	Policy Support	Climate change	Text
	Study 1	-0.46	0.04	Positive	Nat. Security	Policy Support	Climate change	Text
	Study 1	-0.49	0.04	Positive	Nat. Security	Policy Support	Climate change	Text
	Study 1	-0.47	0.04	Positive	Morality	Policy Support	Climate change	Text
	Study 1	-0.04	0.04	Positive	Morality	Policy Support	Climate change	Text
	Study 1	-0.10	0.04	Positive	Other	Policy Support	Climate change	Text
	Study 1	-0.10	0.04	Positive	Other	Policy Support	Climate change	Text
Cook & Lewandowsky (2016)	Study 1	0.02	0.02	Positive	Consensus	Belief in ACC	Climate change	Image/Map
	Study 1	0.15	0.02	Positive	Other	Belief in ACC	Climate change	Text
	Study 1	0.11	0.02	Positive	Consensus	Belief in ACC	Climate change	Image/Map
	Study 1	0.21	0.02	Positive	Consensus	Belief in ACC	Neither	Image/Map
	Study 1	0.13	0.02	Positive	Other	Belief in ACC	Neither	Text

	Study 1	0.19	0.02	Positive	Consensus	Belief in ACC	Neither	Image/Map
	Study 1	0.07	0.02	Positive	Consensus	Other	Neither	Image/Map
	Study 1	0.02	0.02	Positive	Other	Other	Neither	Text
	Study 1	0.03	0.02	Positive	Consensus	Other	Neither	Image/Map
Carrico et al. (2015)	Study 1	-0.02	0.01	Positive	Other	Belief in natural CC	Neither	Text
	Study 1	0.07	0.01	Positive	Other	Belief in natural CC	Neither	Text
	Study 1	0.08	0.01	Positive	Other	Risk	Neither	Text
	Study 1	-0.02	0.01	Positive	Other	Risk	Neither	Text
	Study 1	0.05	0.005	Positive	Other	Policy Support	Global warming	Text
	Study 1	0.00	0.005	Positive	Other	Policy Support	Global warming	Text
	Study 1	-0.07	0.005	Positive	Other	Policy Support	Global warming	Text
	Study 1	0.00	0.005	Positive	Other	Policy Support	Global warming	Text
	Study 2	0.15	0.01	Positive	Other	Belief in natural CC	Neither	Text
	Study 2	0.09	0.01	Positive	Other	Belief in natural CC	Neither	Text
	Study 2	0.11	0.01	Positive	Other	Risk	Neither	Text
	Study 2	0.01	0.01	Positive	Other	Risk	Neither	Text
	Study 2	0.06	0.01	Positive	Other	Policy Support	Global warming	Text
	Study 2	0.01	0.01	Positive	Other	Policy Support	Global warming	Text
Zaval et al. (2015)	Study 1	0.14	0.01	Positive	Other	Belief in natural CC	Global warming	Other
	Study 1	0.21	0.01	Positive	Other	Policy Support	Neither	Other
	Study 1	0.24	0.01	Positive	Other	Other	Climate change	Other
Albertson & Busby (2015)	Study 2	-0.06	0.02	Positive	Morality	Concern	Climate change	Text
	Study 2	-0.22	0.02	Positive	Economy	Concern	Climate change	Text
	Study 2	-0.07	0.02	Positive	Economy	Concern	Climate change	Text
	Study 2	-0.13	0.03	Positive	Morality	Belief in ACC	Climate change	Text
	Study 2	0.01	0.03	Positive	Economy	Belief in ACC	Climate change	Text
	Study 2	-0.09	0.03	Positive	Economy	Belief in ACC	Climate change	Text
	Study 2	-0.09	0.02	Positive	Morality	Other	Climate change	Text
	Study 2	-0.22	0.02	Positive	Economy	Other	Climate change	Text
	Study 2	-0.13	0.02	Positive	Economy	Other	Climate change	Text
	Study 2	-0.14	0.02	Positive	Morality	Other	Climate change	Text
	Study 2	-0.06	0.02	Positive	Economy	Other	Climate change	Text
	Study 2	-0.04	0.02	Positive	Economy	Other	Climate change	Text
van der Linden et al. (2014)	Study 1	0.05	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.10	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.09	0.01	Positive	Consensus	Concern	Climate change	Text
	Study 1	0.11	0.01	Positive	Consensus	Policy Support	Climate change	Text
Schuldt & Roh (2014)	Study 2	0.00	0.04	Positive	Other	Belief in natural CC	Both	Image/Map
	Study 2	-0.13	0.04	Negative	Other	Belief in natural CC	Both	Image/Map
Bolsen et al. (2014)	Study 1	0.08	0.02	Positive	Other	Belief in natural CC	Global warming	Text

	Study 1	-0.06	0.02	Negative	Other	Belief in natural CC	Global warming	Text
	Study 1	0.16	0.02	Positive	Other	Belief in natural CC	Global warming	Text
	Study 1	0.11	0.02	Negative	Other	Belief in natural CC	Global warming	Text
	Study 1	-0.03	0.02	Positive	Other	Belief in ACC	Global warming	Text
	Study 1	-0.11	0.02	Negative	Other	Belief in ACC	Global warming	Text
	Study 1	0.09	0.02	Positive	Other	Belief in ACC	Global warming	Text
	Study 1	-0.15	0.02	Negative	Other	Belief in ACC	Global warming	Text
	Study 1	-0.11	0.02	Positive	Other	Policy Support	Neither	Text
	Study 1	-0.26	0.02	Negative	Other	Policy Support	Neither	Text
	Study 1	-0.09	0.02	Positive	Other	Policy Support	Neither	Text
	Study 1	-0.10	0.02	Negative	Other	Policy Support	Neither	Text
	Study 2	-0.12	0.01	Positive	Other	Belief in natural CC	Global warming	Text
	Study 2	-0.05	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 2	0.00	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 2	-0.09	0.01	Positive	Other	Belief in ACC	Global warming	Text
	Study 2	0.00	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 2	-0.10	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 2	0.02	0.01	Positive	Other	Policy Support	Neither	Text
	Study 2	0.00	0.01	Positive	Consensus	Policy Support	Neither	Text
	Study 2	0.03	0.01	Positive	Consensus	Policy Support	Neither	Text
Jang (2013)	Study 1	-0.37	0.02	Negative	Other	Belief in ACC	Climate change	Text
	Study 1	0.02	0.02	Positive	Other	Belief in ACC	Climate change	Text
	Study 1	-0.36	0.02	Negative	Other	Concern	Global warming	Text
	Study 1	0.01	0.02	Positive	Other	Concern	Global warming	Text
	Study 1	-0.29	0.02	Negative	Other	Policy Support	Climate change	Text
	Study 1	0.05	0.02	Positive	Other	Policy Support	Climate change	Text
	Study 1	-0.35	0.02	Negative	Other	Policy Support	Neither	Text
	Study 1	0.04	0.02	Positive	Other	Policy Support	Neither	Text
Feinberg & Willer (2013)	Study 3	0.19	0.02	Positive	Morality	Belief in ACC	Global warming	Text
	Study 3	-0.06	0.02	Positive	Morality	Belief in ACC	Global warming	Text
Risen & Critcher (2011)	Study 2	0.44	0.05	Positive	Other	Belief in natural CC	Global warming	Other
	Study 3	0.40	0.12	Positive	Other	Belief in natural CC	Global warming	Other
	Study 4	-0.05	0.07	Positive	Other	Belief in natural CC	Global warming	Other
Joireman et al. (2010)	Study 2	0.71	0.10	Positive	Other	Belief in natural CC	Global warming	Other
Bakaki & Bernauer (2017)	Study 1	-0.03	0.01	Positive	Other	Policy Support	Global warming	Text
	Study 1	-0.03	0.01	Balanced	Other	Policy Support	Global warming	Text
Clayton et al. (2013)	Study 2	0.25	0.02	Positive	Other	Other	Climate change	Text
	Study 2	0.32	0.02	Positive	Other	Other	Climate change	Text
	Study 2	-0.12	0.02	Positive	Other	Other	Climate change	Text
	Study 2	-0.05	0.02	Positive	Other	Policy Support	Climate change	Text

	Study 2	-0.04	0.02	Positive	Other	Policy Support	Climate change	Text
	Study 2	-0.10	0.02	Positive	Other	Policy Support	Climate change	Text
	Study 2	-0.07	0.02	Positive	Other	Other	Climate change	Text
	Study 2	-0.09	0.02	Positive	Other	Other	Climate change	Text
	Study 2	0.02	0.02	Positive	Other	Other	Climate change	Text
	Study 2	0.03	0.02	Positive	Other	Other	Climate change	Text
	Study 2	0.03	0.02	Positive	Other	Other	Climate change	Text
	Study 2	-0.17	0.02	Positive	Other	Other	Climate change	Text
	Study 2	-0.10	0.02	Positive	Other	Risk	Climate change	Text
	Study 2	-0.11	0.02	Positive	Other	Risk	Climate change	Text
	Study 2	-0.17	0.02	Positive	Other	Risk	Climate change	Text
	Study 2	-0.06	0.02	Positive	Other	Concern	Climate change	Text
	Study 2	-0.14	0.02	Positive	Other	Concern	Climate change	Text
	Study 2	-0.06	0.02	Positive	Other	Concern	Climate change	Text
Budescu et al. (2012)	Study 1	0.15	0.01	Positive	General CC Info	Belief in natural CC	Global warming	Text
	Study 1	-0.03	0.01	Positive	Other	Belief in natural CC	Global warming	Text
	Study 1	-0.13	0.01	Positive	Other	Belief in natural CC	Global warming	Text
	Study 1	0.17	0.01	Positive	General CC Info	Other	Global warming	Text
	Study 1	-0.05	0.01	Positive	Other	Other	Global warming	Text
	Study 1	-0.25	0.01	Positive	Other	Other	Global warming	Text
	Study 1	0.14	0.01	Positive	General CC Info	Belief in ACC	Global warming	Text
	Study 1	0.06	0.01	Positive	Other	Belief in ACC	Global warming	Text
	Study 1	-0.17	0.01	Positive	Other	Belief in ACC	Global warming	Text
	Study 1	0.14	0.01	Positive	General CC Info	Risk	Global warming	Text
	Study 1	0.06	0.01	Positive	Other	Risk	Global warming	Text
	Study 1	0.01	0.01	Positive	Other	Risk	Global warming	Text
van der Linden et al. (2019)	Study 1	0.12	0.001	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 1	0.14	0.001	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 1	0.10	0.001	Positive	Consensus	Concern	Global warming	Text
	Study 1	0.08	0.001	Positive	Consensus	Policy Support	Global warming	Text
Goldberg et al. (2019)	Study 1	-0.05	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 1	-0.05	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 1	-0.02	0.01	Positive	Consensus	Concern	Global warming	Text
	Study 2	0.04	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 2	0.16	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 2	0.09	0.01	Positive	Consensus	Concern	Global warming	Text
	Study 3	0.03	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 3	-0.03	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 3	0.01	0.01	Positive	Consensus	Concern	Global warming	Text
	Study 4	0.17	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text

	Study 4	0.07	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 4	0.08	0.01	Positive	Consensus	Concern	Global warming	Text
Shin & Preston (2019)	Study 2	0.28	0.01	Positive	Religion	Belief in natural CC	Neither	Text
	Study 2	0.08	0.01	Balanced	Religion	Belief in natural CC	Neither	Text
	Study 2	0.24	0.01	Positive	Religion	Belief in ACC	Climate change	Text
	Study 2	0.13	0.01	Balanced	Religion	Belief in ACC	Climate change	Text
	Study 3	0.24	0.01	Positive	Religion	Belief in natural CC	Neither	Text
	Study 3	0.27	0.01	Positive	Religion	Belief in ACC	Climate change	Text
Gehlbach et al. (2019)	Study 1	0.16	0.01	Positive	Other	Belief in ACC	Both	Other
Sparks (2017)	Study 2	0.09	0.01	Positive	Psych. Dist. Far	Other	Climate change	Image/Map
	Study 2	0.13	0.01	Positive	Psych. Dist. Near	Other	Climate change	Image/Map
Skurka et al. (2019)	Study 1	0.24	0.01	Positive	Consensus	Risk	Climate change	Video
	Study 1	0.19	0.01	Positive	Emotion	Risk	Climate change	Video
	Study 1	0.08	0.01	Positive	Consensus	Risk	Climate change	Video
	Study 1	0.03	0.01	Positive	Emotion	Risk	Climate change	Video
Goldberg, Gustafson, et al. (2019)	Study 2	0.06	0.004	Positive	Religion	Belief in natural CC	Global warming	Text
	Study 2	0.07	0.004	Positive	Religion	Belief in natural CC	Global warming	Text
	Study 2	0.14	0.004	Positive	Religion	Belief in ACC	Global warming	Text
	Study 2	0.04	0.004	Positive	Religion	Belief in ACC	Global warming	Text
	Study 2	0.14	0.004	Positive	Religion	Concern	Global warming	Text
	Study 2	0.08	0.004	Positive	Religion	Concern	Global warming	Text
Bolsen et al. (2019)	Study 1	0.15	0.01	Positive	General CC Info	Belief in natural CC	Climate change	Text
	Study 1	0.17	0.01	Positive	General CC Info	Belief in natural CC	Climate change	Image/Map
	Study 1	0.06	0.01	Balanced	Other	Belief in natural CC	Climate change	Text
	Study 1	0.21	0.01	Balanced	Other	Belief in natural CC	Climate change	Image/Map
	Study 1	0.20	0.01	Positive	General CC Info	Risk	Climate change	Text
	Study 1	0.24	0.01	Positive	General CC Info	Risk	Climate change	Image/Map
	Study 1	0.13	0.01	Balanced	Other	Risk	Climate change	Text
	Study 1	0.19	0.01	Balanced	Other	Risk	Climate change	Image/Map
	Study 1	0.13	0.01	Positive	General CC Info	Other	Climate change	Text
	Study 1	0.11	0.01	Positive	General CC Info	Other	Climate change	Image/Map
	Study 1	0.06	0.01	Balanced	Other	Other	Climate change	Text
	Study 1	0.15	0.01	Balanced	Other	Other	Climate change	Image/Map
	Study 1	0.14	0.01	Positive	General CC Info	Risk	Climate change	Text
	Study 1	0.19	0.01	Positive	General CC Info	Risk	Climate change	Image/Map
	Study 1	-0.01	0.01	Balanced	Other	Risk	Climate change	Text
	Study 1	0.23	0.01	Balanced	Other	Risk	Climate change	Image/Map
Truelove et al. (2016)	Study 1	0.05	0.03	Positive	Other	Concern	Global warming	Other
	Study 1	0.33	0.03	Positive	Other	Concern	Global warming	Other

Wolske et al. (2019)	Study 1	-0.05	0.01	Positive	Other	Policy Support	Unclear	Text
	Study 1	-0.17	0.01	Positive	Other	Policy Support	Unclear	Text
	Study 1	-0.02	0.01	Positive	Other	Policy Support	Unclear	Text
	Study 1	-0.05	0.01	Balanced	Other	Policy Support	Unclear	Text
	Study 1	0.04	0.01	Balanced	Other	Policy Support	Unclear	Text
	Study 1	-0.02	0.01	Balanced	Other	Policy Support	Unclear	Text
Myers et al. (2015)	Study 1	0.03	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.03	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.04	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.08	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	-0.05	0.01	Positive	Consensus	Belief in natural CC	Climate change	Text
	Study 1	0.01	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.08	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.06	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.10	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.00	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.17	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	0.05	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	0.16	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	0.14	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	-0.07	0.01	Positive	Consensus	Risk	Climate change	Text
	Study 1	0.01	0.01	Positive	Consensus	Policy Support	Climate change	Text
	Study 1	0.04	0.01	Positive	Consensus	Policy Support	Climate change	Text
	Study 1	0.06	0.01	Positive	Consensus	Policy Support	Climate change	Text
	Study 1	0.02	0.01	Positive	Consensus	Policy Support	Climate change	Text
	Study 1	-0.07	0.01	Positive	Consensus	Policy Support	Climate change	Text
Watkins & Goodwin (2019)	Study 1	-0.02	0.02	Positive	Other	Policy Support	Global warming	Other
Stroik et al. (2019)	Study 1	0.08	0.003	Positive	Other	Policy Support	Neither	Text
	Study 1	-0.17	0.003	Negative	Other	Policy Support	Neither	Text
	Study 2	0.02	0.002	Positive	Other	Policy Support	Neither	Text
	Study 2	-0.42	0.002	Negative	Other	Policy Support	Neither	Text
Cruz (2019)	Study 1	0.07	0.01	Positive	Economy	Policy Support	Climate change	Text
	Study 1	-0.26	0.01	Negative	Economy	Policy Support	Climate change	Text
Porter et al. (2019)	Study 1	-0.37	0.01	Negative	Other	Other	Neither	Text
	Study 1	0.16	0.01	Balanced	Other	Other	Neither	Text
	Study 2	-0.13	0.004	Negative	Other	Other	Neither	Text
	Study 2	0.06	0.004	Balanced	Other	Other	Neither	Text
Motta et al. (2019)	Study 1	0.07	0.001	Positive	General CC Info	Belief in ACC	Neither	Text

Mildenberger et al. (2019)	Study 1	0.13	0.003	Positive	Psych. Dist. Near	Other	Neither	Image/Map
	Study 1	0.12	0.003	Positive	Psych. Dist. Near	Other	Neither	Image/Map
Halperin & Walton (2018)	Study 1	0.19	0.01	Positive	Psych. Dist. Near	Belief in natural CC	Climate change	Text
	Study 1	0.05	0.01	Positive	Psych. Dist. Far	Belief in natural CC	Climate change	Text
	Study 1	0.17	0.01	Positive	Psych. Dist. Near	Belief in natural CC	Global warming	Text
	Study 1	0.05	0.01	Positive	Psych. Dist. Far	Belief in natural CC	Global warming	Text
Schoenefeld & McCauley (2016)	Study 1	0.13	0.06	Positive	Psych. Dist. Near	Other	Climate change	Text
	Study 1	-0.03	0.06	Positive	Psych. Dist. Far	Other	Climate change	Text
	Study 1	-0.12	0.06	Positive	Psych. Dist. Near	Policy Support	Climate change	Text
	Study 1	-0.02	0.06	Positive	Psych. Dist. Far	Policy Support	Climate change	Text
Kotcher et al. (2018)	Study 1	0.16	0.01	Positive	General CC Info	Risk	Global warming	Text
	Study 1	0.10	0.01	Positive	General CC Info	Other	Global warming	Text
	Study 1	0.09	0.01	Positive	General CC Info	Concern	Global warming	Text
	Study 1	0.10	0.01	Positive	General CC Info	Risk	Global warming	Text
	Study 1	-0.02	0.01	Positive	General CC Info	Policy Support	Global warming	Text
Rode et al. (2019)	Study 1	0.17	0.02	Positive	General CC Info	Belief in ACC	Climate change	Text
	Study 1	0.34	0.02	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 1	0.28	0.02	Positive	General CC Info	Risk	Both	Text
	Study 1	0.32	0.02	Positive	Consensus	Risk	Both	Text
	Study 1	0.32	0.02	Positive	General CC Info	Risk	Both	Text
	Study 1	0.33	0.02	Positive	Consensus	Risk	Both	Text
	Study 1	0.07	0.02	Positive	General CC Info	Policy Support	Global warming	Text
	Study 1	0.20	0.02	Positive	Consensus	Policy Support	Global warming	Text
	Study 2	-0.15	0.01	Positive	General CC Info	Belief in ACC	Climate change	Text
	Study 2	0.07	0.01	Positive	Consensus	Belief in ACC	Climate change	Text
	Study 2	-0.1	0.01	Positive	General CC Info	Risk	Both	Text
	Study 2	0.05	0.01	Positive	Consensus	Risk	Both	Text
	Study 2	-0.15	0.01	Positive	General CC Info	Risk	Both	Text
	Study 2	0.00	0.01	Positive	Consensus	Risk	Both	Text
	Study 2	-0.18	0.01	Positive	General CC Info	Policy Support	Global warming	Text
	Study 2	-0.02	0.01	Positive	Consensus	Policy Support	Global warming	Text
Goldberg, van der Linden, Ballew, Rosenthal, Gustafson, et al. (2019)	Study 1	0.08	0.01	Positive	Consensus	Belief in natural CC	Global warming	Text
	Study 1	0.05	0.01	Positive	Consensus	Belief in natural CC	Global warming	Video
	Study 1	0.06	0.01	Positive	Consensus	Belief in ACC	Global warming	Text
	Study 1	0.05	0.01	Positive	Consensus	Belief in ACC	Global warming	Video
	Study 1	0.18	0.01	Positive	Consensus	Concern	Global warming	Text
	Study 1	0.08	0.01	Positive	Consensus	Concern	Global warming	Video
	Study 1	0.16	0.01	Positive	Consensus	Policy Support	Global warming	Text
	Study 1	0.11	0.01	Positive	Consensus	Policy Support	Global warming	Video
	Study 1	-0.31	0.004	Negative	Other	Policy Support	Neither	Text

Stroik & Jamelske (2017)	Study 2	-0.52	0.003	Negative	Other	Policy Support	Neither	Text
Clarke et al. (2019)	Study 1	-0.01	0.02	Positive	Consensus	Policy Support	Climate change	Video
	Study 1	-0.05	0.02	Positive	Consensus	Policy Support	Climate change	Video

Note. CC = Climate change; ACC = Anthropogenic climate change. In Sparks (2017), the study used was Study 2 from Chapter 4. "Study" refers to the independent experiment used in the paper. If a paper had one experiment, then it is listed in the table as "Study 1". If a paper had multiple experiments, then the table lists the name of the study that was used. If a paper had multiple samples (but not labeled as separate experiments in the paper, like "Study 1" or "Study 2"), then they are listed in the table as "Study 1", "Study 2", etc. to denote independent samples.

References

Albertson, B., & Busby, J. W. (2015). Hearts or minds? Identifying persuasive messages on climate change. *Research & Politics*, *2*(1), 1–9. https://doi.org/10.1177/2053168015577712

Anderson, A. A., & Becker, A. B. (2018). Not just funny after all: Sarcasm as a catalyst for public engagement with climate change. *Science Communication*, *40*(4), 524–540. https://doi.org/10.1177/1075547018786560

Bakaki, Z., & Bernauer, T. (2017). Do global climate summits influence public awareness and policy preferences concerning climate change? *Environmental Politics*, *26*(1), 1–26. https://doi.org/10.1080/09644016.2016.1244964

Baumer, E. P. S., Polletta, F., Pierski, N., & Gay, G. K. (2017). A simple intervention to reduce framing effects in perceptions of global climate change. *Environmental Communication*, *11*(3), 289–310. https://doi.org/10.1080/17524032.2015.1084015

Bolsen, T., & Druckman, J. N. (2018). Do partisanship and politicization undermine the impact of a scientific consensus message about climate change? *Group Processes & Intergroup Relations*, *21*(3), 389–402. https://doi.org/10.1177/1368430217737855

Bolsen, T., Kingsland, J., & Palm, R. (2018). The impact of frames highlighting coastal flooding in the USA on climate change beliefs. *Climatic Change*, *147*, 359–368. https://doi.org/10.1007/s10584-018-2143-0

Bolsen, T., Leeper, T. J., & Shapiro, M. A. (2014). Doing what others do: Norms, science, and collective action on global warming. *American Politics Research*, *42*(1), 65–89. https://doi.org/10.1177/1532673X13484173

Bolsen, T., Palm, R., & Kingsland, J. T. (2019). Counteracting climate science politicization with effective frames and imagery. *Science Communication*, *41*(2), 147–171.

https://doi.org/10.1177/1075547019834565

Brewer, P. R., & McKnight, J. (2015). Climate as comedy: The effects of satirical television news on climate change perceptions. *Science Communication*, *37*(5), 635–657. https://doi.org/10.1177/1075547015597911

Brewer, P. R., & McKnight, J. (2017). "A statistically representative climate change debate": Satirical television news, scientific consensus, and public perceptions of global warming. *Atlantic Journal of Communication*, *25*(3), 166–180. https://doi.org/10.1080/15456870.2017.1324453

Budescu, D. V., Por, H.-H., & Broomell, S. B. (2012). Effective communication of uncertainty in the IPCC reports. *Climatic Change*, *113*, 181–200. https://doi.org/10.1007/s10584-011-0330-3

Carrico, A. R., Truelove, H. B., Vandenbergh, M. P., & Dana, D. (2015). Does learning about climate change adaptation change support for mitigation? *Journal of Environmental Psychology*, *41*, 19–29. https://doi.org/10.1016/j.jenvp.2014.10.009

Chu, H., & Yang, J. Z. (2018). Taking climate change here and now – mitigating ideological polarization with psychological distance. *Global Environmental Change*, *53*, 174–181. https://doi.org/10.1016/j.gloenvcha.2018.09.013

Clarke, E. J. R., Klas, A., Stevenson, J., & Kothe, E. J. (2019). The role of late-night infotainment comedy in communicating climate change consensus. *PsyArXiv*. https://doi.org/10.31234/osf.io/ufg9r

Clayton, S., Koehn, A., & Grover, E. (2013). Making sense of the senseless: Identity, justice, and the framing of environmental crises. *Social Justice Research*, *26*, 301–319. https://doi.org/10.1007/s11211-013-0185-z

Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using bayesian networks. *Topics in Cognitive Science*, *8*(1), 160–179. https://doi.org/10.1111/tops.12186

Cook, J., Lewandowsky, S., & Ecker, U. K. H. (2017). Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLoS ONE*, *12*(5), e0175799. https://doi.org/10.1371/journal.pone.0175799

Cruz, S. M. (2019). Lateral attitude change on environmental issues: Implications for the climate change debate. *Climatic Change*, *156*, 151–169. https://doi.org/10.1007/s10584-019-02474-x

Deryugina, T., & Shurchkov, O. (2016). The effect of information provision on public consensus about climate change. *PLoS ONE*, *11*(4), e0151469. https://doi.org/10.1371/journal.pone.0151469

Dixon, G., Hmielowski, J., & Ma, Y. (2017). Improving climate change acceptance among U.S. conservatives through value-based message targeting. *Science Communication*, *39*(4), 520–534. https://doi.org/10.1177/1075547017715473

Drummond, A., Palmer, M. A., & Sauer, J. D. (2016). Enhancing endorsement of scientific inquiry increases support for pro-environment policies. *Royal Society Open Science*, *3*(9), 160360. https://doi.org/10.1098/rsos.160360

Feinberg, M., & Willer, R. (2013). The moral roots of environmental attitudes. *Psychological Science*, *24*(1), 56–62. https://doi.org/10.1177/0956797612449177

Gehlbach, H., Robinson, C. D., & Vriesema, C. C. (2019). Leveraging cognitive consistency to nudge conservative climate change beliefs. *Journal of Environmental Psychology*, *61*, 134–137. https://doi.org/10.1016/j.jenvp.2018.12.004

Goldberg, M. H., Gustafson, A., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). A social identity approach to engaging Christians in the issue of climate change. *Science Communication*, *41*(4), 442–463. https://doi.org/10.1177/1075547019860847

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., Gustafson, A., & Leiserowitz, A. (2019). The experience of consensus: Video as an effective medium to communicate scientific agreement on climate change. *Science Communication*, *41*(5), 659–673. https://doi.org/10.1177/1075547019874361

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). The role of anchoring in judgments about expert consensus. *Journal of Applied Social Psychology*, *49*(3), 192–200. https://doi.org/10.1111/jasp.12576

Guisinger, A., & Saunders, E. N. (2017). Mapping the boundaries of elite cues: How elites shape mass opinion across international issues. *International Studies Quarterly*, *61*(2), 425–441. https://doi.org/10.1093/isq/sqx022

Halperin, A., & Walton, P. (2018). The importance of place in communicating climate change to different facets of the American public. *Weather, Climate, and Society, 10,* 291–305. https://doi.org/10.1175/WCAS-D-16-0119.1

Hardy, B. W., & Jamieson, K. H. (2017). Overcoming endpoint bias in climate change communication: The case of Arctic sea ice trends. *Environmental Communication, 11*(2), 205–217. https://doi.org/10.1080/17524032.2016.1241814

Hu, S., Zheng, X., Zhang, N., & Zhu, J. (2018). The impact of mortality salience on intergenerational altruism and the perceived importance of sustainable development goals. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.01399

Jang, S. M. (2013). Framing responsibility in climate change discourse: Ethnocentric attribution

bias, perceived causes, and policy attitudes. *Journal of Environmental Psychology*, *36*, 27–36. https://doi.org/10.1016/j.jenvp.2013.07.003

Joireman, J., Barnes Truelove, H., & Duell, B. (2010). Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *Journal of Environmental Psychology*, *30*(4), 358–367. https://doi.org/10.1016/j.jenvp.2010.03.004

Kotcher, J., Maibach, E., Montoro, M., & Hassol, S. J. (2018). How Americans respond to information about global warming's health impacts: Evidence from a national survey experiment. *GeoHealth*, *2*(9), 262–275. https://doi.org/10.1029/2018GH000154

Ma, Y., Dixon, G., & Hmielowski, J. D. (2019). Psychological reactance from reading basic facts on climate change: The role of prior views and political identification. *Environmental Communication*, *13*(1), 71–86. https://doi.org/10.1080/17524032.2018.1548369

Manning, C., Mangas, H., Amel, E., Tang, H., Humes, L., Foo, R., Sidlova, V., & Cargos, K. (2018). Psychological distance and response to human versus non-human victims of climate change. In W. Leal Filho, R. W. Marans, & J. Callewaert (Eds.), *Handbook of Sustainability and Social Science Research* (pp. 143–161). Springer. https://doi.org/10.1007/978-3-319-67122-2_8

Mildenberger, M., Lubell, M., & Hummel, M. (2019). Personalized risk messaging can reduce climate concerns. *Global Environmental Change*, *55*, 15–24. https://doi.org/10.1016/j.gloenvcha.2019.01.002

Motta, M., Chapman, D., Stecula, D., & Haglin, K. (2019). An experimental examination of measurement disparities in public climate change beliefs. *Climatic Change*, *154*, 37–47. https://doi.org/10.1007/s10584-019-02406-9

Myers, T. A., Maibach, E., Peters, E., & Leiserowitz, A. (2015). Simple messages help set the

record straight about scientific agreement on human-caused climate change: The results of two experiments. *PLoS ONE, 10*(3), e0120985. https://doi.org/10.1371/journal.pone.0120985

Porter, E., Wood, T. J., & Bahador, B. (2019). Can presidential misinformation on climate change be corrected? Evidence from Internet and phone experiments. *Research & Politics*, *6*(3), 1–10. https://doi.org/10.1177/2053168019864784

Risen, J. L., & Critcher, C. R. (2011). Visceral fit: While in a visceral state, associated states of the world seem more likely. *Journal of Personality and Social Psychology*, *100*(5), 777–793. https://doi.org/10.1037/a0022460

Rode, J. B., Iqbal, S., & Ditto, P. H. (2019). [Unpublished data]. University of California, Irvine.

Schoenefeld, J. J., & McCauley, M. R. (2016). Local is not always better: The impact of climate information on values, behavior and policy support. *Journal of Environmental Studies and Sciences, 6,* 724–732. https://doi.org/10.1007/s13412-015-0288-y

Schuldt, J. P., Pearson, A. R., Romero-Canyas, R., & Larson-Konar, D. (2017). Brief exposure to Pope Francis heightens moral beliefs about climate change. *Climatic Change, 141*, 167–177. https://doi.org/10.1007/s10584-016-1893-9

Schuldt, J. P., & Roh, S. (2014). Of accessibility and applicability: How heat-related cues affect belief in "global warming" versus "climate change." *Social Cognition*, *32*(3), 217–238. https://doi.org/10.1521/soco.2014.32.3.217

Shin, F., & Preston, J. L. (2019). Green as the gospel: The power of stewardship messages to improve climate change attitudes. *Psychology of Religion and Spirituality*. Advance online publication. https://doi.org/10.1037/rel0000249

Singh, S. P., & Swanson, M. (2017). How issue frames shape beliefs about the importance of

climate change policy across ideological and partisan groups. *PLoS ONE, 12*(7), e0181401. https://doi.org/10.1371/journal.pone.0181401

Skurka, Chris, Niederdeppe, J., & Nabi, R. (2019). Kimmel on climate: Disentangling the emotional ingredients of a satirical monologue. *Science Communication, 41*(4), 394–421. https://doi.org/10.1177/1075547019853837

Skurka, Christofer, Niederdeppe, J., Romero-Canyas, R., & Acup, D. (2018). Pathways of influence in emotional appeals: Benefits and tradeoffs of using fear or humor to promote climate change-related intentions and risk perceptions. *Journal of Communication, 68*(1), 169–193. https://doi.org/10.1093/joc/jqx008

Sparks, A. (2017). *Reducing distance to increase action: How psychological proximity drives activism* [Doctoral dissertation, University of California, Santa Barbara]. https://escholarship.org/uc/item/7nq534jf

Stroik, P., Chakraborty, D., Ge, W., Boulter, J., & Jamelske, E. (2019). Effect of reciprocity on public opinion of international climate treaties: Experimental evidence from the US and China. *Climate Policy, 19*(8), 959–973. https://doi.org/10.1080/14693062.2019.1617666

Stroik, P., & Jamelske, E. (2017). [Unpublished data]. University of Wisconsin-Eau Claire.

Tesler, M. (2018). Elite domination of public doubts about climate change (not evolution). *Political Communication, 35*(2), 306–326. https://doi.org/10.1080/10584609.2017.1380092

Truelove, H. B., Yeung, K. L., Carrico, A. R., Gillis, A. J., & Raimi, K. T. (2016). From plastic bottle recycling to policy support: An experimental test of pro-environmental spillover. *Journal of Environmental Psychology, 46,* 55–66. https://doi.org/10.1016/j.jenvp.2016.03.004

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to

communicate the scientific consensus on climate change: Plain facts, pie charts or metaphors? *Climatic Change, 126,* 255–262. https://doi.org/10.1007/s10584-014-1190-4

van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology*, *62,* 49–58. https://doi.org/10.1016/j.jenvp.2019.01.009

Watkins, H. M., & Goodwin, G. P. (2019). Reflecting on sacrifices made by past generations increases a sense of obligation towards future generations. *Personality and Social Psychology Bulletin*. Advance online publication. https://doi.org/10.1177/0146167219883610

Wolske, K. S., Raimi, K. T., Campbell-Arvai, V., & Hart, P. S. (2019). Public support for carbon dioxide removal strategies: The role of tampering with nature perceptions. *Climatic Change*, *152*, 345–361. https://doi.org/10.1007/s10584-019-02375-z

Wong-Parodi, G., & Fischhoff, B. (2015). The impacts of political cues and practical information on climate change decisions. *Environmental Research Letters*, *10*(3), 034004. https://doi.org/10.1088/1748-9326/10/3/034004

Zaval, L., Markowitz, E. M., & Weber, E. U. (2015). How will I be remembered? Conserving the environment for the sake of one's legacy. *Psychological Science*, *26*(2), 231–236. https://doi.org/10.1177/0956797614561266

Zhou, J. (2016). Boomerangs versus javelins: How polarization constrains communication on climate change. *Environmental Politics*, *25*(5), 788–811. https://doi.org/10.1080/09644016.2016.1166602