





Influencing climate change attitudes in the United States: A systematic review and meta-analysis

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Abstract

Researchers interested in climate change communication have investigated how people respond to messages about it. Through meta-analysis, the current research synthesizes the multitude of experimental studies on this topic to uncover which interventions are most effective at influencing attitudes about climate change. The meta-analysis focuses on experimental studies that included a control condition and measured climate change attitudes among participants in the United States. After a large literature search, 396 effect sizes were retrieved from 76 independent experiments ($N=76,033$ participants). Interventions had a small, significant positive effect on attitudes, $g=0.08$, 95% CI [0.05, 0.10], 95% prediction interval [-0.04, 0.19], $p<.001$. Surprisingly, type of intervention was not a statistically significant moderator of this 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. Interventions that aimed to induce skepticism (e.g., misinformation) had a significantly stronger average effect on attitudes than did ones that intended to promote belief in climate change, suggesting that belief in climate change is more easily weakened than strengthened.

Introduction

Although immediate action can substantially reduce the negative consequences of climate change (IPCC, 2018), public beliefs and willingness to act do not reflect accurately the scientific evidence on climate change and emissions reductions needed to mitigate it. Specifically, whereas 97% of climate scientists agree that human-caused global warming is occurring, a recent poll found that only 62% of the American sample reported that they believe global warming is human-caused (Leiserowitz, Maibach, Rosenthal, Kotcher, Bergquist, et al., 2020). Additionally, support for action on climate change is fractured along political lines. For example, 83% of Democrats, 56% of Independents, and 22% of Republicans reported that global warming should be a high priority for the President and Congress (Leiserowitz, Maibach, Rosenthal, Kotcher, Ballew, et al., 2020). Taken together, these polls reveal that Americans are divided politically -- with Independent and Republican attitudes further away from scientific consensus than Democrat

attitudes -- and they differ in beliefs about the cause of global warming, its potential effects, policies that should be enacted to curtail them, and its priority as a voting issue (Leiserowitz, Maibach, Rosenthal, Kotcher, Ballew, et al., 2020). 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 it.

When considering how to alter perceptions about climate change, researchers have proposed a number of interventions, including making climate change more concrete and local, tailoring messages to the audience's values, and using messages to assuage defensive reactions (Fielding, Hornsey, & Swim, 2014; Weber, 2016). While previous reviews have discussed interventions (e.g., Markowitz & Shariff, 2012; Pearson, Schuldt, & Romero-Canyas, 2016; Weber, 2016), a comprehensive quantitative synthesis has not yet been conducted. Combining studies quantitatively can help determine which interventions are effective at influencing climate change attitudes and for whom. A recent meta-analysis more narrowly tested the effect of message frames on various climate change attitudes and behavioral intentions, analyzing 27 effect sizes from nine published studies (Li & Su, 2018). The current meta-analysis expands the scope of interventions to include any type of experimental manipulation across a larger range of studies. In particular, the current meta-analysis integrates and reconciles experimental studies of interventions designed to influence climate change attitudes for people in the United States while identifying potential moderators of their effectiveness. We turn to those moderators next.

Political ideology is a strong predictor of climate change beliefs, and there is evidence that political party in particular drives differences in support for attempts to address climate change (Ehret, Sparks, & Sherman, 2017; Hornsey, Harris, Bain, & Fielding, 2016; McCright & Dunlap, 2011). Researchers have examined strategies to communicate climate change in a way that increases acceptance of it or endorsement of policies, especially among conservatives and those most skeptical of climate change. Therefore, it is important to test the differential effectiveness of interventions among liberals, conservatives, and moderates.

Research on motivated reasoning provides some predictions about how individuals may process information about climate change. *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 consistent 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's beliefs change 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 (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 (P. S. Hart & Nisbet, 2012; Kahan, Peters, Dawson, & Slovic, 2017; Palm, Lewis, & Feng, 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, & Leiserowitz, 2019). Traditional research on motivated reasoning may be "too hot", assuming more directional, political motivated reasoning than the evidence suggests (Hennes, Kim, & Remache, 2020).

A recent meta-analysis highlights evidence that political partisans tend to reject information that is counter to their pre-existing beliefs (Ditto et al., 2019), suggesting that conservatives will be less influenced by climate change interventions (i.e., smaller effect sizes) than liberals. If conservatives are motivated to form accurate conclusions, then some interventions might be effective like those that provide evidence perceived as strong by conservatives (Druckman & McGrath, 2019). However, it is unlikely that many of the traditional science-based interventions will consist of evidence perceived as strong by conservatives, given their distrust of climate science (Lewandowsky & Oberauer, 2016; Washburn & Skitka, 2018). If conservatives are motivated to form directional conclusions, then interventions may be effective if they affirm conservative values (Druckman & McGrath, 2019). Given the specific nature of these two

elements -- interventions that provide strong evidence as perceived by conservatives or affirm conservative values -- it seems unlikely that many interventions will fit either situation. Therefore, it is expected that most interventions are interpreted in a partisan manner, leading to rejection of the information rather than change in attitudes and thus smaller effect sizes for conservatives.

Relatedly, there is a line of research that investigates how attitude measures are phrased and whether they use the term “global warming” or “climate change.” Some evidence suggests that the phrasing is important for conservatives (Schuldt, Konrath, & Schwarz, 2011), such that conservatives are more likely to believe in climate change than in global warming. Other studies show that Independents are especially influenced by the phrase choice (Benjamin, Por, & Budescu, 2017). As this line of research compares “global warming” to “climate change” (rather than treatment vs. control), it is unclear whether interventions using one phrase or the other would be more effective and therefore we do not propose a hypothesis.

A second theoretical moderator is the type of climate change attitude. Attitudes can include belief that climate change is happening, belief that climate change is caused by humans, concern about climate change, and support for climate change mitigation policy, among many others. Public polling reveals differences across these attitudes. For example, a recent poll found that around 73% of Americans believe in global warming, 62% believe it is human-caused, 66% are at least somewhat worried about it, and 44% say they have experienced its effects (Leiserowitz, Maibach, Rosenthal, Kotcher, Bergquist, et al., 2020). While support for climate change policy varies depending on the specific policy, Hornsey et al. (2016) provided meta-analytic evidence that the link between climate change belief and policy support is weak, suggesting distance between these two attitudes. One reason for this distance may be that any climate change policy would likely 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., 2019, Hardisty et al., 2010). This could make it even more difficult for interventions to increase it.

In addition, there is evidence that liberals and conservatives respond differently across these attitude outcomes. As public opinion polling has found, liberals have a strong belief in anthropogenic climate change, whereas many conservatives believe that the earth is warming but not due to human activity (Leiserowitz, Maibach, Rosenthal, Kotcher, Ballew, et al., 2020). Additionally, research suggests that support for climate change policy could be diminished among conservatives due to the regulatory nature of policy implementation (Campbell & Kay, 2014). This finding indicates that liberal and conservative differences in policy support might be larger than differences in climate change belief.

However, other research suggests the opposite conclusion. Renewable energy legislation can garner conservative support (Gillis & Popovich, 2017), especially when it is framed in line with conservative ideology (Hess, Mai, & Brown, 2016). Recent polling found that Trump voters support policies such as generating renewable energy on public land (77%), regulating pollutants that cause global warming (62%), and funding more research in clean energy (71%; Leiserowitz, Maibach, Roser-Renouf, Cutler, & Rosenthal, 2017). Corroborating these results, a recent media article noted that Trump won many of the country's top wind energy producing states in the 2016 election (Gillis & Popovich, 2017). Therefore, although there seems to be more evidence to suggest that liberals and conservatives respond differently to policies about climate change, other data suggests liberal and conservative attitudes towards policy may be closer than they are for other types of attitudes. Importantly, given that the current meta-analysis is focused on climate change, there may be less conservative support for the policies included in this meta-analysis than for other general environmental policies such as recycling policies.

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.

Common interventions involve describing the effects of climate change, whether through introducing a new scientific finding or simply providing general information. Within the field of climate change communication, the *information-*

deficit model posits that increasing public knowledge will lead to increased public support to address climate change (for a review, see Suldovsky, 2017). Some evidence suggests that knowledge about climate change may be beneficial for generating action on global warming and correcting misperceptions (Bord, O'Connor, & Fisher, 2000; Guy, Kashima, Walker, & O'Neill, 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 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 that both liberals and conservatives engage in denying scientific information that is not in accordance with their attitudes (Washburn & Skitka, 2018). Conservatives are less trusting of climate science than liberals are (e.g., Pechar, Bernauer, & Mayer, 2018), suggesting that additional information about climate change may be persuasive for liberals but not for conservatives. A related line of research has emerged in the past few years focusing on messaging about agreement among climate scientists. This research attempts to bridge the gap between science and the public. Often based on the *gateway belief model* (GBM), research on this topic posits that knowledge of 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, & Maibach, 2019; van der Linden, Leiserowitz, Feinberg, & Maibach, 2015).

Multiple experimental studies have examined the effectiveness of consensus messaging, with many providing support for the GBM (e.g., Brewer & McKnight, 2017; Myers, Maibach, Peters, & Leiserowitz, 2015; van der Linden, Leiserowitz, & Maibach, 2019; van der Linden et al., 2015). However, the overall effectiveness of consensus messaging -- especially when looking at attitudes such as belief and support for policy -- is debated (Dixon, Hmielowski, & Ma, 2019, 2017; Kahan, 2017; Kerr & Wilson, 2018; Ma, Dixon, & Hmielowski, 2019; van der Linden, Leiserowitz, & Maibach, 2018, 2017; van der Linden, Maibach, & Leiserowitz, 2019). Experimental evidence on consensus messaging is mixed regarding whether effective consensus messages merely increase participants' beliefs about the scientific consensus itself or if they also increase other climate change attitudes, such as belief and policy support.

Because of the potential catastrophic effects of climate change, discussion of it often creates anxiety and fear. Media members debate whether appeals to fear are better at compelling action than optimistic calls for hope (Mann, Hassol, & Toles, 2017; Wallace-Wells, 2017). Meta-analyses on fear appeals suggest that it may be an effective motivator depending on other aspects of the message (Tannenbaum et al., 2015; Witte & Allen, 2000). Although fear-based messaging in other domains is somewhat effective, its success within the environmental domain is mixed (see Reser & Bradley, 2017, for a review). Researchers have also examined the link between positive emotions and climate change attitudes (Smith & Leiserowitz, 2014). However, Chapman, Lickel, and Markowitz (2017) criticized the use of emotional messages as an effective tool in climate change communication, citing mixed evidence of emotions research and the unpredictable ways in which people respond to emotional messages. Given the range of responses they can provoke, the effectiveness of emotional messages relies on the combination of the emotion used to influence attitudes and the audience receiving the message.³

Because climate change is an abstract and difficult to grasp concept, it can be challenging for people to feel urgency in 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; Trope & Liberman, 2010), research using psychological distance manipulations attempts to make climate change feel closer psychologically. Some correlational studies suggest that people have stronger attitudes toward climate change the closer they feel to it (A. S. Singh, Zwickle, Bruskotter, & Wilson, 2017). Although theoretically expected to increase climate change attitudes, the experimental evidence for the effectiveness of psychological distance interventions is mixed (McDonald, Chai, & Newell, 2015), perhaps because reduced distance may increase fear (Spence & Pidgeon, 2010) or because CLT may not be a good theoretical fit for climate change (Brügger, 2020). This mixed evidence leaves doubt as to whether these interventions will be effective overall.

National security interventions highlight the benefits of addressing climate change through the lens of national security (e.g., increased energy independence), which may be more relevant for conservatives than for liberals. In a meta-analysis of political ideology and personality, Jost et al. (2003) found that conservatism was associated with death anxiety, system instability, uncertainty tolerance, and fear of threat and loss -- all constructs related to security. However, liberals and conservatives in the United States share a common ingroup identity as Americans so have a vested interest in its success, which makes an appeal to national security a potentially effective intervention for both groups (e.g., Wolsko, 2017).

Economic interventions highlight the economic benefits of addressing climate change or the economic harms of failing to do so. These interventions rely on Americans' (and particularly conservatives') widely-held desire for a healthy economy (Pew, 2016). Conservatives may be particularly attuned to economic issues as conservatism as an ideology generally favors small government and a free market economy (e.g., Crowson, 2009; Everett, 2013). Therefore, 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 values often associated with conservatism.⁴

Religious interventions included in the current meta-analysis generally take on two forms: arguing for environmental action by relying on religious values or texts and highlighting a religious figure's (e.g., Pope Francis) support for environmental causes. These interventions 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.⁵ Given this targeted nature of religious interventions, however, it is unlikely that they would be effective across multiple studies with religiously diverse samples.

Given that moralized attitudes (those rooted in one's sense of moral right or wrong) are fundamentally different from non-moralized attitudes (Skitka, Bauman, & Sargis, 2005), research using moral interventions attempts to increase engagement with climate change by reframing it as a moral issue. Some studies suggest that aligning a climate message with the moral values of its audience is an effective way to break through political polarization. Specifically, reframing climate change in terms of conservative morality (see Graham et al., 2011, Graham et al., 2009) seems to be an effective way to engage conservatives in climate change (Feinberg & Willer, 2013; Wolsko, 2017; Wolsko, Ariceaga, & Seiden, 2016). Other studies have used less specific moral messaging as an intervention to moralize climate change, relying on moral intuitions to drive support for action on climate change (Markowitz & Shariff, 2012).

While the evidence for each intervention type is complex, interventions that target specific audiences seem most promising. In particular, moral, economic, and national security interventions include studies that show strong positive effects for conservatives. The effectiveness of more general interventions, such as those that include information about the effects of climate change, is less clear due to the range of evidence for and against them.

The type of sample that studies recruit may play a role in the effectiveness of their interventions. Many studies within 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, Huber, & Lenz, 2012; Levay, Freese, & Druckman, 2016). There is some evidence that the conservatives on MTurk are similar to conservatives in general, whereas the liberals are slightly more liberal (Clifford, Jewell, & Waggoner, 2015). This asymmetry in strength of political identity implies interventions that are particularly effective for liberals are also more effective for MTurk samples than for nationally representative samples. However, research generally finds that MTurk samples provide quality data and perform similarly to nationally representative samples in experiments (Buhrmester, Kwang, & Gosling, 2011; Casler, Bickel, & Hackett, 2013; Crump, McDonnell, & Gureckis, 2013; Kees, Berry, Burton, & Sheehan, 2017).

Historically, college student samples have not been representative of the general public in psychology studies (Sears, 1986). Some polling evidence suggests that young Republicans and young people in general are more supportive of

action to curb emissions than the general population (Mooney et al., 2014). Another recent poll shows that 77% of American adults under 30 years-old 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 to 49 for the environment and climate change, respectively. This generational shift implies that college student conservatives might be less skeptical of climate change than the average American conservative. As a result, there may potentially be a ceiling effect for college students, such that interventions are not effective simply because college students already have extremely strong positive 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, Christenson, & Glick, 2020; Druckman & Kam, 2011).

In the previous section, we discussed reasoning for why intervention effectiveness might differ based on political affiliation, type of attitude, type of intervention, and type of sample. The current meta-analysis tests if interventions work overall then various moderators to identify factors of theoretical, practical, and methodological importance that explain variation in effect sizes across studies. Because politics is a key driver of climate change attitudes, we test each moderator individually then its interaction with political affiliation. This meta-analysis provides insight into factors that lead to successful interventions with the goal of helping identify the best ways to spur collective action on climate change.

Section snippets

Inclusion criteria

Studies had to meet the following three criteria to be included in the meta-analysis: 1) random assignment of participants into study conditions, 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....

Exclusion criteria

Given our ...

Retrieving effect sizes

75 reports qualified for inclusion in the meta-analysis (Fig. 1).¹⁰ The meta-analysis ultimately integrated 63 reports with 76 independent samples and 396 effect sizes from 76,033 participants. For each experiment, we...

Discussion

The current meta-analysis quantitatively integrated and reconciled experimental studies that tested interventions to influence climate change attitudes. This meta-analysis brought together 76 independent experiments with 396 total effect sizes that tested an intervention against a control condition to enable a consistent comparison across studies. Addressing climate change by implementing mitigation and adaptation strategies requires a public willingness to take action. Therefore, it is...

Data available

All data and study materials are publicly available at: <https://osf.io/q7jhe/>...

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Author statement

J.B.R: Conceptualization, Investigation, Analysis, Writing – Original Draft, Writing – Review & Editing, Supervision; **A.L.D:** Conceptualization, Analysis, Writing – Original Draft, Writing – Review & Editing, Supervision; **C.N.B:** Investigation, Writing – Review & Editing; **D.B.B:** Investigation, Writing – Review & Editing; **R.L.M:** Investigation, Writing – Review & Editing; **P.H.D:** Conceptualization, Writing – Review & Editing, Supervision....

Declaration of competing interest

None....

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...In the light of our findings, it might also be effective to sprinkle accurate and complete argumentation structures, which contribute more to knowledge construction, in order to provide heterogenous opinions and break open the echo chamber. Combinations of reframing or counter-framing and simple argumentation could reduce the required effort, so that such interventions might be done by intelligent bots, rather than by humans (Rode et al., 2021). On the side of social media companies, dubious websites that spread disinformation and fake news need to be consequently flagged and fact-checked to avoid sceptic users of falling into a disinformation rabbit-hole....

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...Following the theory of cultural cognition (Kahan et al., 2011), one would expect backfire effects if the presented consensus did not match the recipient's worldview. However, such backfire effects could not be found in the above meta-analyses (Rode et al., 2021; van Stekelenburg et al., in press). A major issue of existing literature on consensus messaging is that it is mainly limited to US-American and Australian samples, with some exceptions from New Zealand (Kerr & Wilson, 2018a; 2018b), Japan (Kobayashi, 2018), the UK (Harris et al., 2019), and Germany (Tschötschel et al., 2021)....

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