*Research Article*

# Promoting Persuasion With Ideologically Tailored Science Messages: A Novel Approach to Research on Emphasis Framing

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## Abstract
Motivated reasoning in response to disconfirming science information presents a challenging barrier to science communication. This article presents a novel approach to emphasis framing, in which functionally equivalent information is framed using ideologically consistent values and tailored to the audiences. In contrast to traditional framing approaches, science information is held constant across frames and only interpretations of the information are varied. Results from an experiment provide initial support for this ideology-based framing approach. Persuasive effects are stronger for an ideologically congruent frame than for an incongruent frame, and no boomerang effects were observed. We discuss implications and directions for future research.

## Keywords
motivated reasoning, boomerang effect, emphasis frame, tailored messaging, energy policies

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Communicating disconfirming information has long been a challenge in many communication contexts, especially in science and environmental communication. Research in psychology and communication has shown that individuals frequently engage in directional motivated reasoning (e.g., Kunda, 1990). They process information in ways that allow them to reach a desired conclusion, usually one confirming their preexisting beliefs and ideology, as opposed to accurately processing the information (Taber & Lodge, 2006). When presented with disconfirming evidence, people tend to engage in counterarguing, source derogation, and denial (Bolsen, Druckman, & Cook, 2014; Kunda, 1987; Slothuus & De Vreese, 2010). These strategies often lead individuals to reject new information in order to maintain their prior beliefs. In some cases, exposure to disconfirming information can even lead to a "boomerang effect," reducing endorsement of, and favorability toward, the position advocated in the message (Byrne & Hart, 2009), and contributing to attitude or partisan polarization (Lord, Ross, & Lepper, 1979; Taber & Lodge, 2006).

As science becomes more politicized (Bolsen & Druckman, 2015), motivated reasoning becomes an increasingly intractable barrier to effective science communication. People form attitudes and beliefs about politicized science topics based not only on scientific facts or evidence but also on their political ideology or partisanship (Fielding & Hornsey, 2016). As a result, disconfirming science information can trigger motivated reasoning, message rejection, decreased support for the issue, and decreased trust in science (Hart & Nisbet, 2012; Nisbet, Cooper, & Garrett, 2015; Zhou, 2016). Among the theoretical frameworks proposed as potential solutions to this problem, framing—or the selection and construction of a "central organizing idea or storyline that provides meaning" (Gamson & Modigliani, 1989, p.3)—has frequently been examined, as it can shape how individuals make sense of the information presented in a message (Goffman, 1974; Scheufele, 1999).

Framing studies in science communication, especially those on emphasis frames, have demonstrated the positive impact of framing a message to match the audiences' ideology—for example, an "economic" or "free market" frame for a climate change mitigation message targeting conservatives versus a "moral imperative" or "nature protection" frame for a message targeting liberals can make the message more persuasive (Campbell & Kay, 2014; Dixon, Hmielowski, & Ma, 2017; Myers, Nisbet, Maibach, & Leiserowitz, 2012; Wolsko, Ariceaga, & Seiden, 2016). Crucially, however, the messages used often contain substantively different information across frame conditions. Although this approach has been effective, it presents challenges for science communicators who typically want to convey the *same information* to different segments of the population while remaining persuasive and avoiding the boomerang effect.

The current study aims to address this issue by conceptualizing and empirically testing a new approach to emphasis framing that uses functionally equivalent information across conditions, while still tailoring the information to the audiences' ideology. More specifically, we expect ideologically congruent frames to mitigate the boomerang effects elicited by motivated reasoning in response to disconfirming science information, and to more strongly shift attitudes in the direction of the message in response to confirming information. The results provide evidence for this approach's effectiveness on persuasive outcomes.

## Motivated Reasoning

### Motivated Reasoning and Disconfirming Information

Motivated reasoning occurs when individuals process information with the goal of arriving at a predetermined conclusion, termed a *directional* goal, as opposed to an *accuracy* goal (Kunda, 1990). One common predetermined conclusion in motivated reasoning is the confirmation of people's preexisting beliefs, attitudes, and ideology (Kahan, 2013; Taber & Lodge, 2006). Directional motivated reasoning can manifest as a tendency to selectively expose to confirming information or to accept confirming messages quickly and without scrutiny (*confirmation bias*). It can also lead individuals to counterargue, derogate the source, discredit the evidence, and reject disconfirming messages (*disconfirmation bias*). Ultimately, individuals are likely to judge confirming messages as stronger and more persuasive than disconfirming messages (*prior attitude effect*; Bolsen et al., 2014; Kunda, 1987; Slothuus & De Vreese, 2010; Taber & Lodge, 2006).

In line with the *disconfirmation bias*, research has shown that exposure to disconfirming information not only fails to sway people's opinions but also can lower support for the issue advocated and lead to more extreme negative attitudes, a phenomenon termed the *boomerang effect* (Byrne & Hart, 2009). Boomerang effects, in turn, can contribute to attitude or partisan *polarization* (Bail et al., 2018; Taber & Lodge, 2006), especially among people who hold strong attitudes (Leeper, 2014) or strong political ideology or partisanship (Mason, 2018), people who are more politically sophisticated (Taber, Cann, & Kucsova, 2009), and in some cases, people who have been exposed to contentious deliberations or disagreements (Kim, 2015; Wojcieszak, 2011). The empirical evidence points not only to the lack of persuasive effect of disconfirming evidence or messages but also to the presence of negative, undesired effects. The same phenomenon has frequently been found in the context of controversial science topics.

## Motivated Reasoning in Science Topics

With the increased politicization of science in recent years (Bolsen & Druckman, 2015), political parties have taken stances on science issues such as climate change (Jacquet, Dietrich, & Jost, 2014), energy policies (Bolsen et al., 2014), and stem cell research (Ho, Brossard, & Scheufele, 2008). This phenomenon has allowed partisans to incorporate information about these politicized science topics into their political beliefs and ideologies, and to engage in directional motivated reasoning when exposed to messages about such topics. In particular, the disconfirmation bias and boomerang effect have been well documented in the context of politicized science. Conservatives' support toward climate change mitigation policies declined after reading a belief-disconfirming message describing the impacts of climate change featuring an outgroup member (Hart & Nisbet, 2012). Similarly, both conservatives and liberals reported more negative affect and engaged in more motivated reasoning after reading disconfirming science messages about politicized issues (climate change and human evolution for conservatives, fracking and nuclear power for liberals), resulting in lower trust in science (Nisbet et al., 2015). Both liberals and conservatives supported an energy bill when it was purportedly sponsored by their ideological allies, but they opposed it when it was attributed to ideological opponents (Bolsen et al., 2014).

This phenomenon presents a difficult challenge for science communication regarding politicized issues (Bolsen & Druckman, 2015; Fielding & Hornsey, 2016). Among the message strategies previously examined to address this problem, emphasis frames have been used to present science messages in ways that are congruent with the audience's ideology. Building on this literature, we are primarily concerned with overcoming the disconfirmation bias that occurs when people encounter ideologically disconfirming science information, but the strategy proposed should also make ideologically consistent messages more persuasive.

## Framing and Science Communication

### Emphasis Frames

The concept of emphasis frame was first proposed by Goffman (1974), who used the term *framing* to refer to "schemata of interpretation" that allow people to perceive, understand, and label events and occurrences, organizing them and giving them meaning (p. 21). Conceptualized in this way, framing provides an account of how people construct or select a "central organizing idea or storyline that provides meaning" (Gamson & Modigliani, 1989,

p. 3), or an interpretive schema through which people interpret and process new information (Goffman, 1974). The operationalization of emphasis frames in science communication often highlights different aspects or attributes of an issue to evoke different responses from people. For example, a message supporting climate change mitigation can have a "risks to the environment," "public health," or "national security" frame, all of which support policies and actions to mitigate climate change, but each highlighting a different reason for the stance (Myers et al., 2012). By emphasizing different aspects or attributes of an issue, the frame increases those attributes' salience in people's mind, prompting people to use them as the basis to evaluate the issue. If those attributes resonate with the audiences' preexisting beliefs, attitudes, or ideology, the frame will be more effective and persuasive. If the attributes do not resonate, the audience is likely to reject the frame (Myers et al., 2012; Zhou, 2016).

Encountering information about a politicized science topic can, however, activate the audiences' political ideology and partisan identity (Fielding & Hornsey, 2016; Mutz, 2008). Thus, if the frame emphasis aligns with the audience's ideology, the information contained within the frame is likely to be more persuasive. This proposition is similar to "value framing," a type of emphasis frame in which the highlighted aspect or attribute in each frame is a value (i.e., equality, tradition, ethical concerns, economic concerns, etc.). Several studies have shown that when the value in a particular frame reflects a highly important value of the audience, the frame resonates, and framing effects occur (Schemer, Wirth, & Matthes, 2012; Shen & Edwards, 2005). Alternatively, a message itself can provide the audience with a value frame to interpret a particular issue (i.e., gay marriage is an issue of equality) and thus exerts impact not only on the audiences' attitudes and beliefs but also on the interpretation they use to understand the issue itself (Brewer & Gross, 2005; Shah, Domke, & Wackman, 1996). As some values are frequently associated with either liberalism or conservatism in the current U.S. political climate (Graham, Haidt, & Nosek, 2009; Zhou, 2016), it is expected that a frame interpreting the issue using a conservative value would be more effective and resonant for a conservative audience, and vice versa, even for disconfirming information. Framing studies that focus on politicized science topics have tested this proposition and found that, indeed, conservatives are more persuaded by messages about the threat posed by climate change when the message is framed in terms of free market solutions than in terms of regulation (Campbell & Kay, 2014; Dixon et al., 2017). Similarly, Wolsko et al. (2016) showed that conservatives reported higher levels of proenvironmental attitudes and conservation intentions after reading an environmental message that framed conservation as a matter of authority, purity, and patriotism—values

that align with conservative rather than liberal ideology (Graham et al., 2009).[1] Clearly, this type of ideology-based framing can overcome the disconfirmation bias and polarization that stem from motivated reasoning in response to disconfirming information in these controversial science topics.

As operationalized in these studies, however, emphasis frames usually contain vastly different information in order to focus on different aspects or attributes of an issue. That is, the focus of a pro-issue frame differs in meaningful ways from the focus of an anti-issue frame. Similarly, in terms of ideology-based framing, the focus of a pro-issue *liberal* frame (e.g., a pro–climate change mitigation message focusing on the *environmental* consequences of climate change) is entirely different from one with a pro-issue *conservative* frame (e.g., a pro–climate change mitigation message focusing on *economic* consequences). Thus, the liberal frame would contain information about the loss of natural habitat from climate change, while the conservative frame would include information about the loss of arable land due to climate change, but no frame would contain both. The resulting differences in information content make it very difficult, perhaps even impossible, to distinguish framing effects from the effects of the information itself (Leeper & Slothuus, 2015; Nelson, Oxley, & Clawson, 1997). From a more applied perspective, the required changes to the message also make it difficult to communicate the same science information to different audience segments. To address this concern, we propose a new operationalization of emphasis frames in which different aspects and attributes of an issue are made salient while presenting equivalent scientific information.

## A Novel Approach to Operationalizing Emphasis Frames

The proposed approach to operationalizing emphasis frames divides the message into two conceptual elements: information and interpretation. For each message pair, the information remains constant, but it is attached to a different interpretation. In both versions of the message, the factual information serves as supporting evidence for the interpretation, while the interpretation serves as the central organizing idea, designed to evoke a particular ideological belief or value in audience members. In other words, the interpretation tells the audience how to contextualize the information, what it means, how it should be understood, and how it fits into their existing beliefs and ideology. For a liberal frame, the interpretation would be compatible with liberal values and ideology; and for a conservative frame, the interpretation would similarly align with conservative values and ideology. The disconfirming information can thus be attached to an ideologically consistent interpretation to reduce the disconfirmation

bias and boomerang effect due to motivated reasoning. This operational-ization of the emphasis frame contains functionally equivalent informa-tion across frames, with ideologically consistent interpretations of this information manipulated for each frame.

Consider the following passage:

> Toxic chemicals in fracking fluid and wastewater have been linked to many health problems, imposing economic costs ranging from healthcare to workplace absenteeism and reduced productivity. In 2008, toxic waste resulted in healthcare costs of more than $10 million in the Arkansas' Fayetteville Shale region alone.

This same piece of information can be used to support the interpretation that fracking is harmful from either a liberal or a conservative ideology. If the information is attached to the interpretation that "fracking brings about seri-ous public health problems," the overall frame evokes a liberal ideology value and should resonate more with self-identified liberals. If the informa-tion is attached to the interpretation that "fracking is unproductive because of money spent on services such as healthcare and toxic waste cleanup," the overall frame evokes a conservative ideology value, and should resonate more with self-identified conservatives, even though the evidence contained reamins the same.

This approach is a stark contrast to more conventional emphasis frame operationalizations, which typically alter the information contained. For example, one message might only describe fracking in terms of its economic costs, while another would focus exclusively on the threat to public health. Under this conventional operationalization, the information is selected to fit the frame, prompting the content of an economic frame to be (drastically) different from the content of a public health frame. Under our proposed alter-native, the interpretation is selected to fit the information and the audience's ideology, allowing the frames to have the same content while prompting the audience to process that same content in differential ways.

This proposed operationalization of the emphasis frame could allow sci-ence communicators to convey the same information about politicized sci-ence topics to different segments of the population while reducing the disconfirmation bias by framing the information in ideologically consistent interpretations. We primarily expect this ideologically tailored framing strategy to make disconfirming messages more persuasive, but the effect should also hold for confirming messages—that is, an ideologically con-gruent confirming message should also be more persuasive than an ideo-logically incongruent one. In the current study, we aim to test the effect of

this form of emphasis frame in the context of energy policies. Energy policy is highly politicized, and individuals' support or opposition typically fall along ideological lines (Funk & Rainie, 2015). In other words, most audience members already possess ideologically consistent beliefs about these energy policies, making this an ideal topic for our test. Attitude toward the issue and policy support for the issue are the two outcomes of interest.

> *Hypothesis 1*: Individuals' ideology will moderate the relationship between emphasis frame and attitude toward the issue. Exposure to an ideologically congruent frame about an issue will lead to more message-consistent attitudes compared to exposure to an incongruent frame.
> *Hypothesis 2*: Individuals' ideology will moderate the relationship between emphasis frame and policy support. Exposure to an ideologically congruent frame about an issue will lead to more message-consistent policy support compared to exposure to an incongruent frame.

Framing effects should extend beyond their influence on people's cognitions. To demonstrate this, we examine the frames' indirect effect on behavioral intention. We anticipate that frame-induced attitude change will in turn influence behavioral intention. According to several planned behavior models, attitude, in conjunction with other factors such as perceived norms and self-efficacy, is an important predictor of behavioral intention (theory of reasoned action, Ajzen, 1991; theory of planned behavior, Fishbein & Ajzen, 1975; integrated model of behavioral prediction, Fishbein & Yzer, 2003). Behavioral intention is, in turn, an important predictor of actual behavior. Behavioral intention can therefore give us more insight into how attitude shift after message exposure to different frames can have an impact beyond people's evaluation of the issue. Thus, we proposed the following hypothesis:

> *Hypothesis 3*: The effect of emphasis frame on behavioral intention in support of the issue will be mediated by attitude toward the issue.

## Method

### Sample

A total of 1,069 participants completed the study. Participants were recruited by Qualtrics Panels from a panel operated by Lucid. Quota sampling was used to obtain equal proportions of males and females, liberals and conservatives. Those who self-identified as moderates were excluded from the study. Twenty-nine participants who spent less than 2 minutes or more than

10 minutes reading the stimulus articles were removed from the sample, leaving $N = 1,040$. Of the 29 cases removed, 15 were liberals and 14 were conservatives; 13 were male and 16 were female. Overall, there were no significant differences between our quota characteristics among the removed cases. The remaining sample included 500 (48.1%) men and 528 (50.8%) conservatives.

The sample had a mean age of $M = 50.90$ years ($SD = 16.52$). Of the participants, 876 (84.2%) self-identified as White/Caucasian, 79 (7.6%) as Black/African American, 52 (5%) as Hispanic/Latino, 32 (3.1%) as Asian/Pacific Islanders, 5 (0.5%) as Native American, 1 (0.1%) as Arab/Middle Eastern, and 18 (1.7 %) as Other. Seventeen (1.6%) participants reported having completed some high school, 208 (20%) having a high school diploma, 224 (21.5%) having completed some college, 142 (13.7%) having an associate's degree, 298 (28.7%) having a bachelor's degree, and 151 (14.5%) having or completing a master's degree or higher. The median annual household income was between $40,000 and $49,000.

## Design and Procedure

This study employed a 2 (issue: fracking vs. renewable energy) $\times$ 2 (argument: pro vs. anti) $\times$ 2 (frame: liberal vs. conservative) between-subjects online experimental design. Participants first answered screening questions about their gender and political ideology in order for us to enforce quota sampling. Those who self-identified as moderates or whose gender or political ideology had been filled by the quota were thanked for their interest and led to exit the study. Those who passed the screening questions were shown the consent form. After participants gave consent, they were randomly assigned to read one of eight articles about either fracking or renewable energy. The argument (pro vs. anti) and the frame (liberal vs. conservative) also vary across conditions (see section "Stimuli" for more details). Afterward, participants were asked to evaluate the article (how enjoyable, how engaging, etc.) to avoid sensitizing participants to the true outcome measures. They then filled out measures related to the outcomes of interest: attitude about the issue, policy support toward the issue, and behavioral intention in support of the issue (see section "Measures" for more details). In addition, participants were asked to evaluate how well each paragraph in the article they read would appeal to conservatives or liberals. This measure served as our manipulation check (see section "Manipulation Check" for more details). Finally, participants reported their demographic information.

## Stimuli

For our stimuli, we selected two ideologically charged energy issues: fracking and renewable energy. Environmental issues in general and energy policies in particular are an important part of the U.S. national agenda (Varadarajan & Zuckerman, 2012). More importantly, there is a clear discrepancy between overall support and partisan support for these two issues. For fracking, the overall support reported was 39%, while the partisan breakdown shows 23% support among liberals compared with 54% support among conservatives. For renewable energy, the overall support reported was 60%, and the partisan breakdown shows the opposite pattern: 77% support from liberals compared with 47% support from conservatives (Funk & Rainie, 2015). Clearly, people base their beliefs and attitudes about energy policies on their ideologies, which we expect to influence their processing and reception of scientific evidence or facts regarding these issues.

We developed eight articles, four about fracking and four about renewable energy, as stimuli for this study. For each issue, there are two articles arguing for the continued use and development of the energy source and two articles arguing against it. Of the two pro-issue articles, one utilizes ideas and values consistent with liberal ideology (care for underprivileged people, equality, protection of the environment, fighting climate change, etc.) as the frame, and the other utilizes ideas and values consistent with conservative ideology (economic development, job creation, nationalism, protection of the beauty and purity of nature, etc.). Similarly, there is a liberal-framed and a conservative-framed version for the two anti-issue articles. For the full text of the eight articles, see Supplemental Appendix A available online.

The information, including factual claims and empirical evidence used in the messages, is identical across framing pairs; only the interpretation varies (similar to the example framing fracking as an economic or a public health concern). Thus, the liberal-framed and conservative-framed articles in each issue-argument pair (pro-fracking, anti-fracking, pro-renewable energy, and anti-renewable energy) contain the same information and only differ by the interpretation of that information. On average, each article contains $M = 500$ words, with a minimum of 493 words (anti-fracking liberal frame) and a maximum of 508 words (pro-renewable energy conservative frame).

## Manipulation Check

After the outcome measures were collected and before demographic questions were asked, participants evaluated how well each paragraph in the

**Table 1.** Stimuli Pretest Results: Perceived Ideological Orientation of Messages.

|  | Liberal frame | | Conservative frame | | | |
|---|---|---|---|---|---|---|
|  | *M* | *SD* | *M* | *SD* | *F* | *p* |
| Pro-fracking | 6.51 | 2.26 | 4.47 | 2.66 | 44.66 | <.001 |
| Anti-fracking | 7.94 | 2.54 | 6.17 | 2.72 | 29.10 | <.001 |
| Pro-renewable energy | 7.89 | 2.49 | 5.51 | 2.50 | 58.67 | <.001 |
| Anti-renewable energy | 5.54 | 2.51 | 4.73 | 2.61 | 6.53 | .011 |

*Note.* Scores were reported on an 11-point scale, anchored by *Conservative* (= 1) and *Liberal* (= 11).

article they read fit either conservative or liberal values. They were shown each paragraph again (each article includes three paragraphs, each of which contains an interpretation and scientific information as supporting evidence) and were asked to indicate whether the paragraph is based on issues and concerns that are more important to conservatives or liberals on a 1 = *Conservative* to 11 = *Liberal* scale. In all cross-ideology pairs (e.g., pro-fracking liberal-frame and pro-fracking conservative-frame pair), the conservative frame was judged to be more conservative than the liberal frame. Means, standard deviations, and *F* test and *p* values are reported in Table 1.

## Measures

*Attitude Toward the Issue.* Attitude about the issue was measured with five items on a 7-point semantic differential scale from −3 to +3. Participants responded to these items ("bad - good," "unfavorable - favorable," "harmful - beneficial," "unviable - viable," "inefficient - efficient," and "unpromising - promising") to indicate how they felt about the issue. On an average, participants reported significantly more positive attitude toward renewable energy ($M = 5.90$, $SD = 1.39$, Cronbach's $\alpha = .95$) than toward fracking ($M = 3.78$, $SD = 2.07$, Cronbach's $\alpha = .98$), $t(1039) = 25.96$, $p < .001$.

*Policy Support.* Policy support was measured with six items on a scale of 1 = *Very strongly disagree* to 11 = *Very strongly agree*. Sample items include "[Fracking/Renewable energy] should be the focus of our national energy policy" and "[Fracking/Renewable energy] should receive subsidies from the federal government." On an average, participants reported significantly higher policy support for renewable energy ($M = 7.91$, $SD = 2.55$,

**Table 2.** Bivariate Correlation Coefficients Between Measures.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Age | — | | | | | | | |
| 2. Gender (female) | .00 | — | | | | | | |
| 3. Ideology | .12*** | .00 | — | | | | | |
| 4. Attitude toward fracking | -.02 | -.13*** | .41*** | — | | | | |
| 5. Attitude toward renewable | .00 | .02 | -.31*** | -.12*** | — | | | |
| 6. Policy support for fracking | -.05 | -.10** | .39*** | .89*** | -.15*** | — | | |
| 7. Policy support for renewable | -.11** | .03 | -.47*** | -.34*** | .74*** | -.30*** | — | |
| 8. Behavioral intention for fracking | .00 | -.11*** | .38*** | .79*** | -.11*** | .81*** | -.28*** | — |
| 9. Behavioral intention for renewable | -.05 | .02 | -.41*** | -.32*** | .63*** | -.31*** | .76*** | -.25*** |

**$p < .01$. ***$p < .001$.

Cronbach's $\alpha$ = .91) compared with fracking ($M$ = 4.52, $SD$ = 2.68, Cronbach's $\alpha$ = .89), $t(1039)$ = 25.94, $p < .001$.

*Behavioral Intention.* Behavioral intention was measured with seven items assessing how likely participants were to engage in a variety of behaviors in support of the issue (vote, sign a petition, contribute money, wear a button, try to convince other people, etc.) on a scale of 1 = *Not at all likely* to 11 = *Extremely likely*. On an average, participants reported significantly stronger intention to engage in behaviors in support of renewable energy ($M$ = 6.84, $SD$ = 2.09, Cronbach's $\alpha$ = .75) than in support of fracking ($M$ = 4.91, $SD$ = 2.09, Cronbach's $\alpha$ = .73), $t(1039)$ = 18.85, $p < .001$. All bivariate correlation coefficients between measures are reported in Table 2.

## Results

We begin by testing for issue-level differences. A pair of three-way analyses of variance (ANOVA) indicate that issue moderates the influence of argument on our two dependent variables: attitude toward the issue and policy support. The model predicting attitude indicates that issue has a significant overall influence, $F(7, 1032)$ = 80.23, $p < .001$, $R^2$ = .35. More important, it shows that there is an interaction between issue (i.e., fracking vs. renewables) and argument (i.e., pro vs. anti), $F(1, 1032)$ = 17.70, $p < .001$. No other interaction was significant. The mean difference in attitude between people who read the pro- and anti-fracking articles is bigger than the mean difference in attitude between people who read the pro- and anti-renewable energy articles. In other words, the effect of argument on attitude is stronger for the issue of fracking than for the issue of renewable energy.[2] The model predicting policy support is also significant, $F(1, 1032)$ = 76.26, $p < .001$, $R^2$ = .34, but the interactions are not: The argument and frame manipulations operated the same way on policy support across issues. Regardless of the reason for the intermittent differences between the issues, all subsequent analyses are conducted separately for fracking and renewable energy.

Next, we turn to the tests of our theoretical predictions. Hypothesis 1 posits that participants' ideology will moderate the relationship between frame condition and *attitude*, such that exposure to a frame that is congruent with a participant's ideology will lead to more argument-consistent attitude compared with exposure to an incongruent frame. To test this hypothesis, we conducted two simple moderation analyses using the PROCESS macro (Hayes, 2013), one for participants who read articles about fracking and one for participants who read articles about renewable energy. In both models, argument (anti vs. pro), frame (liberal vs.
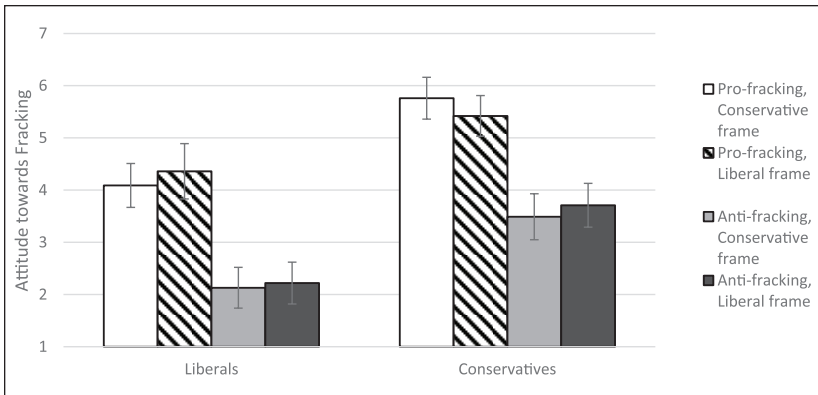
**Figure 1.** The effect of a persuasive message on attitude toward fracking, by argument, frame, and participant's ideology.

conservative), participants' ideology, and all interaction terms were included as predictors; participants' age and gender as covariates; and attitude as the outcome variable.

The model of fracking *attitude* is significant, $F(9, 510) = 35.84, p < .001$, $R^2 = .39$. Both argument ($\beta = 2.21, SE = 0.44, t = 4.97, p < .001$) and participants' ideology ($\beta = 0.35, SE = 0.07, t = 5.03, p < .001$) significantly influence attitude. In general, conservatives report more positive attitudes toward fracking than liberals, and participants who read the pro-fracking articles hold more positive attitudes than those who read anti-fracking articles, controlling for other predictors. These relationships can be seen in Figure 1. However, the three-way interaction term was not significant, $\beta = 0.19, SE = 0.14, t = 1.35, \Delta R^2 = .002, p = $ n.s. Although the pattern is generally in the expected direction—for example, liberals appear more responsive to the liberally framed pro-fracking article than the conservatively framed one—we cannot rule out the possibility that this difference is the product of chance. We summarize the effect of interactions between argument direction and frame conditioned on participant ideology in Table 3. (The results of the model described here are shown in the upper-left quadrant.) Thus, the first test does not provide support for the idea that ideologically framing scientific information influences people's attitude toward fracking.

The model of renewable energy *attitude* is also significant, $F(9, 509) = 27.89, p < .001, R^2 = .33$. Argument ($\beta = 1.06, SE = 0.36, t = 2.93, p = .004$) and participants' ideology ($\beta = -0.27, SE = 0.06, t = -4.68, p < .001$) are again significant predictors of attitude. As expected, liberals

**Table 3.** Interaction Between Argument Direction and Frame Conditioned on Ideology, by Issue.
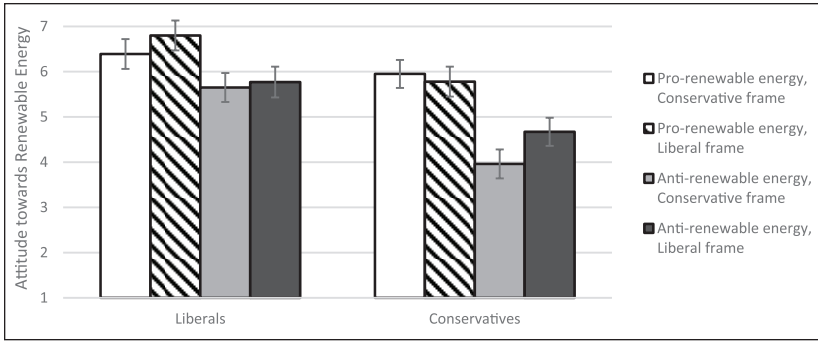
| | Attitude | | Policy support | |
|---|---|---|---|---|
| | β | *SE* | β | *SE* |
| Fracking | | | | |
| Liberal participants | −0.20 | 0.42 | −0.65 | 0.56 |
| Conservative participants | 0.60 | 0.41 | 1.34* | 0.55 |
| Renewable energy | | | | |
| Liberal participants | −0.43 | 0.32 | −1.11* | 0.54 |
| Conservative participants | 1.05** | .32 | 1.29* | 0.54 |

*Note.* Cell values correspond to the interaction between pro-issue argument and conservative frame.
*p < .05. **p < .01.

report more positive attitudes toward renewable energy than conservatives, and participants who read pro-renewable articles hold more positive attitudes than those who read anti-renewable articles, controlling for other predictors. In this model, the three-way interaction term is also significant, $\beta = 0.36$, $SE = 0.11$, $t = 3.25$, $\Delta R^2 = .014$, $p = .001$. As can be seen in Figure 2, the effect of argument on participants' attitude is larger when the frame is congruent with their ideology. For example, conservatively framed anti-renewable energy articles lead to more negative attitude toward renewable energy among conservatives than liberally framed anti-renewable energy articles. This effect is attenuated when the frame is not congruent with the participant's ideology. A similar pattern is observed among liberals, though the interaction between argument and frame is only significant among conservatives and not among liberals (see the lower-left quadrant of Table 3). The evidence of our new type of emphasis frame's effect on participants' attitude toward renewable energy provides partial support for Hypothesis 1.

Hypothesis 2 proposes that participants' ideology will moderate the relationship between resonance frame and *policy support*, such that exposure to a frame congruent with participants' ideology will lead to more argument-consistent policy support for the issue compared with exposure to an incongruent frame. To test this hypothesis, we again conducted two simple moderation analyses using the PROCESS macro (Hayes, 2013), one for participants who read articles about fracking and the other for participants who read articles about renewable energy. In both models, argument (anti vs. pro), frame (liberal vs. conservative), participants' ideology, and all interaction

**Figure 2.** The effect of a persuasive message on attitude toward renewable energy, by argument, frame, and participant's ideology.
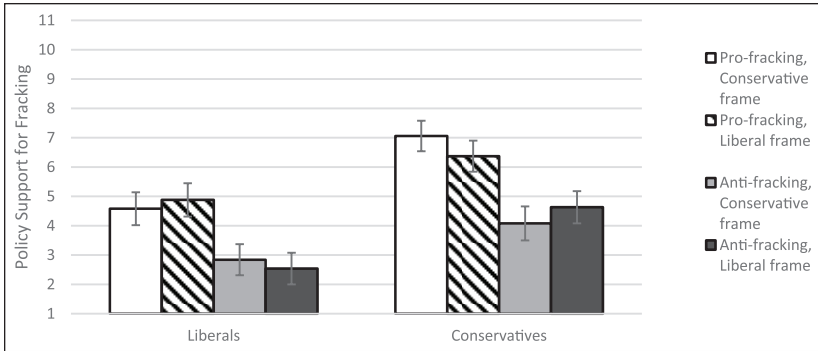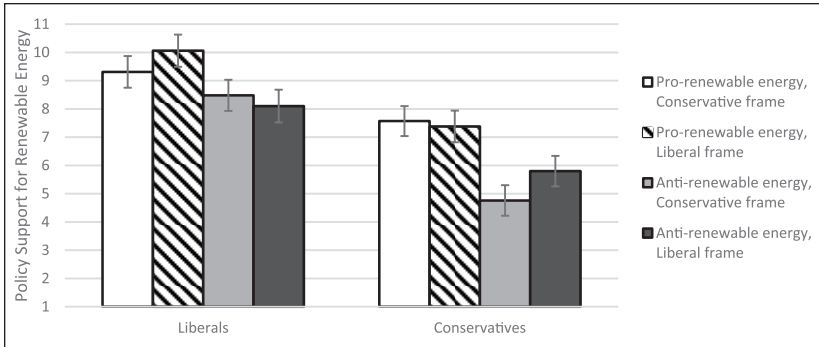


**Figure 3.** The effect of a persuasive message on policy support for fracking, by argument, frame, and participant's ideology.

terms are included as predictors; participants' age and gender as covariates; and policy support as the outcome variable.

The model for fracking *policy support* is significant, $F(9, 510) = 28.00$, $p < .001$, $R^2 = .33$. Argument ($\beta = 2.54$, $SE = 0.60$, $t = 4.26$, $p < .001$) and participants' ideology ($\beta = 0.51$, $SE = 0.09$, $t = 5.56$, $p < .001$) are both significant predictors, as is the three-way interaction term, $\beta = 0.46$, $SE = 0.18$, $t = 2.52$, $\Delta R^2 = .008$, $p = .01$. Figure 3 shows that arguments framed in ideologically consistent ways have a larger effect on participants' policy support than those framed in ideologically inconsistent ways. As with attitudes about renewables, the interaction between argument and frame is significant for conservative participants but nonsignificant for liberal participants

**Figure 4.** The effect of a persuasive message on policy support for renewable energy, by argument, frame, and participant's ideology.

(see the upper-right quadrant of Table 3). Although the influence of the frames on fracking attitudes was nonsignificant, the influence on policy support for fracking provides at least partial evidence that the frames are influential.

The model for renewable energy *policy support* is also significant, $F(9, 509) = 37.91, p < .001, R^2 = .40$. Argument ($\beta = 2.13, SE = 0.60, t = 3.52, p < .001$) and participants' ideology ($\beta = -0.61, SE = 0.10, t = -6.40, p < .001$) are significant predictors of policy support, and the three-way interaction term is significant, $\beta = 0.58, SE = 0.19, t = 3.13, \Delta R^2 = .012, p = .002$. This interaction is illustrated in Figure 4, which shows that the effect of a message on participants' policy support depends on the frame and their ideology. Compared to the results for attitudes about renewables, the interaction between argument and frame is significant for both conservatives and liberals (see the lower-right quadrant of Table 3). Thus, our new approach to emphasis framing influences message effects on policy support for both fracking and renewable energy, consistent with Hypothesis 2.

Finally, Hypothesis 3 proposes that the effect of framing on behavioral intention in support of the issue will be mediated by attitude toward the issue. To test this hypothesis, we estimated a pair of moderated mediation models using PROCESS (Hayes, 2013), one for fracking and the other for renewable energy. In both models, argument (anti vs. pro, coded as 0 and 1, respectively), frame (liberal vs. conservative, coded as 0 and 1, respectively), participants' ideology, and all interaction terms were included as predictors; participants' age and gender as covariates; attitude toward the issue as the mediator; and behavioral intention in support of the issue as the outcome. Mediation tests used 10,000 bootstrapped samples throughout. The model

related to fracking was significant, $F(9, 510) = 35.84$, $p < .001$, $R^2 = .39$. Attitude toward fracking was highly predictive of behavioral intention in support of fracking, $\beta = 0.85$, $SE = 0.03$, $t = 31.23$, $p < .001$, but the three-way interaction between argument, frame, and participants' ideology on attitude was not significant. Furthermore, the indirect effect of the frame on behavioral intention via attitude was not significant under any levels of the moderators.

The model focused on renewable energy was significant, $F(9, 509) = 27.89$, $p < .001$, $R^2 = .33$, as was the three-way interaction between argument, frame, and participants' ideology on attitude. Attitude toward renewable energy was also a significant predictor of behavioral intention in support of renewable energy, $\beta = 1.03$, $SE = 0.04$, $t = 24.02$, $p < .001$. Thus, the indirect effect of the frame on behavioral intention via attitude was significant. Specifically, among liberals, reading the liberal-framed pro-renewable energy article led to higher behavioral intention than reading the conservative-framed pro-renewable energy article, $\beta = -0.43$, boot $SE = 0.18$, bootstrapping 95% CI [$-0.82$, $-0.11$]. Among conservatives, reading the conservative-framed anti-renewable energy article led to lower behavioral intention than reading the liberal-framed anti-renewable energy article, $\beta = -0.83$, boot $SE = 0.26$, bootstrapping 95% CI [$-1.35$, $-.032$]. ($\beta$ represents the mean difference between the liberal frame and the conservative-framed frame conditions, with negative effect indicating that participants who read the liberal-framed frame reported higher behavioral intention than those who read the conservative frame.) Therefore, Hypothesis 3 was partially supported.

## Discussion

Effective persuasive communication of ideologically disconfirming information about controversial, politicized science topics has long been considered an intractable problem, due in large part to the prevalence of directional motivated reasoning. The current study proposed and tested a novel approach to emphasis framing designed to help overcome this bias. The approach holds constant the science information while varying the interpretation in ways that promote compatibility with the audience's ideology. We argue that tailoring messages in this way will enhance the persuasiveness of science messages, especially in reducing the potential boomerang effects in response to disconfirming information, across politically diverse audience segments.

We test this framing approach using two different energy policy topics, and the results are promising. We find the most consistent effects when predicting *policy support*. Support for the promoted policy is higher when information is framed in ideologically congruent ways than when it is not, regardless of the topic or the message stance. This finding can have important social implications, as policy support has been shown to influence people's willingness to fund and comply with a policy (Hensher, Shore, & Train, 2005; Meier & Morgan, 1982) as well as promote the development of and subsidies for new industries (Weiller & Neely, 2014). In short, shifts in policy support can meaningfully translate to what policies are enacted in real life and how people respond to these policies. The effect of framing on *attitude* is less robust. Pro-renewable energy articles are associated with greater favorability among conservatives when the science information is framed to be congruent with conservative values than when the same information is framed to be congruent with liberal values. There was no corresponding effect for fracking-related messages.

Finally, we observed a significant indirect path from framing to behavioral intention on the issue of renewable energy, but not fracking. For renewable energy, attitude was a significant mediator in the relationship between emphasis frame and behavioral intention. When reading an article whose stance is congruent with their own ideology (liberals reading pro-renewable energy articles and conservatives reading anti-renewable energy articles), the frame had significant indirect effects on behavioral intention via attitude. For liberals, reading the pro-issue liberal-framed article led to higher behavioral intentions in support of renewable energy; and for conservatives, reading the anti-issue conservative-framed article led to lower behavioral intentions. This pattern did not, however, replicate with fracking. These findings provide additional evidence for the effect of the new approach to using emphasis frame not only on the audience's cognitive processes but also on their future behaviors. When participants read an article about renewable energy whose stance aligns with their ideology, the effect this frame had on their behavioral intention was effectively mediated via attitude. Overall, we observed a complete absence of boomerang effects in all outcomes.

Taken as a whole, the pattern of results reported here provides preliminary evidence for the power of ideologically tailored science messages to persuade: mitigate the potential boomerang effects from exposure to disconfirming science information, and enhance persuasion from exposure to confirming information. Results demonstrate that we can manipulate how information included in a message is interpreted via framing, which affects recipients' message acceptance. After reading a message containing scientific information presented in an ideologically congruent interpretation, people reported

attitudes, policy support, and behavioral intention (mediated via attitude) in the direction of the message argument. This pattern held for both pro- and anti-arguments, and the effects were particularly strong for a message with both ideologically congruent stance and frame (e.g., a conservative-framed anti-renewable message). Furthermore, we can do this while keeping the informational content between frames constant and varying only the interpretations.

In practical terms, the results suggest that this type of emphasis frame can serve as an effective method to communicate disconfirming scientific information to audiences predisposed to resist the message. Within the context of environmental and energy issues, we provide evidence that this type of frame can safeguard people's attitude, policy support, and subsequent behavioral intention from ideologically motivated reasoning to disconfirming messages, and more strongly shift these outcomes in the desired direction for confirming messages. Other controversial science topics such as climate change, stem cell research, or genetically modified organisms may also benefit from this approach. Targeted and tailored messaging has been a fruitful area of research in both science (Dixon et al., 2017) and health communication (Kreuter & Wray, 2003), and this approach to emphasis framing may be a useful addition in the message-tailoring toolbox, one that does not require presenting completely different information to different segments of the audience.

The proliferation of partisan channels and platforms, including cable news, talk radio, online news sites and blogs, and so on (Arceneaux & Johnson, 2013; Stroud, 2011) poses a challenge to the proposed approach. To the extent that individuals screen themselves off from counterattitudinal messages, contact with the kinds of science messages we described in this article will be limited. Fortunately, however, a large and growing body of empirical evidence suggests that most Americans' media diets include a nontrivial amount of content from ideologically discrepant sources (e.g., see Bakshy, Messing, & Adamic, 2015; Flaxman, Goel, & Rao, 2016). Similarly, major news outlets ("mainstream news") are used by people across the political spectrum (Webster, 2014; Weeks, Ksiazek, & Holbert, 2016). In other words, science communicators can reach relatively diverse audiences, and this research suggests that they will be well served by crafting their comments in ways that resonate with those most likely to be biased against the scientific evidence (e.g., favoring a conservative frame over a liberal frame for a pro-renewable energy message). Furthermore, partisan outlets sometimes accept, or even invite, contributions from science communicators. If a scientist submits an opinion piece to the *Wall Street Journal* or to the *New York Times*, tailoring that message to its audience will likely

increase its impact, or at least minimize the backlash. And if a policy expert is invited to appear on Fox News or MSNBC, his or her ability to talk about the scientific evidence in terms resonating with its audience is likely to be beneficial for message reception.

Ethical considerations must also be made for the use of this approach. It is certainly possible for experts or science communicators to cherry-pick certain facts to support a particular agenda or to attach inaccurate interpretations to existing information, especially for issues in which the science information is highly complex and audience members are not likely to detect such inaccuracy. In fact, partisan media and political advocates frequently either selectively highlight supportive evidence (*selective presentation* of information) or deliberately interpret the same set of facts or circumstances to support their policy preferences (*selective interpretation* of the same information) (An & Gower, 2009; De Vreese et al., 2001). It is advisable, then, to follow the evidence—that is, to first identify the science information that needs to be communicated and then use this framing approach to construct ideologically congruent interpretations to most effectively convey this information. The end product should be a scientifically accurate message that also resonates with the audience.

While the current study has a more applied focus, it carries important theoretical implications. It introduces, conceptualizes, and tests a novel approach to emphasis framing, one in which the informational content and the interpretation are independently manipulated. In this way, it contributes to framing research more generally by clarifying and distinguishing persuasive effects due to difference in information content versus those due to framing, an ongoing and contentious issue in the framing literature (Borah, 2011; Scheufele & Iyengar, 2017). Although the effect sizes are small, they are theoretically meaningful for this body of literature. By narrowing the scope and increasing the clarity of framing as a construct, we hope to help make emphasis frames more theoretically sound and practically useful, not just for communicating environmental topics (e.g., climate change, energy policies, conservation) but also for other topics in science, health, risk, and political communication. This approach can be especially important for issues that entail the dissemination of disconfirming information (e.g., anti-vaccination, stem cell research, evolution, abortion, immigration). Finally, this new type of emphasis frame is not only useful for science communicators but also for scholars studying how the mass media and opinion leaders portray and disseminate science information, and how public opinions and policies are swayed by these practices, especially in the context of politicized scientific topics.

That our results are not entirely consistent across issues is an important limitation. The effect of the messages tested on attitude was stronger for fracking than for renewable energy, and we thus analyzed the issues separately. Doing so, we observed that framing effects were more consistently supported for the renewable energy messages than for the fracking messages. This may be an artifact of the messages used. For example, it could be that the frame manipulation was not strong enough, which is consistent with the observation that the effects were in the expected direction, but were not large enough to be significant. However, for both pairs of pro- and anti-fracking articles, the liberal frame was judged to be significantly different from the conservative frame, and the interaction effect was observed for one of the two dependent variables. Alternatively, this could be a product of the issues selected. For example, one issue may be more controversial or highly charged than the other, producing a stronger motivated reasoning response. Furthermore, participants may process information about fracking differently than information about renewable energy because of differences in interest, knowledge, issue polarization, and so on. We cannot resolve this question using the data collected here, but we recognize that it is important to explore more fully moving forward. Future studies should measure the degree to which a science issue is contentious among partisan audience members and consider it as a potentially moderator.

Finally, we see no evidence of boomerang effects, even when participants were presented with messages framed in ideologically incongruent ways. This finding might be due to the fact that within the context of a study, participants were required to read the stimuli articles in detail, and thus processed and evaluated them with less bias than they would in real life. Alternatively, fracking and renewable energy as science topics may be less controversial and polarized than previously investigated topics such as climate change or nuclear power, prompting less motivated reasoning. In either case, future studies should examine other topics not only to strengthen the findings with regard to the framing effects found here but also to test the generalizability of this novel type of emphasis frames in a variety of science topics, frames, and audiences.

Despite these limitations, the current study makes an important contribution to the literature and practice of science communication by proposing and demonstrating the effect of a novel approach to emphasis frames, which allows for functionally equivalent science information to be presented in ideologically congruent ways. This approach successfully enhanced the persuasiveness of science messages in politicized topics for highly resistant audience segments. Empirical findings provide initial evidence for this message strategy to overcome ideology-based motivated reasoning and the

associated boomerang effect usually found for disconfirming messages, as well as to further increase the favorability of confirming messages. The results provide enough tentative support to merit additional exploration, and we hope that scholars will examine these ideas more fully by testing this type of frame in other contexts, using other issues, drawing on other ideological values, and testing on other audiences.

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## Funding

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## Supplemental Material

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## Notes

1. Other studies have also looked at emphasis frames in science topics and found positive effect for framing (e.g., Detenber, Ho, Ong, & Lim, 2018; Druckman & Bolsen, 2011). However, the emphasized aspects or attributes in these frames did not align with liberalism or conservatism, and they were thus not designed to address the problem of motivated reasoning in science communication. Therefore, these studies are not reviewed here.
2. This finding may indicate that it is harder to shift people's attitude about renewable energy compared with their attitude about fracking. Alternatively, because attitude toward renewable energy is significantly more positive than attitude toward fracking, there may be a ceiling effect for participants who read the pro-renewable articles.

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