

Message Framing and Climate Change Communication: A Meta-Analytical Review

Nan Li
Texas Tech University

Leona Yi-Fan Su
University of Utah

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Abstract

This meta-analytic study reviewed experimental studies that examined the effects of message framing on public engagement with climate change. We included 10 studies that used self-reported measures of climate-related attitudes and behaviors, with 26 comparison pairs. The results suggested that message framing generally has a positive effect on individuals' engagement with climate change and its two sub-categories – behavioral intentions and support for climate policy. More specifically, we found message frames that emphasize the environmental, economic, and moral dimensions of climate change have a small-to-medium size impact on individuals' engagement with climate change. In contrast, message frames around public health implications or geographical identity barely influence individuals' engagement with this issue. We discussed the implications on strategic communications of climate change.

Keywords

climate change, framing, emphasis frame, meta-analysis

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Message Framing and Climate Change Communication: A Meta-Analytical Review

Ambitious policies for mitigating climate change require substantial public support, yet the politicization of public discourses surrounding this issue has prevented a considerable portion of the United States constituents from taking appropriate actions (McCright & Dunlap, 2011). A 2016 Gallup poll showed that public views on climate change are split, with 84% of Democrats and only 40% of Republicans acknowledging the reality of climate change (Saad & Jones, 2016). The partisan polarization around climate change, as being significantly growing during the past decade, might lead to greater oscillation in policy outcomes (Dunlap, McCright, & Yarosh, 2016).

For decades, political scientists and communication scholars have identified framing as an effective communication strategy to connect a broad coalition of Americans to the issue of climate change (Nisbet, 2009). Framing climate change means to "remaining true to the underlying science of the issue while applying research from communication and other fields to tailor messages to the existing attitudes, values, and perceptions of different audiences" (Nisbet, 2009, p. 14). Messages are developed to emphasize certain considerations and dimensions of climate change, such as the environmental and public health implications of the warming trend or the economic costs and benefits associated with adaptation and mitigation technologies (Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010). Alternatively, climate change has been portrayed as a threat to national security or as a chance to expand our moral commitment to future generations and disadvantaged societal members (Markowitz, 2012; Markowitz & Shariff, 2012).

In an attempt to raise public awareness of climate change, mainstream media and opinion leaders have repeatedly conveyed these new meanings through a variety of frame devices, such as catchphrases, metaphors, sound bites, photographs, and other visual aids (Nisbet & Scheufele, 2009). Such frame devices often focus on different content aspects of the same issue and vary in the degree of abstraction (see Schäfer & O'Neill, 2017 for a review). In this study, we focused on the *topical frame*, which refers to content-oriented frames that are specific to an issue (Schäfer & O'Neill, 2017). Existing evidence on the effects of topical frames on individuals' concern and engagement with climate change is largely inconsistent (Bernauer & McGrath, 2016). Researchers have not arrived at a clear consensus regarding which type of topical frameworks are most effective and on what attitudinal or behavioral outcomes. While some researchers have advocated the use of tactic frames to promote environmental behaviors, others doubted the effectiveness of simple reframing in boosting public support for climate policy (Bernauer & McGrath, 2016)

The aim of this meta-analytic study is to review the existing empirical studies on climate change frames and offer conclusions regarding the main effect of message framing on a series of behavioral and attitudinal outcomes. We reviewed the existing literature and re-analyzed the experimental data published between 2010 and 2017. Specifically, we examined the overall effect of message framing on four outcomes, including climate-related concerns, behavioral intentions, support for climate policy, and a combined measure of all three.

Additionally, we examined the respective effect of five topical frames, namely *economic frame*, *morality frame*, *environment and biodiversity frame*, *geographical identity frame*, and *public health frame* on these measures. The effects of potential moderators, including the type of message frame, the source of framed messages, and the presentation mode (i.e. visual vs. textual) were also tested. We discussed the implications of developing communication strategies to promote public awareness and support for climate policy.

Theoretical Framework and Literature Review

In spite of the tremendous volume of research done on framing, the concept has been characterized by theoretical ambiguity and a lack of methodological consistency regarding how it has been operationalized (Cacciatore, Scheufele, & Iyengar, 2015). Previous researchers have defined message frame in a variety of ways, most of which can find their roots in psychological or sociological traditions (Scheufele & Iyengar, 2013). Framing studies that grew from the psychological tradition focus on presenting a piece of an informationally-equivalent message in different formats or styles (Scheufele & Iyengar, 2013). For example, Whitmarsh (2008) used different terminologies to label the issue of climate change and found that the term *global warming* can evoke more concerns among the UK public than the term *climate change*.

In contrast to this type of *equivalence frame*, the *emphasis frame* adopted from sociological foundations conceptualizes frame as a component of journalistic and popular discourses (Borah, 2011; Scheufele & Iyengar, 2013). Gitlin (1980) suggested that frames emerge in public discourses in part as an outcome of journalistic routines that allow them to quickly identify and classify information and “package it for efficient relay to their audiences” (p. 7). News frames are “a central organizing idea or storyline that provides meaning to an unfolding strip of events” (Gamson & Modigliani, 1989, p. 3). In general, this line of research focuses on the “words, images, phrases, and presentation styles” that are used to construct news stories and the processes that shape this construction (Druckman, 2001, p. 227).

In this study, we focused on the concept of *emphasis frame* and defined message frame as information that conveys differing perspectives on some events or issues. Frames, in this sense, are interpretive storylines “communicating why an issue might be a problem, who or what might be responsible for it and what should be done about it” (Nisbet, 2009, p. 15). By assigning greater weight to certain considerations or elements of an issue, emphasis frames can influence individuals to focus on those particular considerations in the decision-making process (Scheufele & Tewksbury, 2007). For instance, Jones and Song (2014) exposed individuals with either individualistic or egalitarian values to message frames that are either cognitively congruent or incongruent to their predispositions. Results showed that when respondents read culturally congruent stories, they tend to organize climate change policy-related concepts in line with what the story presents (Jones & Song, 2014). Similarly, Rohling et al. (2016) showed that messages tailored towards farmers’ needs of local and geographically relevant discourses resonate most effectively with them when it comes to the discussion of climate change.

Climate Change and Message Frames

As Nisbet (2009) pointed out, emphasis frames only function as organizing devices and are not equivalent to specific policy positions. A frame can include pro, anti, and neutral arguments or a combination of any of those (Nisbet, 2009). With regard to climate change, five frames are commonly used to highlight the economic, environmental, and moral implications of this issue for both local and global communities. For instance, Republican leaders have constantly used the economic consequence frame to oppose action on climate change (Bidwell, 2016). However, scholars and advocates have suggested tempering this discourse with a framed narrative emphasizing the job opportunities created by renewable energy and the economic benefits of increased energy productivity (Dernbach, 2016).

In addition to the *economic frame*, publics tend to organize their conception of climate change based on its environmental and ecological implications. As Maibach et al. (2010) noticed, “climate

change is framed as an environmental problem, this interpretation likely distances many people from the issue and contributes to a lack of serious and sustained public engagement necessary to develop solutions” (p.2). However, there is one subcategory of the *environmental frame* that has been accepted in general and particularly among people who reject the notion of human-caused climate change – the geographical identity frame (Sapiains, Beeton, & Walker, 2016). This frame, as developed by Sapiains and colleagues, emphasizes that environmental actions are fundamental for the preservation of the geographical identity and attaches great cultural values to the natural environment (Sapiains et al., 2016). Survey results showed that climate skeptics residing in Australia were more willing to “do something for the environment” when environmental conservation is associated with their identity rather than with climate change per se or biodiversity (Sapiains et al., 2016).

More recently, scholars and religious leaders have emphasized the religious and moral dimensions of climate change (Severson & Coleman, 2015). An increasing number of Christian leaders, including Pope Benedict XVI, have been “emphasizing the religious duty to be stewards of God’s creation” (Nisbet, 2009, p.21). In his encyclical letter, *Laudato Si*, Pope Francis emphasized that it is a moral commitment to address climate change as it disproportionately affects the poorest countries and has profound effects on human rights and social justice (Li, Hilgard, Scheufele, Winneg, & Jamieson, 2016). In addition, the *morality and ethics frame* emphasizes an “expanded identity” into future generations. Markowitz and Shariff (2012) suggested that this frame could bolster a sense of moral imperative to mitigate climate change and to promote superordinate values to overcome the divergent opinions between liberals and conservatives around this issue.

During the past decade, the public health implications of climate change have also emerged as powerful interpretative resources for experts and advocates (Maibach et al., 2010). The *public health frame* stresses the potential of climate change to increase the spread of geographically limited infectious diseases, asthma, allergies, and other salient health problems (Maibach et al., 2010). Other serious health consequences of climate change are associated with the migrations of people from coastal regions and the destruction of agriculture in already stressed regions of the world (Dickinson, Crain, Yalowitz, & Cherry, 2013). The *public health frame* also shifts the geographic location of climate change impacts, “replacing visuals of remote Arctic regions, animals, and people with more socially proximate neighbors and places across local communities and cities” (Nisbet, 2009, p.22).

Framing Effects on Climate-related Attitudes and Behaviors

The “emphasis” approach to framing demonstrates that highlighting certain considerations in a message can lead individuals to focus on those particular considerations when making decisions (Borah, 2011). Studies have found that exposing individuals to different types of climate change frames can shape their concerns, behavioral intentions, and support for climate policy (e.g., Scannell & Gifford, 2013; Wolsko, Ariceaga, & Seiden, 2016). For instance, researchers showed that messages have a significant impact on individuals’ value-belief systems and subsequently on their behaviors when they present climate change as a threat to individuals’ geographical identity (Scannell & Gifford, 2013). Specifically, when being exposed to a message emphasizing the negative impact of climate change on the local environment, people were more likely to shift their opinions on climate change compared to when they read a message emphasizing global impact (Scannell & Gifford, 2013).

In addition, researchers have suggested that message framing works most effectively when it resonates with recipients' preexisting attitudes and/or mental schemas. Wolsko et al. (2016) exposed liberals and conservatives to climate change messages using differing moral frames. They demonstrated that when reading a story that portrays environmental protection as a matter of "obeying authority, defending the purity of nature, and demonstrating one's patriotism to the United States," conservatives are more likely to shift their attitudes in the pro-environmental direction than liberals are (Wolsko, Ariceaga, & Seiden, 2016, p.7).

Nonetheless, previous research has not arrived at a clear consensus regarding which types of climate frames are most effective and on what attitudinal and/or behavioral outcomes. While some researchers have suggested using religious moral frames and economic efficiency frames to promote public support for climate policy, the effectiveness of such frames has not received sufficient empirical support (Severson & Coleman, 2015). In a similar vein, Bernauer and McGrath (2016) found that simply reframing the issue of climate change in terms of its benefits for technological innovation, green jobs, community building, and public health could not motivate individuals to be supportive for climate policy.

Purpose and Research Objectives

With these inconsistent findings in mind, we intended to examine and systematically differentiate the main effects of different climate change frames on three attitudinal and behavioral outcomes, including general concerns of climate change, behavioral intentions, and climate policy support. To achieve this goal, we conducted a meta-analysis of existing experimental studies on climate change framing. In addition, we explored how the effects of each climate frame on attitudinal and behavioral outcomes might vary for other message characteristics, including source (sourced vs. unsourced) and presentation mode (visual vs. text-only). Our major research objectives include the following.

1. To understand the overall impact of message framing on public engagement with climate change and its three sub-categories, including climate change concern, behavioral intentions, and support for climate policy.
2. To examine whether and how the persuasive effects of message framing vary across different types of frames, including the environment, economic, public health, geographical identity, and morality frames.
3. To examine how the persuasive effects of message framing might differ between messages that are attributed to different sources (i.e., sourced vs. unsourced) and presented in differing modes (i.e., visual vs. text-only).

Methods

Literature search

Common terms referring to climate change, including climate change, global warming, climate mitigation, climate denial, climate adaptation, climate regulation, climate policy, and climate disaster were used as the primary keywords for searching journal publications. In addition, we paired each of the terms with the term framing or frame to locate specific studies that test the effect of message framing in climate change communication. To maximize the number of qualified publications, we turned to multiple electronic databases, including PsycINFO, Web of Science, Google Scholars, and Academic Research Complete (EBSCO) to search published journal articles. Twenty unique entries published in scholarly journals between 2010 and 2017 were obtained.

Criteria for inclusion in the meta-analysis included the following. First, the study had to focus specifically on the issue of climate change and/or related policy. Studies that addressed environmental protection or other climate-related issues, such as drought and natural disaster, were excluded. Second, the study must be a lab experiment or a field study where the effect of message framing was compared against a non-framing contrast group. If a study included a comparison only between two message frames (e.g., Bertolotti & Catellani, 2015), it was excluded. Third, the outcome variables should include at least one persuasion measure, such as attitudes, behavioral intentions, or support for regulatory policy. Our fourth criterion was that studies must contain available statistics for the meta-analytical purpose, such as sample size, Pearson's correlation, mean difference, standard deviation, p-value, regression coefficient etc. (see Borenstein, Hedges, Higgins, & Rothstein, 2011 for a review). One researcher with advantaged knowledge of statistics extracted the data and entered them into the Comprehensive Meta-Analysis V3 software for analysis. We included English-language studies conducted in a variety of countries and locations. Table 1 overviewed the details of studies that met these criteria. In total, nine published studies were identified.

Treatment of Dependent Variables

The effect of message framing was the dependent variable in this study. We operationalized it in terms of the overall changes in climate concerns, behavioral intentions, and policy support. If a study assessed changes in only one of the three measures, it was treated as the only indicator of framing effect for that study. If a study contained multiple criterion measures, we recorded the measures separately and calculated an effect size measure for each of them (Borenstein et al., 2011).

Coding of Moderating Variables

Frame type. Scheufele and Iyengar (2014) identified two board traditions of framing research and distinguished the concept of “equivalence framing” from “emphasis framing” based on the different ways in which they were operationalized in previous studies and the different psychological mechanisms underlying such processes. This study focused on emphasis-based frames, which vary the perspective or underlying dimension for considering an event (e.g., framing climate change as a public health problem or an environmental problem). Although we included studies that compared the effects of equivalence frames (i.e. frames that only vary the modes in which identical information is presented) if it met the inclusion criteria, we recoded the type of frames depending on its issue focus. Based on the literature review showed earlier, we categorized climate change frames into five categories, including *morality*, *environment and biodiversity*, *geographical identity*, *public health*, and *economy*.

The *morality* frame emphasizes widely shared humanistic values such as a duty to one another, concerns for future generations, and the intrinsic goodness (e.g., sanctity) of human and nonhuman life (Severson et al., 2015). This type of frame often calls for collective action on climate change and associates it with a sense of urgency (for example, “we have to act now or it will be too late”). Alternatively, morality frames can elicit a religious response to climate change by emphasizing the stewardship of humans over God's creation. Together, we coded messages that connect climate change with collective actions, future generations, human stewardship, social norms, and moral commitments into this category.

Table 1

Sampled Studies, Sample Size, Frame Type, Presentation Mode and Message Source.

Study Name	Sample Size	Frame Type	Presentation Mode	Has a Source or Not
Dickinson et al., 2013	647	Health	Text	No
Dickinson et al., 2013	667	Environment	Text	No
Dickinson et al., 2013	701	Morality	Text	No
Dickinson et al., 2013	742	Morality	Text	No
Hart, 2011	40	Environment	Text	Yes
Hart, 2011	40	Environment	Text	Yes
Hart & Feldman, 2016	315	Environment	Visual	Yes
Hart & Feldman, 2016	315	Economy	Visual	Yes
Hart & Feldman, 2016	315	Environment	Visual	Yes
Hart & Feldman, 2016	315	Morality	Visual	Yes
Hurlstone et al., 2014	40	Morality	Text	No
Hurlstone et al., 2014	40	Morality	Text	No
Hurlstone et al., 2014	600	Morality	Text	No
Jang & Mo, 2013	109	Identity	Visual	Yes
Jang & Mo, 2013	109	Identity	Visual	Yes
Sapiains et al., 2016	72	Environment	Text	No
Sapiains et al., 2016	72	Economy	Text	No
Sapiains et al., 2016	72	Identity	Text	No
Severson et al., 2015	49	Economy	Text	No
Severson et al., 2015	51	Economy	Text	No
Severson et al., 2015	51	Environment	Text	No
Severson et al., 2015	53	Environment	Text	No
Severson et al., 2015	54	Morality	Text	No
Severson et al., 2015	56	Morality	Text	No
Scannell & Gifford, 2013	300	Identity	Text	No
Scannell & Gifford, 2013	300	Identity	Text	No
Wolsko et al., 2016	185	Morality	Text	No

The second category was labeled *environment and biodiversity*, grouping framed discourses that emphasize the implications of climate change on plants, animals, and other aspects of nature. The core of this category is the importance of environmental motivations associated with the protection of plants and animals as drivers of pro-climate actions (Severson & Coleman, 2015). In terms of content, the *environment and biodiversity* frame identifies animal and plant species that are particularly vulnerable to the effects of climate change and depicts the potential or actual harms caused by climate change. Messages focusing on the negative impacts of climate change on nature in general or on specific animals, such as birds, polar bears, and zoo animals were coded into this category.

The *geographical identity* frame focuses on one's sense of attachment to a geographical region, such as a country, state, or city. Differing from the *environment and biodiversity* frame, the *geographical identity* frame places less emphasis on the intrinsic value of material benefits associated with environmental protection (Sapiains et al., 2016). Rather, it highlights the psychological and social benefits of taking care of the environment for the preservation of one's geographical identity (Sapiains et al., 2016). For instance, if a message framed climate change as a national security threat or discussed the environmental, economic, and social impact of climate change at the state and local level, we coded it as an identity-framed message. Similarly, if a message showed a nation or region's share of carbon emissions and framed it as a significant contributor to climate change, it would be coded into this category as well.

The fourth category is the *public health* frame, which delineates the health risks associated with climate change – including increased morbidity and mortality – due to multiple hazards, such as rising temperatures and increased frequency of extreme weather events (Myers, Nisbet, Maibach, & Leiserowitz, 2012). In addition to highlighting the physical impact, public health-framed messages emphasized the negative impacts of climate change on individuals' mental and psychological health. Messages in this category highlighted the health impact of climate change and usually pointed out the fact that individuals most at risk are the poor, the very young, the elderly, those already suffering from health problems, and individuals who lack access to affordable health care (Myers et al., 2012).

Finally, the *economy* frame included discourses addressing the economic impacts of climate change on societies and individuals. Messages in this category emphasized the materialistic reasons for mitigating climate change, such as installing solar panels when there were government subsidies, saving energy or water to reduce costs in the family budget, or paying an extra amount of tax for reducing the negative impacts of climate change on the local environment (Sapiains et al., 2016). In addition, messages that calculated the economic burdens caused by climate change, such as damages to property and infrastructure, declining productivity of agriculture, fisheries, energy production, and disruption to daily business were coded into this category.

Message source. We coded message format based on whether the framed message was presented as a piece of sourced or unsourced information. Previous studies have shown that the perceived source credibility can significantly influence the persuasive effect of a message (e.g., Hovland & Weiss, 1951). Considering the potential confounding effect of message sources, we coded news articles and other formats of stimuli that had an identified source as sourced information. When the framed message was simply presented as a preamble to survey questions, such as a brief introductory paragraph or part of a sentence, we coded it as unsourced information.

Presentation mode. In addition, we coded the presentation mode of each framed message as visual or text. While most visual frames are accompanied by textual explanations, we coded

messages that contained images, graphics, and interactive visual interfaces as visual and everything else as text-only information.

Calculation of Effect Size

The unit of analysis was an experimental pair in which the effects of a framed message was compared with a control group. Several articles presented multiple experimental pairs because multiple experiments were conducted or multiple group comparisons were included. In addition, if a study used multiple persuasion outcome variables, such as attitudes, behavioral intentions, or policy support, the effect on each measure was recorded separately and considered as an independent investigation. In total, our sample included 27 experimental pairs. For each experimental pair, we calculated the effect size statistic Standardized Mean Difference (SMD) and its 95% confidence interval (Borenstein et al., 2011). The Q statistics were used as a test of heterogeneity of effect sizes (Borenstein et al., 2011).

Results

Sample

Among the nine studies and 27 experimental pairs, sample sizes ranged from 40 to 762. When the sample size for experimental conditions was not available, we assumed an equal distribution of participants across the experimental and comparison groups.

Overall Effects of Climate Change Framing

The overall framing effect was computed using the random-effects model (Borenstein et al., 2011). Overall, message framing showed a significant effect on public engagement with climate change ($SMD = .172, p < .001$). As the standardized mean difference was relatively small and had a 95% confidence interval of .103 – .242, we concluded that the impact of message framing on public engagement with climate change was small (Table 2).

When the outcome variables were analyzed separately, ten comparison pairs examined the effects of message framing on *climate change concerns*, including awareness, emotional reactions, and perceived importance and harm. The main effect of message framing on *climate change concerns* was not significant ($SMD = .069, p = .455$). Fifteen comparison pairs investigated the effect of message framing on *behavioral intentions* related to climate change, including adopting clean energy technologies, as well as engaging in pro-environmental and conservation actions. Results yielded a small-size effect ($SMD = .156, CI = .075 - .236, p < .001$). In addition, nine comparison pairs used *public support for climate policy* as the outcome variable. Results showed that message framing has a medium-size effect on public support for climate policy ($SMD = .327, CI = .044 - .610, p = .023$). An overall analysis indicated that no substantial heterogeneity existed in the distribution of the effect sizes across all the investigations ($Q = 36.339, p = .067$).

Effects of Frame Type

Partitioning the data on the types of message frame yielded four comparison pairs examining the effects of *economic frame*, eight pairs examining the effects of *environment and biodiversity frame*, one pair examining the effects of *public health frame*, five pairs examining the effects of *geographical identity frame*, and nine pairs examining the effects of *morality frame*. Results showed that the *economic frame* ($SMD = .291, CI = .039 - .543, p = .024$), the *environment and biodiversity frame* ($SMD = .280, CI = .16 - .4, p < .001$), and the *morality frame* ($SMD = .168, CI$

= .098 – .238, $p < .001$) had a small-to medium size effect on the outcome variables (Table 3). However, the *public health frame* ($SMD = .035$, $CI = -.012 – .189$, $p = .660$) and the *geographical identity frame* ($SMD = .122$, $CI = -.0131 – .375$, $p = .344$) did not have a significant impact on the combined measure of climate change engagement.

Table 2.

Overall Effects of Climate Change Framing on Attitudinal and Behavioral Outcomes

Dependent Variable	<i>SMD</i>	<i>CI</i>	<i>p</i>
Climate change concerns	.069	n.s.	$p = .455$
Behavioral intentions	.156	.075 – .236	$p < .001$
Policy support	.327	.044 – .610	$p = .023$
Combined measure	.172	.103 – .242	$p < .001$

Note: n.s. indicates the 95% confidence interval is not significantly different than zero.

Table 3.

Effects of Different Frames on The Combined Measure of Climate Change Engagement

Frame Type	# of pairs	<i>SMD</i>	<i>CI</i>	<i>p</i>
Economy	4	.291	.039 - .543	$p = .024$
Environment and biodiversity	8	.280	.16 - .4	$p < .001$
Morality	9	.168	.098 - .238	$p < .001$
Public health	1	.035	n.s.	$p = .660$
Geographical identity	5	.122	n.s.	$p = .344$

Note: n.s. indicates the 95% confidence interval is not significantly different than zero.

Effects of Message Source

Among the nine studies under study, three studies attributed the framed message to a news organization, such as the Associated Press while six studies did not explicitly indicate the source of the presented information. Results showed that the main effect of a framed message was only significant when it was not attributed to a specific source ($SMD = .273$, $CI = .087 - .459$, $p = .004$). When the message was presented as part of a news story, the effect was not significant ($SMD = -.147$, $CI = -.508 - .215$, $p = .426$).

Effects of Presentation Mode

The sample included four studies that incorporated visual materials, such as graphics and figures to frame their messages. The main effect of visual framing was not significant ($SMD = -.147$, $CI = -.508 - .215$, $p = .426$). When the frame was delivered through texts only, the effect was significant ($SMD = .273$, $CI = .087 - .459$, $p = .004$). However, since most visual frames were attributed to a news organization, this result should be interpreted with caution.

Discussion

Framing, the idea of making certain aspects of an issue more salient in mediated communication, has been widely applied to climate change communication. The purpose of this study is to use meta-analysis to quantify the main effects of message framing on communicating climate change and promoting pro-climate behaviors. Results showed that although message frames seldom change people's concerns about climate change, they turn to be moderately shaping individuals' behavioral intentions and support for climate policy. Specifically, message frames that emphasized the economic, environmental, and moral dimensions of climate change were shown to have a small to medium effect on the combined measure encompassing climate change concerns, behavioral intentions, and policy support. However, frames featuring one's geographical identity in relation to climate change and/or the public health implications were not necessarily impactful. In addition, message frames not attributed to specific source were more effective than the ones from known sources, such as newspapers or other media outlets.

Before discussing the results in more details, we noted a few methodological limitations. First, the analysis only consisted of data published in peer-reviewed journals and might render our results to be subject to publication bias. Previous research showed that statistically significant results are three times more likely to be published than studies with null results in social science experiments (Franco et al., 2014). By only including formally published results, we might overestimate the main effect of message framing on the outcome variables. Future research should extend the search and include unpublished data or data published in alternative outlets, such as conference presentations, working reports, dissertations, and theses. Second, due to the limited sample size, we collapsed some categories in the tests of frame variables. For example, we did not separate secular morality frames, such as those emphasizing social norms and collective actions, from religious morality frames that focus on the environmental stewardship. Future researchers will need to develop more nuanced frame categories based on an expanded sample size.

Despite these limitations, our results shed important insights into the psychological mechanism underlying the effects of message frames. When used properly and forcefully, message frames can significantly shape individuals' behavioral intentions related to climate change and support for policy. In contrast, the effects of message framing on climate change concerns were rather limited. This finding was somewhat counterintuitive because researchers generally believe that changes in behavioral intentions and policy support are direct outcomes of attitudinal changes (Jones, Hine, & Marks, 2016). Nonetheless, message framing might result in behavioral changes by altering other variables such as perceived norms, self-efficacy, among others (Kahlor, Dunwoody, Griffin, Neuwirth, & Giese, 2003). The latter process might be particularly relevant when message frames emphasized one's moral commitment and responsibility to address climate change or the economic benefits of adopting clean energy technologies.

In addition, although researchers have highlighted the potential usefulness of the public health and geographical identity frames in communicating about climate change (Myers et al., 2012), we did not find sufficient evidence to support this claim. However, one should note that there was only one study testing the effect of the public health frame in our sample. Additional experimental studies are needed to thoroughly understand how an emphasis on the public health implications of climate change might change people's opinions and behaviors. Besides, several studies that examined the impact of geographical identity frames were not included in this study due to an absence of control groups (e.g., Bertolotti & Catellani, 2015). Researchers suggested that emphasizing the geographical relevance of climate change resulted in more positive attitudes among local respondents than highlighting the global impact of this phenomenon (Scannell &

Gifford, 2013). However, we knew little about the magnitude of effect size compared to a control group that receives no information.

Regarding other moderating variables, we found that the effect size was different depending on whether the framed messages were attributed to a news outlet or simply presented as a preamble to survey questions. Results showed that message frames are most effective when the source was not specifically indicated. This finding was particularly intriguing because the credibility level of a given news source did not seem to magnify the effectiveness of message framing, which contradicted the previous consensus (e.g., Kim & Kim, 2014). For decades, scholars and practitioners have called for a use of credible sources for enhancing the message strength. Presumably, the use of a well-known source, such as the Associated Press, should motivate people to assign high credibility to the conveyed message and exert significant influence; however, we found no positive evidence that can support this.

In addition, visual frames were not as effective as textual ones. However, since most visual frames used a known news outlet, such as the *Los Angeles Times*, as the source, it was impossible to partial out the potential confounding effect. Previous research has shown the potential power of visual framing in cultivating a positive belief of climate change and motivating supportive behaviors (see Schäfer & O'Neill, 2017 for a review). For example, Hart and Feldman (2016) found that images of solar panels accompanied by texts that discussed actions to address climate change significantly increased viewers' perceptions of self-efficacy. Future researchers need to investigate the potential effects of visuals and imagery in shaping public perceptions of climate change and behavioral intentions.

For decades, scientists, communication scholars, and professionals have acknowledged the power of linguistic devices in altering individuals' attitudes and behaviors regarding controversial sciences. Our results reflected that simple reframing of climate change into a potential opportunity for economic growth, an environmental hazard, or a moral issue might modestly change people's intentions of adopting environmental behaviors and support for policy. Although the effect is of minimal to medium size, depending on the type of frame and the specific outcome, it is statistically significant and applies to people with various backgrounds and cultural values. However, a large amount of literature shows that climate concerns and policy preferences are strongly shaped by "factors that cannot be affected or offset through climate change communication per se" (see Bernauer & McGrath, 2016, p.3 for a review). Citizens' attitudes and overall concerns regarding climate change largely hinge on their demographical backgrounds, worldviews, political ideology, and the characteristics of one's societal and geographical environments (Hornsey, Harris, Bain, & Fielding, 2016). Such factors also influence their selection of and attention paid to different sources of information. Therefore, appropriate message frames should be developed to tailor target audiences' specific values and backgrounds to maximize their persuasive effects.

Framing as a strategic communication device has been frequently used to convey environmental and scientific issues to a concerned public. With regard to climate change, the public discourse is always filled with framed narratives by interest groups, political actors, or corporations promoting particular viewpoints. However, empirical evidence on the effects of topical frames was largely mixed and inconsistent. Additionally, we lacked a systematic understanding of how framing effects might vary across the different presentation modes, sources, and content focus. Given the ever-growing volume of research in this field, it is important for communication researchers to clarify the nuanced ways in which message frames can be operationalized. By identifying the most effective frames through a systematic meta-analysis,

communication researchers would be able to reevaluate the theoretical rigor of existing evidence and propose strategies for science communications.

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ABOUT THE AUTHORS

Nan Li is an assistant professor of agricultural communications in the Department of Agricultural Education and Communications at Texas Tech University. This research relates to her work on strategic communications in the context of agriculture, science, and public policy.

Leona Yi-Fan Su is an assistant professor in the Department of Advertising at the University of Illinois at Urbana-Champaign. Her research focuses on examining the interplay between media and society in the context of science, health, and environmental topics.