Oxford Research Encyclopedia of Climate Science

Summary and Keywords

The importance of framing as a concept is reflected by the massive amount of attention it has received from scholars across disciplines. As a communicative process, framing involves making certain considerations salient as a way to simplify or shape the way in which an audience understands a particular problem and its potential solutions. As recently as the early 2000s, social scientists began to examine how strategic frames in a communication affect both individuals' beliefs about climate change and the actions they are willing to support to mitigate the likely effects. Research on the effects of how strategic frames influence the attitudes, beliefs, and preferences of individuals in this domain primarily builds on insights from framing theory, which explains that an individual's attitude or preference in any given context depends on the available, accessible, and most applicable (i.e., perceived strongest) considerations. But it is much more than theory: frames related to the effects and potential solutions for climate change have been employed strategically by various actors in an effort to shape public opinion and public policy.

date: 28 January 2018

Strategic Framing and Persuasive Messaging to Influence Climate Change Perceptions and Decisions

Perceptions of scientific consensus on climate change are thought to play an important role in determining support for policy actions. Consequently, strategic actors promote a particular agenda by accentuating the inherent uncertainty of climate science, thus casting doubt on the scientific consensus. This has contributed to partisan polarization on climate change and the rise of protective forms of information processing and reasoning in this domain. Strategic messages and frames that resonate with particular subgroups have no effect, or may even backfire, on other segments of the population. Additionally, as individuals who possess different partisan identities become more knowledgeable and numerate, they become increasingly likely to accept information and messages that bolster their existing group loyalties and to reject communications that challenge those identities. Science communicators are thus presented with a considerable barrier to building consensus among the public for action on climate change. In response, scholars have begun to identify strategies and approaches for addressing audiences with the kinds of messages that are most likely to resonate with individuals possessing a diverse range of values and political identities. Further research must identify ways to overcome partisan motivated reasoning on climate change and the persistent and deleterious effects that have resulted from the politicization of climate science.

Keywords: climate change, framing, polarization, politicization, motivated reasoning

Introduction

In recent years, scholars have begun to examine how exposure to communications that highlight different aspects of climate change—such as the level of consensus among climate scientists, the effects that will occur as a result of climate change, and potential policy solutions—influence the public's perceptions and willingness to take action on the issue. The bulk of this work focuses on how individuals respond to information they are exposed to in experimental settings that employ specifically tailored messages. This research on climate change communication is inherently interdisciplinary and is produced by experts from the disciplines of communication, psychology, sociology, political science, and economics. Although the development of a coherent body of scholarship on strategic communications and persuasive messaging to influence climate change perceptions and decisions is a relatively recent phenomenon, it has witnessed tremendous growth due to the attention it has received from these scholars and from practitioners across the social sciences.

Research on how frames and strategic messages impact attitudes and behaviors in the domain of climate change provides answers to such questions as the following: What impact does communicating scientific consensus information have on audiences? How can one correct widespread misperceptions and inaccurate beliefs about climate change? How can one overcome identity-based polarization and build the consensus necessary for meaningful policy action? Answering these questions "requires a careful understanding of

date: 28 January 2018

the factors that seed polarization, and the strategies available for restoring cooperation, for decreasing the perception of entrenched group differences, and for building broader consensus" (Nisbet, 2014, p. 76). Some of these answers can be found by reviewing the body of work that has accumulated on how framed communications affect climate change perceptions and decisions, focusing primarily on those cognitions representing an individual's beliefs about the sources of climate change, the personal relevance of climate change, support for related policies, the efficacy of taking action, the intention to take action, beliefs about scientific facts in general and with regard to climate change specifically, trust in scientific evidence, and the belief that scientists are in fact experts.

Framing Effects and Climate Change

The concept of a *frame in a communication* refers to words, phrases, or images that make a subset of the potentially relevant considerations toward some attitude object salient to an audience, for example, a candidate, policy, or issue (Druckman, 2001). For example, a communicator might highlight the economic, environmental, public health, or moral effects associated with climate change, thereby providing an "interpretive storyline that set[s] a specific train of thought in motion, 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; see also Moser, 2010). Given the catalyzing nature of frames for the individual, frame selection is not an insignificant decision in communicating information about climate change.

Framing, an unavoidable reality of communication, has been studied for decades by scholars interested in understanding how communications help individuals negotiate meaning through the lenses of their own values and cultural worldview (Entman, 1993; Goffman, 1974; Levin, Schneider, & Gaeth, 1998). Frames in communication work by increasing the weight individuals attach to a specific consideration about a particular object when forming an evaluation or opinion. This is formulated in the seminal framing literature as $A = \sum v_i w_i$, where A is a person's attitude about an attitude object, v is an evaluative dimension or specific consideration toward that object, and w is the weight attached to that evaluative dimension (Chong & Druckman, 2007A, 2007B). This theoretical structure is adhered to here, as it explains how exposure to frames in a communication influences how audiences think about an issue by making salient, or accessible, specific considerations that are subsequently privileged in the opinion-formation process. This is a *framing effect* (Druckman, 2001).

Only since the early 2000s have scholars been conducting systematic research on the emergence of macrolevel frames in media and public discourse related to climate change. Earlier work had laid a foundation by identifying a typology of frames that reoccur across debates on science policy. These included the following: social progress, scientific and technical uncertainty, economic development and competitiveness, Pandora's box and

date: 28 January 2018

Frankenstein's monster, public accountability and governance, conflict and strategy, and a middle path through polarized views (see Gamson & Modigliani, 1989). The frames that emerge in public discourse (e.g., media coverage) on climate change ultimately determine the considerations that are available, accessible, and applicable when individuals think about aspects of the issue. They are simultaneously strategic devices that communicators employ to influence or persuade audiences to think about a problem in a particular way. One is thus faced here with the dual tasks of discerning both framing effects and framing strategies.

Experimental Research on Framing Effects and Climate Change

Some of the earliest experimental research on how frames shape public opinion on climate change focused its attention on surveys and question-wording choices. That is, different terms—including "global warming," "climate change," "global climate change," and the "greenhouse effect"—were often used interchangeably in public discourse in the 2000s. Whether or not this assumption of substitutability was employed, it has since been determined that the use of different terminology elicits varying audience perceptions regarding personal concerns and beliefs about climate change. Whitmarsh (2009), for one, in a survey of 589 residents of south England found differences in the concerns, responsibilities, and perceived impacts of global climate change generated by the terms "climate change" versus "global warming." However, Villar and Krosnick (2011) found that "climate change" and "global warming" were perceived as equally serious in survey experiments conducted in both the United States and England; however, they identified partisan differences in the United States: Democrats perceived "global warming" as more of a concern, whereas Republicans were more receptive to "climate change." Schuldt, Konrath, and Schwarz's (2011) large survey on the personal beliefs of U.S. adults on the existence of global warming and climate change showed that belief that it is happening is greater when the phenomenon is labeled "climate change" as opposed to "global warming." Moreover, and consistent with Villar and Krosnick (2011), there was a significant effect of partisanship whereby Republicans were more likely to report a belief in "climate change" as opposed to "global warming."

Inconsistencies across this work over time led Schuldt, Roh, and Schwarz (2015) to conduct a large survey experiment on partisans in the United States that manipulated whether the issue was described as "climate change" or "global warming" in order to assess three "fundamental beliefs that are routinely polled in climate surveys" (p. 68): whether the phenomenon actually exists, whether scientists agree about its existence, and whether there is support for an emissions-reduction climate-mitigation policy. The results suggested that while Democrats are largely unaffected by the manipulation, that is, they believed in it consistently irrespective of how it was labeled, Republicans are more likely to acknowledge it is happening, that scientific consensus exists, and to support policy action when the language of "climate change" is used (as opposed to "global warming"). In this way, the survey-oriented approach to understanding framing

date: 28 January 2018

effects in communications on climate change is important, "underscoring the influence of seemingly mundane questionnaire design considerations in shaping apparent American public opinion on climate change" (p. 82).

Emphasis-Framing Effects and Climate Change

Studies have also explored how exposure to frames emphasizing different aspects of climate change influences opinions. For example, Maibach, Nisbet, Baldwin, Akerlof, and Diao (2010) and Myers, Nisbet, Maibach, and Leiserowitz (2012) investigated how accentuating either public-health effects or national security effects stemming from climate change shaped Americans' understanding of the issue. Emphasizing the effects of climate change on public health was more effective than employing a national security frame at generating positive emotions like hope instead of anger. Given that a public-health frame "stresses climate change's potential to increase the incidence of infectious diseases, asthma, allergies, heat stroke, and other salient health problems" (Nisbet & Newman, 2015, p. 367), the personal relevance of climate change increases for the audience. It also shifts the geographic location of the perceived impacts from (frequently referenced) remote places and regions (e.g., polar bears in the Arctic) to socially proximate places like cities and local communities (see also Leiserowitz, 2007; Morton, Rabinovich, Marshall, & Bretschneider, 2011; Spence & Pidgeon, 2010). This framing strategy may also capitalize on the already increased relevance generated by weather events experienced personally, although such effects are usually short-lived (Egan & Mullin, 2012, 2016; Konisky, Hughes, & Kaylor, 2016; Sisco, Bosetti, & Weber, 2016). Egan and Mullin (2012) state, "For each 3.1 Fahrenheit that local temperatures in the past week have risen above normal, Americans become one percentage point more likely to agree that there is 'solid evidence' that the earth is getting warmer" (pp. 796–797).

Other work that has focused on emphasis-framing effects has integrated a number of different strategies. Bolsen, Leeper, and Shapiro (2014) exposed individuals to messages highlighting behavioral norms or mentioning science to examine their effects on those individuals' beliefs about whether anthropogenic global warming is happening and whether they were willing to take personal action to reduce greenhouse gas emissions. In the first of two large, web-based experiments conducted in the United States, they found that a frame that highlighted a norm that others are not willing to take action on climate change reduced the perceived efficacy of taking action, as well as willingness to take personal action. Specifically, individuals were randomly assigned to one of two norm-messaging conditions (pro norm vs. con norm) and read about a recent poll that had showed that "[over 85%/less than 15%] of Americans believe that the world's average temperature is rising primarily because of human activities . . . [and] . . . [the vast majority/only a small minority] said they would consider driving smaller cars, reducing travel, and supporting legislation (e.g., a tax) to reduce the nation's emission of greenhouse gases" (p. 71). In the second experiment, Bolsen et al. added an additional message indicating the existence of a scientific consensus and that the "vast majority of

scientists (over 90%) believe the earth is experiencing a warming trend. Indeed, there is a broad scientific consensus about this issue." The results from the second experiment demonstrate clear partisan differences on all key outcome measures but largely null effects of the pro-norm frame. But a frame emphasizing the existence of a scientific consensus decreased partisan differences in the belief that climate change is being caused by humans.

In another study on how different types of frames structure climate change opinions and behaviors, Hart (2011) explores whether exposing adults in upstate New York to a *thematic* or an *episodic* frame related to climate change is more impactful. "A thematic frame provides general trends and information about an issue (e.g., general trends of the impact of climate change), whereas an episodic frame provides a case study of the issue (e.g., the impact of climate change on an individual; Iyengar, 1991)" (Hart, 2011, p. 29). To test for differences in episodic versus thematic frames associated with the effects of climate change on Artic polar bears on individuals' support for government policies to mitigate climate change and make behavioral changes, Hart conducted a three-condition experiment involving 40 participants per condition, who were assigned to read fabricated stories that were ostensibly from the Associated Press. The episodic stimuli presented a story about one polar bear struggling to survive, while the thematic stimuli focused on the impact climate change was having on polar bears in the Artic more generally. The results demonstrate that thematic frames increase support for government action to address climate change relative to an episodic frame; further, the effect appears to be mediated by assignment of treatment responsibility, emotional response, and concern for the victim (i.e., polar bears).

Visual Imagery and Climate Change Frames

Given the importance of media representations of climate change in influencing attitudes and behaviors, a growing body of literature explores how visual images that highlight different aspects of climate change influence perceptions and decisions (Hart & Feldman, 2016a; O'Neill, 2013; O'Neill, Boykoff, Niemeyer, & Day, 2013; O'Neill & Nicholson-Cole, 2009). O'Neill (2013) explains, "Visual framing begins because it is impossible to capture complex reality in one image . . . the use of particular visual framings helps to promote particular ways of conceptualizing climate change, whilst marginalizing others" (pp. 11–12). One aspect of this line of research involves cataloguing the dominant visual images portrayed in news stories about climate change. Interestingly, new stories on climate change most commonly include pictures of individuals (e.g., politicians), often highlighting political conflict or policy contestation, followed by geographically distant impact imagery highlighting the negative effects that will result from unchecked pollution (O'Neill, 2013; O'Neill et al., 2013). O'Neill (2013) explains, "This 'distancing' visual frame is exemplified through generic images of industrial smokestacks, ice imagery or non-human nature, rather than as an issue with impacts causes and solutions close to home" (p. 16). A second aspect of this line of research involves evaluating individual-level opinions

date: 28 January 2018

following exposure to such images. Although imagery that heightens perceptions of a threat can increase the perceived importance (salience) of the issue of climate change, it can also decrease individuals' perceptions of efficacy and personal engagement with the issue (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009).

Hart and Feldman (2016A) examine how imagery and text in news coverage of climate change affect individuals' perceptions about the importance of climate change, their perceived personal efficacy or, more generally, whether taking personal action will actually overcome the problem. Specifically, the researchers manipulated the image in news stories associated with climate change by providing a photograph showing solar panels, floods, a march calling for climate change action, smoke rising from a power plant, or no photograph at all. The text of the stories reported information about the effects that will result from climate change (e.g., heat waves, floods, droughts, extreme weather, human illness and disease, etc.), actions that can be taken to reduce greenhouse gas emissions as a way to address climate change (e.g., making power plants more efficient, reducing reliance on coal for energy, promoting low-carbon sources of energy), or both impact and efficacy frames. The experiment was conducted in the context of a survey in the United States with 1,575 participants recruited from a Qualtrics Panel. The results demonstrate that the solar panel image was associated with a greater sense of efficacy than each of the other photographs except for the climate protest march. Moreover, studies that discussed actions that can be taken to address climate change were more effective than stories that focused on impacts only. The results also showed indirect effects on individual behavior change measures such as intentions to engage in energy conservation based on increased perceptions of efficacy resulting from the solar image and action-oriented message.

date: 28 January 2018

Competitive Frames and Individual-Level Differences

Thus far, a scant number of articles have examined the effects of exposure to competitive messages emphasizing competing considerations about climate change. However, several recent studies explore how simultaneous exposure to competitive frames, as well as individual-level differences, influence opinion formation and decisions. Among them, Nisbet, Hart, Myers, and Ellithorpe (2013) conducted a survey experiment in the United States to evaluate how communications that simultaneously accentuate the perceived costs and benefits influence opinions and intentions to take action. The authors posit a "moderated-mediation model of framing effects on audience attitudes about climate change . . . [that] occurs when an audience predisposition (i.e., open- or closed-mindedness) moderates the influence of message exposure on an intervening mediating variable (i.e., perceived costs-benefits of climate mitigation) on our dependent variable of interest (i.e., climate change mitigation policy)" (p. 770). Nisbet et al. hypothesized that exposure to a framed message in a noncompetitive message environment will more likely result in attitude change relative to the impact of the frame in competition, and that only open-minded individuals will be influenced by the framed arguments. This hypothesis was tested in a two-wave survey experiment administered by Knowledge Networks in the United States that utilized a nationally representative population sample with a noncompetitive message condition, a competitive message condition, or a control group. The stimulus consisted of participants viewing a 45-second video promoting government climate change polices, framed either in terms of "environmental disaster" or "national security," followed by a posttest questionnaire evaluating attitude change from an initial survey conducted several weeks earlier. In the competitive framing condition, participants viewed one or the other of the pro-climate mitigation policy videos, followed by a second video that framed climate change in terms of creating an "economic disaster." Based on how participants viewed the cost and benefits of eight different climate mitigation polices, there was no evidence to support the prediction that one-sided message conditions shift opinions on climate change but cancel each other out in the competitive framing conditions. Rather, open-mindedness conditioned the effects that manifested in the competitive framing conditions but not the one-sided conditions. This manifesting among open-minded individuals in the competitive conditions may reflect the fact, shown in Chong and Druckman (2007b), that exposure to competitive frames simultaneously can generate a motivation to scrutinize information more closely or accurately.

Goal-Framing Effects and Climate Change

A variety of other distinct types of frames and framing effects have been identified in the broader literature on the framing process (for a review, see Levin et al., 1998). Several experimental studies have focused on how exposure to messages that cast information either in either a positive (e.g., gains from action) or negative (e.g., losses from inaction)

date: 28 January 2018

light influence perceptions about climate change (Spence & Pidgeon, 2010; Morton et al., 2011). This class of framing effects is referred to as a type of "equivalency framing effect" (see Druckman, 2004), distinct from emphasis- or issue-framing effects in that the underlying psychological processes driving the observed effect of the communication on preferences and behavior are rooted in an unconscious negativity bias in the encoding of the stimulus information.

This class of frames is often operationalized by focusing on the losses that will result from inaction toward climate change versus the gains that may be realized from action. Although the broader literature on equivalency framing effects, rooted in prospect theory (Druckman, 2004; Kahneman & Tversky, 1979), motivates expectations that negative information will be more powerful than positive information as a result of loss aversion, most research on this class of framing effects indicates that the effectiveness of a loss versus a gain frame in mobilizing action is context-dependent. For example, in the framing and health-behavior literature, positive frames emphasizing the benefits that will occur if an action is taken are more effective at motivating preventative behaviors (e.g., the application of sunscreen) compared to loss frames emphasizing the negative results that will occur if an action is not taken (Rothman, Bartels, Wlaschin, & Salovey, 2006). In this light, Maibach et al. (2010) found that individuals responded more positively to communications that highlight positive considerations about the health benefits that will result from climate-mitigation-related policies relative to messages highlighting the health costs that climate change presents, framing these health benefits and costs in terms of their impacts on air and water pollution, food availability, and the potential to contract diseases.

Scientific Literacy and Messages Highlighting Scientific Consensus

Over the past several decades, scholars have initiated a field of study focused on risk communication and how different messages influence related assessments (Fischhoff, 1995). A dominant theme in this literature—and one directly related to frames and communications on climate change—is the need to sufficiently inform the public about the facts in a particular debate, so that accurate risk assessments, cost-benefit analyses, and policy selections can be made. The more scientifically literate the citizenry, and the more scientific-consensus evidence is invoked, the more accurate the public's decisions will be (e.g., Bauer, Allum, & Miller, 2007). Despite the increasing certainty among climate scientists since the late 1990s about the reality of human-caused climate change, the American public remains deeply divided over whether the phenomenon is occurring. This disbelief about the fundamental causes of climate change fosters divisions over the optimal policy choices and the extent to which the United States should act. Consequently, empirical studies are increasingly testing for the effects of messages that

date: 28 January 2018

convey the existence of a scientific consensus regarding man-made climate change on beliefs and support for policy action (e.g., Deryugina & Shurchkov, 2016; Lewandowsky, Gignac, & Vaughan, 2013; Myers, Maibach, Peters, & Leiserowitz, 2015; van der Linden, 2016; van der Linden, Leiserowitz, Feinberg, & Maibach, 2015).

Communicating Scientific Consensus on Climate Change

There is evidence showing that individuals' beliefs about the scientific consensus on climate change play an important role in shaping their support for policy action. Ding, Maibach, Zhao, Roser-Renouf, and Leiserowitz (2011) conducted a nationally representative survey in the United States and found that perceptions that there is a scientific consensus on climate change led respondents to express greater concern about climate change, to have increased belief that it is occurring, and to have increased support for mitigation policies. In a similar light, Lewandowsky et al. (2013) conducted two surveys on pedestrian convenience samples in the United States that explored whether scientific consensus generally promotes acceptance of scientific facts and whether communicating scientific consensus about human-caused climate change shifts beliefs toward the consensus position. In one study, Lewandowsky et al. randomly assigned participants to either a control condition or a scientific consensus condition, the latter of which included a graph and accompanying text stating that 97% agreement exists among climate scientists about the reality of climate change. Although participants in the control condition underestimated the level of consensus on climate change, this decreased significantly in the scientific-consensus treatment condition. Based on these results, the authors concluded that there is a "vital role of highlighting a scientific consensus when communicating scientific facts" (Lewandowsky et al., 2013, p. 403).

Van der Linden et al. (2015) provides experimental evidence that perceptions of scientific consensus serve as a gateway belief, in that "perceived scientific agreement [acts] as a gateway belief that either supports or undermines other key beliefs about climate change, which in turn, influence support for public action" (p. 2). The paper argues that much of the public is unaware of the level of scientific agreement among climate scientists as a result of the actions of individuals who employ framed communications highlighting inherent uncertainty of science in order to cast doubt on scientific consensus: "merchants of doubt" (Oreskes & Conway, 2010; Pielke, 2007). Kahan (2015B) revisited the van der Linden et al. data, however, and found that there were no significant differences between individuals who received a consensus frame and those who did not. In sum, there is some work demonstrating the positive impact that accentuating the level of scientific consensus on climate change can have on public perceptions regarding the level of scientific consensus, with indirect effects on fundamental beliefs about climate change and policy support (Myers et al., 2015; van der Linden, Leiserowitz, Feinberg, & Maibach, 2014; van der Linden, Leiserowitz, & Maibach, 2016).

date: 28 January 2018

Counterframes and the Politicization of Science

In light of the importance of perceptions of scientific consensus, a key macrolevel frame in the "debate" over climate has been for political actors to highlight "scientific and technical uncertainty" as a way to manufacture doubt among the public about the level of scientific consensus. Van der Linden et al. (2015) argued the following: "[B]y strategically sowing seeds of doubt, organized opponents of climate change action have continually tried to undermine the validity of the scientific consensus argument" (Oreskes & Conway, 2010, p. 7). The *politicization of science* refers to a communication tactic in which actors accentuate the inherent uncertainty of science as a way to cast doubt on the existence of scientific consensus, typically in support of a particular agenda (Bolsen & Druckman, 2015). In one of the few experiments conducted on the effects of exposure to a frame highlighting the politicization of science on support for a green energy technology, Bolsen, Druckman, and Cook (2014B) found that exposure to politicization stunts the positive impact of otherwise credible scientific information. It also generates anxiety and decreases trust in scientific evidence when it is invoked in a political argument. Thus, educating the public about the level of scientific consensus on climate change has been more difficult than simply capturing their attention and reporting "facts" as a way to mobilize action. Communicators seeking to accentuate scientific consensus have had to compete with other strategic actors who are implicitly accentuating scientific uncertainty to foster support for the status quo—for example, continued reliance on existing energy sources.

Given the reality of counterframing attempts, politicization, and partisan polarization on climate change, there is an ongoing and provocative debate in the literature about the effectiveness of communicating the existence of a scientific consensus as a way to overcome the persistent polarization on the subject (e.g., see Kahan, 2015B; Lewandowsky et al., 2013). Nisbet et al. (2015) explain, "The deficit model of science communication implies that public skepticism around scientific issues stems primarily from a lack of accurate knowledge (Bauer et al., 2007; Brossard & Lewenstein, 2010) . . . . [T]he solution to this problem, therefore is to provide accurate information to the public . . . . However, considerable evidence contradicts this basic assumption, especially when considering politically controversial issues like climate change" (p. 286). For instance, research on beliefs about whether anthropogenic climate change is occurring in the United States reveals large differences between subgroups of respondents within the United States (Bolsen, Druckman, & Cook, 2015; Kahan, 2015A; McCright & Dunlap, 2011). Druckman and Bolsen (2011, p. 660) explain, "The implicit model of opinion formation underlying much of the work on risk perception and scientific literacy treats citizens and consumers as rational thinkers who carefully integrate new information in expected ways (e.g., individuals are treated as Bayesians). The realities of opinion formation, however, suggest otherwise . . . attitudes depend on multiple factors beyond factual information [including]

date: 28 January 2018

values (e.g., Nisbet & Goidel, 2007), trust in science (e.g., Rodriguez, 2007), and frames or arguments . . . (e.g., Nisbet & Mooney, 2007)."

date: 28 January 2018

Cultural Cognition, Motivated Reasoning, and Polarization

An alternative explanation for persistent disagreement over climate change focuses not on educating the public or increasing science comprehension but instead on identifying an individual's values and the groups with which she or he identifies and the underlying motivations to uphold one's identity-defining affinities. A growing literature on this subject calls into question the general efficacy of communicating scientific consensus by itself or making evidence-based arguments as a strategy for building a consensus for policy action. Kahan et al. (2011) argue, "If the answer were that members of the public are simply less informed than experts, one would expect disagreement on issues like climate change to abate in the face of widespread dissemination of scientific findings" (pp. 147–148). Thus, the alternative explanation that Kahan and colleagues have advanced is a theory of cultural cognition of risks on complex scientific issues such as climate change.

On a formal level cultural cognition theory (CCT) posits that the values of *individualism* as opposed to *communitarianism* and *hierarchy* as opposed to *egalitarianism* influence how individuals view the risks associated with issues such as support for nanotechnology, HPV vaccination, and global warming (Kahan, 2015A; Kahan, Braman, Slovic, Gastil, & Cohen, 2009). According to CCT, people form perceptions of risk that "connect them to others who share their cultural values . . . [and they form] 'worldviews' or preferences for how to organize society or other collective enterprise . . . along two orthogonal dimensions" (Kahan, 2014, p. 208). On the first dimension, people who value individualism prefer a social ordering that places the highest priority on protection of liberty and views individuals as responsible for collective outcomes. At the other end of this same dimension, communitarians place relatively less value on liberty and are more willing to place restrictions on individual liberties to promote the collective good. Communitarians also see government as primarily responsible for collective outcomes. On the second dimension, CCT posits that individuals who value hierarchy prefer a social ordering that is "pervaded with rankings that tie authority to social roles versus ones that deny that who can tell what to do can depend on any sort of socially stratified system of classifications" (p. 208). At the opposite end of the second dimension, egalitarians reject social stratification and view nature as fragile and the environment as needing protection from risks. Kahan (2014) explains, "In previous studies, we and other researchers had found that individuals with simultaneously 'hierarchical' and 'individualistic' worldviews and those with simultaneously 'egalitarian' and 'communitarian' ones tend to hold opposing perceptions of environmental risks, including ones associated with climate change and nuclear power, and risks associated with guns and gun control" (p. 208). This may be in part due to a tendency toward solution aversion as a motivation in opinion formation and expression about global warming, and the concomitant regulations and

date: 28 January 2018

restraints perceived as resulting from mitigation and adaptation efforts (see also Campbell & Kay, 2014).

Research on how CCT affects climate change communications with respect to perceptions and decisions highlights the tendency for motivational processes to influence how individuals select, interpret, and respond to messages. This is best represented by motivated reasoning, which is the unconscious tendency to achieve a predetermined goal when processing information (Kunda, 1990; Taber & Lodge, 2006). When people engage in *directional* motivated reasoning (e.g., about whether man-made climate change is happening), they tend to give more weight to evidence that is consistent with their existing beliefs, identities (e.g., partisan loyalties) or values. They also tend to dismiss information that is inconsistent with their existing views or group loyalties, and evaluate evidence and arguments as stronger when they are consistent with one's beliefs or identities (Bolsen et al., 2014C; Druckman et al., 2013).

Although approximately two thirds of Americans currently believe that global warming is happening (Leiserowtiz et al., 2014), there are large partisan and ideological differences in expressed beliefs on this issue. Numerous surveys in the United States find that Democrats and liberals are more concerned about global warming, consider it to be more of a threat, and are more likely to support policy action than Republicans and conservatives (Leiserowitz, 2006; Wood & Vedlitz, 2007; Zia & Todd, 2010). Identity-driven motivated reasoning causes individuals who hold different partisan identities to express different opinions about the fundamental science of climate change. Hart and Nisbet (2012) explain, "This broad polarization in opinion about climate change is not only due to increased policy polarization in general between the parties . . . but also due to a specific party divide on environmental issues that has been developing since the 1980s . . . . [S]trong political partisans are likely to employ motivated reasoning when exposed to messages about climate change with ideological predispositions moderating information effects on policy attitudes" (p. 706). Consequently, the authors hypothesize that exposure to frames highlighting who will be affected by climate change will lead to boomerang effects among partisans in the United States due to motivated reasoning. "A boomerang effect occurs when a messages is strategically constructed with a specific intent but produces a result that is the opposite of the intent" (Hart & Nisbet, 2012, p. 704). The authors test for the presence of a boomerang effect among participants in a convenience sample experiment conducted in upstate New York. The experiment varied information in a simulated news story about climate change that highlighted the potential for the increased likelihood of diseases such as West Nile virus and including the pictures of eight farmers who were potentially at risk. The researchers also manipulated the social distance of the individuals highlighted in the story (i.e., whether the respondent resided in upstate New York versus the state of Georgia or the country of France). Although there were no main effects from the different messages, the results supported a moderated-mediation model in which social identification with the victim influences support for climate mitigation. Further, political partisanship moderates the impact of the social distance manipulation. Thus, Republicans participants exposed to messages with low

date: 28 January 2018

social distance cues were not significantly different from a control group that received no information. On the other hand, Republicans in the high social-distance message group expressed significantly less support for climate mitigation policies relative to the control group.

In a similar vein, Nyhan and Reifler (2010) conducted a series of experiments to evaluate whether exposing individuals to factual information about climate change in graphical and textual forms causes people to update their factually incorrect beliefs about climate change. The results showed that communicating factual information about climate change failed to correct misperceptions and produced boomerang effects among polarized partisans. And, also in a similar line of research, Kahan et al. (2011) conducted a study to test the hypothesis that cultural cognition theory driven by directional motivated reasoning explains the failure of expert consensus to dispel public controversy over the issues of climate change, nuclear waste storage, and gun rights. They conducted a nationally representative survey experiment in the United States and varied attributions of a "low risk" or "high risk" frame on each issue to one of three featured (randomized) scientists. In strong support of directional motivated reasoning as driving information processing in this instance, participants' evaluations of whether the scientist was an expert depended on the fit between the position the scientist was taking on a given issue and the position that dominated among the subject's own cultural groups.

According to the scientific deficit model, or public irrationality thesis (Kahan et al., 2012), knowledge deficits and information processing differences (i.e., "system 1" as opposed to "system 2" processing of scientific information) lie at the heart of the disjuncture between the opinions of climate scientists and the general public. If this is the case, then information campaigns that seek to "educate" the public should lead those who are relatively more knowledgeable among all subgroups in society (i.e., liberals, conservatives, Republicans, Democrats, individualist-hierarchialists, and communitarian-egalitarians) to express beliefs that are relatively more consistent with those of climate scientists regarding the fundamentals of global warming. But if directional motivated reasoning drives opinion formation, then as individuals become more knowledgeable they express positions more consistent with the groups with which they identify on this issue.

Kahan et al. (2012) conducted a nationally representative survey in the United States that measured the risk climate change presents as well as the numeracy and scientific literacy of the participants. They demonstrate that more numerate individuals who hold hierarchical-individualist values are significantly more likely than less numerate individuals sharing the same values to align their beliefs about global warming with their cultural predispositions (see Bolsen et al., 2015; Malka, Krosnick, & Langer, 2009).

Kahan (2015A) explains:

> The striking convergence of items measuring perceptions of global warming risk and like facts, on the one hand, and ones measuring political outlooks, on the other, suggests that they are all indicators of a single latent variable. The

date: 28 January 2018

established status of political outlooks as indicators of cultural identity supports the inference that that is exactly what that latent variable is . . . whether people "believe in" climate change, like whether they "believe in" evolution, *expresses who they are* [emphasis in original]. . . . But because positions on climate change have become such a readily identifiable indicator of ones' cultural commitments, adopting a stance toward climate changes that deviates from the one that prevails among her closest associates could have devastating consequences, psychic and material. . . . [T]hus it is perfectly rational—perfectly in line with using information appropriately to achieve an important personal end—for that individual to attend to information on climate change in a manner that more reliably connects her beliefs on climate changes to the ones that predominate among her peers than to the best available scientific evidence . . . . Identity-protective cognition is not a breakdown in individual reasoning but a form of it. Without question, this style of reasoning is collectively disastrous: the more proficiently it is exercised by the citizens of a culturally diverse democratic society, the less likely they are to converge on scientific evidence essential to protecting them from harm.

(pp. 11, 14)

Kahan makes clear that this form of directional motivated reasoning is perfectly rational at the individual level and upholds the motivation to protect identity-defining commitments with groups; however, at the same time, it leads to suboptimal collective results that undermine the role science can have in informing public dialogue and political debate on the issue. Relations with one's peers are at stake, as "[a] hierarchical individualist who expresses anxiety about climate change might well be shunned by his co-workers at an oil refinery in Oklahoma City. A similar fate will probably befall the egalitarian-communitarian English professor who reveals to colleagues in Boston that she thinks the scientific consensus on climate change is a hoax . . . . Given how much the ordinary individual depends on peers for support—material and emotional—and how little impact his beliefs have on the physical environment, he would probably be best off if he formed risk perceptions that minimized any danger of estrangement from his community" (Kahan et al., 2012, p. 734).

Notwithstanding the findings of Kahan and colleagues, some continue to argue that strategic frames highlighting scientific consensus and providing factual information to individuals can be an effective way to influence perceptions and decisions on climate change. Further, critics of CCT contend that although directional motivated reasoning may cause strong partisans to be resistant to messages highlighting scientific consensus, this may be confined just to strong partisans in the United States (van der Linden, 2015). There is clearly something distinct about climate science perceptions in the United States. For example, Ding et al. (2011) argue that "many US citizens' perceptions of scientific agreement about climate change are not the product of motivated reasoning. Whereas the motivated reasoning model may characterize the minority of highly committed partisans with strongly held views, our findings [suggest] that the majority of US citizens—who have lower levels of involvement with the issue—are likely to base their

date: 28 January 2018

beliefs about climate change on their perceptions of scientists views" (p. 464). Bolsen and Druckman (2016) implemented a large, nationally representative survey experiment in the United States that provided scientific consensus information about human-caused climate change to some participants. They find that the effect of a frame that highlighted the existence of a scientific consensus on climate change increases perceptions of scientific agreement among both Democrats and Republicans, consistent with the gateway-belief model. Nonetheless, the direct effect of communicating the consensus position on belief in the existence of human-induced climate change was conditional on partisan group identity and partisans' knowledge levels. Specifically, low-knowledge partisans shift their opinion toward the scientific consensus position relative to similar individuals in a control condition, whereas high-knowledge partisans polarized following exposure to the same messages relative to similar partisans in a control condition. Further, when a consensus statement was "politicized," the positive effect of communicating consensus information to low-knowledge partisans disappears. Their results accentuate the highly contingent nature of climate change communication effects in the contemporary United States (see also Cook & Lewandowsky, 2016).

date: 28 January 2018

Communicating Climate Science in a Polarized Era

Communicators who seek to build greater support for action on climate change face numerous challenges; however, a number of strategies for how best to build consensus support have been identified in the literature. The hurdles presented by decades of politicization of climate science and extant polarization levels are formidable, as the literature makes clear. The public consistently ranks climate change as a low priority in the United States. Further, partisan polarization contributes to identity-protective motivations in the selection, interpretation, and evaluation of messages that highlight scientific consensus to persuade the public to take action. Partisan motivated reasoning and the reality of decades of media coverage amplifying messages from strategic actors who politicize climate science has led to subpopulations in the United States with relatively well-established beliefs about climate change that diverge from the scientific consensus. A question on the frontier of climate change communication research is how to disseminate relevant scientific information in a way that results in greater consensus among all segments of the public. The implication is that a consensus about climate change among the public will have the greatest impact on the political agenda and on the policymaking process.

A growing body of literature offers recommendations for ways climate change communicators can work to build greater consensus in a polarized era (Druckman, 2015; Lupia, 2013; Nisbet, 2014; Nisbet & Fahy, 2015). These recommendations can be distilled into four categories. First, it is important for communicators to emphasize aspects of messages in order to increase personal importance of the issue and select frames that resonate with diverse subgroups of citizens. For instance, accentuating the local public-health effects that will result from climate change may have a greater impact on beliefs and willingness to take action among conservative Republicans in the United States compared to messages emphasizing the pollution or environmental effects that will also occur. Nisbet (2014) explains, "Framing climate change in terms of public health [makes] climate change personally relevant to new audiences by connecting the issue to health problems that are already familiar and perceived as important. The frame also shifts the geographic location of impacts, replacing visuals of remote Arctic regions, animals, and peoples with more socially proximate neighbors and places across local communities and cities" (p. 181). Framing climate change as geographically proximate increases its saliency for the general public, as environmental issues are prioritized more when there are local effects (Ansolabehere & Konisky, 2014). Proximity can also be personal rather than geographical. People subjected to a high-compassion treatment expressed stronger beliefs that the humanitarian crisis resulting from climate change is man-made (Lu & Schuldt, 2016). Other research shows that, in response to news prompts, a public-health-

date: 28 January 2018

consequences frame resulting from taking climate-change-related actions produces feeling of hope for the public (Myers et al., 2012).

Similarly, communicators may accentuate positive solutions to combat climate change and highlight policies that are likely to appeal to individuals who hold different values (Hoffman, 2015). "For environmental communication scholars, a major implication is that effective public engagement on climate change—no matter how effectively the science might be conveyed—will depend in part on the context set by proposed policy frameworks and technological solutions" (Nisbet & Newman, 2015, p. 368). For example, Kahan et al. (2011) found that when hierarchical-individualists were exposed to a frame that a solution to climate change is not to regulate emissions but to invest in nuclear power, their support for policy action on climate change increased. Nisbet (2014) argues, [B]uilding political consensus on climate change will depend heavily on experts and their institutions calling attention to a broad portfolio of policy actions and technological solutions . . . as effective honest brokers, scientists and their institutions should pro-actively encourage journalists, policymakers, and the public to discuss a broad menu of options, rather than tacitly allow (or sometimes promote) efforts by climate activists, bloggers and commentators to limit debate to just a handful of options that fit with their own ideology and cultural outlook" (p. 183).

In addition to employing frames likely to resonate with diverse audiences, a second strategy involves recruiting credible messengers from diverse cultural subgroups to deliver information perceived as trustworthy. Only frames from credible sources are likely to be impactful in shaping opinions (Druckman, 2001; Lupia, 2013), and, in politicized environments, there is often suspicion about the true motives and expertise of a science communicator and whether or not there are shared common interests (Kahan et al., 2011; Lupia, 2013). It is thus important to bring together scientists and communicators who hold different values and ideological leanings to communicate a consensus about fundamental science when it exists. Nisbet (2014) states, "[O]nce community members from differing political backgrounds join together to achieve a broadly inspiring goal like protecting people and a local way of life, then the networks of trust and collaborations formed can be used to move this diverse segment toward cooperation in pursuit of national policy goals" (p. 179). As persuasion does not occur unless a listener perceives both expertise and shared interest (Druckman, 2015; Lupia, 2013), it is crucial to find credible voices that speak to as many Americans as possible on climate change. A diversity of credible sources from distinct cultural subgroups could make a difference in overcoming identity-based protective motivations in processing climate science communication. For example, "among heirarchalists/individualists, they are more likely to reject scientific information when it is conveyed by someone such as former Vice President Al Gore, whom they view as antagonistic and oppositional to their vision of a good society (Kahan et al., 2011). On the other hand, they may be more open to the same scientific advice and policy recommendations when emphasized by a decorated military general . . . cultural affiliation with the identity of experts or advocates may enhance or mitigate the

date: 28 January 2018

persuasiveness of a particular frame of reference (see Kahan et al., 2010)" (Nisbet & Newman, 2015, p. 369).

Third, climate change communicators must pay greater attention to the motivational processes that govern how individuals interpret and process arguments and evidence in this domain. There are ways to reduce the likelihood of partisan (directional) motivated reasoning in the evaluation of political information. In certain contexts, individuals do not pursue an identity-protective motivation and instead evaluate information in a more evenhanded fashion with the goal of forming an accurate or correct belief (Druckman, 2012; Bolsen et al., 2014C; Bolsen & Druckman, 2015). Druckman (2015) explains, "To the extent possible, those passing on the information must try to stimulate their audience to be motivated to form accurate opinions; when this occurs, [directional] motivated reasoning disappears and people spend more time elaborating on and accepting the information" (p. 65). Druckman further recommends three distinct approaches to inducing an accuracy motivation, including making information personally relevant to an individual; providing information from multiple sources—for example, both Democrats and Republicans—which can stimulate an accuracy motivation (Bolsen et al., 2014C); and, inducing individuals to anticipate being required to justify their opinions to others.

Fourth, and finally, climate change communicators and scientific organizations must work to combat the damage done by decades of politicization of climate science by actors accentuating the inherent uncertainty of science as a way to cast doubt on scientific consensus. To recapitulate, Bolsen and Druckman (2015) argue that this is a unique communicative tactic that does not involve providing misinformation per se (e.g., by citing rival evidence or studies that challenge the scientific consensus) but rather involves emphasizing the fundamental uncertainty of any scientific finding or body of scientific evidence. Politicization generates uncertainty and anxiety when it is invoked in strategic messages and causes individuals to distrust otherwise credible and persuasive scientific arguments and evidence (Bolsen et al., 2014B). Nonetheless, there are ways to counteract the politicization of science in certain contexts so that individuals are more open to frames that reference scientific consensus. Bolsen and Druckman (2015) demonstrated, in two large, nationally representative survey experiments in the United States, that the uncertainty and anxiety that politicization generates toward two different emergent energy technologies was eliminated when participants were provided with warnings that a scientific consensus does indeed exist and that they should not believe claims that a "debate" continues. This initial warning may have inoculated participants against the effects of politicization and provided them with accessible arguments to refute politicization claims in the face of consensus information. In other words, in this particular case, a message with a warning that one would later encounter inaccurate statements politicizing science but that it should be dismissed vitiated the powerful impact politicization has on undermining the positive impact of consensual scientific information. Furthermore, the ill effects that result from politicization were also counteracted by corrective information that a consensus does exist and politicization should be discounted, especially when that corrective information is encountered in a

date: 28 January 2018

context in which individuals are motivated to evaluate messages with the goal of forming an accurate belief. More recent evidence from a follow-up replication study focused on belief in human-induced climate change, however, found that warnings and corrections were ineffective at combating the deleterious effects that resulted from exposure to politicization (Bolsen & Druckman, 2016).

Despite this initial work, there is a dearth of empirical research on how to overcome the politicization of science in the domain of climate change. Additional research is needed to understand the individual and contextual factors that limit or counteract the politicization of science. The expert community must reinvest in American's civic capacity to discuss, debate, and participate in collective decisions (Nisbet, 2014; Nisbet & Markowitz, 2015). Universities, cities, and media partners in local regions can develop communication initiatives to challenge how all citizens think and talk about climate change as a way to build and find areas of consensus through public engagement efforts. This will provide a forum for different stakeholders to communicate climate science in ways that build greater consensus over time.

References

Ansolabehere, S., & Konisky, D. M. (2014). *Cheap and clean: How Americans think about energy in the age of global warming*. Cambridge, MA: MIT Press.

Bauer, M. W., Allum, N., & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, *16*, 79–95.

Bolsen, T., & Druckman, J. N. (2015). Counteracting the politicization of science. *Journal of Communication*, *65*, 745–769.

Bolsen, T., & Druckman, J. N. (2016). Partisan group identity and belief in human-caused climate change. Unpublished manuscript.

Bolsen, T., Druckman, J. N., & Cook, F. L. (2014a). Communication and collective actions: A survey experiment on motivating energy conservation in the U.S. *Journal of Experimental Political Science*, *1*(1), 24–38.

Bolsen, T., Druckman, J. N., & Cook, F. L. (2014b). How frames can stunt support for scientific adaptations: Politicization and the status quo bias. *Public Opinion Quarterly*, *78*(1), 1–26.

Bolsen, T., Druckman, J. N., & Cook, F. L. (2014c). The influence of partisan motivated reasoning on public opinion. *Political Behavior*, *36*, 235–262.

Bolsen, T., Druckman, J. N., & Cook, F. L. (2015). Citizens', scientists', and policy advisors' beliefs about global warming. *Annals of the American Academy of Political and Social Science*, *658*(1), 271–295.

Bolsen, T., Leeper, T. J., & Shapiro, M. A. (2014). Doing what others do: Norms, science, and collective action on global warming. *American Politics Research*, *42*(1), 17–30.

Brossard, D., & Lewenstein, B. V. (2010). A critical appraisal of models of public understanding of science: using practice to inform theory. In L. Kahlor & P. A. Stout (Eds.), *Communicating Science: New agendas in communication* (pp. 11–39). New York: Routledge.

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

Chong, D., & Druckman, J. N. (2007a). Framing theory. *Annual Review of Political Science*, *10*, 103–126.

Chong, D., & Druckman, J. N. (2007b). A theory of framing and opinion formation in competitive elite environments. *Journal of Communication*, *57*, 99–118.

Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using Bayesian networks. *Topics in Cognitive Science*, *8*, 160–179.

Deryugina, T., & Shurchkov, O. (2016). **The effect of information provision on public consensus about climate change. Online publication**. *PloS One*, *11*(4), e0151469.

Dietz, T. (2013). Bringing values and deliberation to science communication. *Proceedings of the National Academy of Sciences*, *110*, 14081–14087.

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

Druckman, J. N. (2001). The implications of framing effects for citizen competence. *Political Behavior*, *23*, 225–256.

Druckman, J. N. (2004). Political preference formation: Competition, deliberation, and the (ir)relevance of framing effects. *American Political Science Review*, *98*, 671–686.

Druckman, J. N. (2012). The politics of motivation. *Critical Review*, *24*(2), 199–216.

Druckman, J. N. (2013). Public opinion: Stunted policy support. *Nature Climate Change*, *3*, 617.

Druckman, J. N. (2015). Communicating policy-relevant science. *PS: Perspectives on Politics*, *48*(1), 58–69.

Druckman, J. N., & Bolsen, T. (2011). Framing, motivated reasoning, and opinions about emergent technologies. *Journal of Communication*, *61*, 659–688.

Strategic Framing and Persuasive Messaging to Influence Climate Change Perceptions and Decisions

Druckman, J. N., Peterson, E., & Slothuus, R. (2013). How elite partisan polarization affects public opinion formation. *American Political Science Review*, *107*, 57–79.

Egan, P. J., & Mullin, M. (2012). Turning personal experience into political attitudes: The effect of local weather on Americans' perceptions about global warming. *Journal of Politics*, *74*, 796–809.

Egan, P. J., & Mullin, M. (2016). Recent improvement and projected worsening of weather in the United States. *Nature*, *532*, 357–360.

Entman, R. M. (1993). Framing: Toward clarification of a fractured paradigm. *Journal of Communication*, *43*, 51–58.

Feinberg, M., & Willer, R. (2011). Apocalypse soon? Dire messages reduce belief in global warming by contradicting just-world beliefs. *Psychological Science*, *36*, 326–338.

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk analysis*, *15*(2), 137–145.

Gamson, W. A., & Modigliani, A. (1989). Media discourse and public opinion on nuclear power: a constructionist approach. *American Journal of Sociology*, *95*(1), 1–37.

Goffman, E. (1974). *Frame analysis: An essay on the organization of human experience*. Cambridge, MA: Harvard University Press.

Hart, P. S. (2011). One or many? The influence of episodic and thematic climate change frames on policy preferences and individual behavior change. *Science Communication*, *33*, 28–51.

Hart, P. S., & Feldman, L. (2016a). The impact of climate change–related imagery and text on public opinion and behavior change. *Science Communication*, *38*, 415–441.

Hart, P. S., & Feldman, L. (2016b). **The influence of climate change efficacy messages and efficacy beliefs on intended political participation**. Online publication. *PloS One*, *11*(8), e0157658.

Hart, P. S., & Nisbet, E. C. (2012). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Communication Research*, *39*, 701–723.

Hart, P. S., Nisbet, E. C., & Myers, T. A. (2015). Public attention to science and political news and support for climate change mitigation. *Nature Climate Change*, *5*, 541–545.

Hoffman, A. J. (2015). *How culture shapes the climate change debate*. Stanford, CA: Stanford University Press.

Iyengar, S. (1991). *Is anyone responsible? How television frames political issues*. Chicago: University of Chicago Press.

date: 28 January 2018

Kahan, D. M. (2014). Making climate-science communication *evidence*-based—all the way down. In D. A. Crow & M. T. Boykoff (Eds.), *Culture, politics, and climate change: How information shapes our common future* (pp. 203–221). London: Routledge Press.

Kahan, D. M. (2015a). Climate-science communication and the measurement problem. *Political Psychology*, *36*, 1–43.

Kahan, D. M. (2015b). What the van der Linden et al. (2015) data actually show (May 13, 2016). Yale Law & Economics Research Paper No. 542. Online publication. Retrieved from SSRN. **https://ssrn.com/abstract=2779661**.

Kahan, D. M., Braman, D., Cohen, G. L., Gastil, J., & Slovic, P. (2010). Who fears the HPV vaccine, who doesn't, and why? An experimental study of the mechanisms of cultural cognition. *Law and Human Behavior*, *34*(6), 501–516.

Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature Nanotechnology*, *4*(2), 87–91.

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

Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of scientific literacy and numeracy on perceived climate change risks. *Nature Climate Change*, *2*, 732–735.

Kahneman, D., & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica*, *47*(2), 263–292.

Konisky, D., Hughes, L., & Kaylor, C. (2016). Extreme weather events and climate change concern. *Climatic Change*, *134*, 533–547.

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

Leiserowitz, A. (2007). Communicating the risks of global warming: American risk perceptions, affective images and interpretive communities. In S. Moser & L. Dilling (Eds.), *Creating a climate for change: Communicating climate change: Facilitating social change* (pp. 44–63). Cambridge, U.K.: Cambridge University Press.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, *77*(1), 45–72.

Leiserowtiz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., Rosenthal, S., & Marlon, J. (2014). *Climate change in the American mind: October, 2014*. Report by Yale University and George Mason University. Yale Project on Climate Change Communication, New Haven, CT.

date: 28 January 2018

Strategic Framing and Persuasive Messaging to Influence Climate Change Perceptions and Decisions

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational behavior and human decision processes*, *76*, 149–188.

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

Lockwood, M. (2011). Does the framing of climate policies make a difference to public support? Evidence from UK marginal constituencies. *Climate Policy*, *11*(4), 1097–1112.

Lu, H., & Schuldt, J. P. (2016). Compassion for climate change victims and support for mitigation policy. *Journal of Environmental Psychology*, *45*, 192–200.

Lupia, A. (2013). Communicating science in politicized environments. *Proceedings of the National Academy of Sciences*, *110*, 14048–14054.

Maibach, E. W., Nisbet, M., Baldwin, P., Akerlof, K., & Diao, G. (2010). Reframing climate change as a public health issue: An exploratory study of public reactions. *BMC Public Health*, *10*(1), 1.

Malka, A., Krosnick, J. A., & Langer, G. (2009). The association of knowledge with concern about global warming: Trusted information sources shape public thinking. *Risk Analysis*, *29*, 6333–6647.

Markowitz, E. M., & Shariff, A. F. (2012). Climate change and moral judgement. *Nature Climate Change*, *2*, 243–247.

McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *Sociological Quarterly*, *52*(2), 155–194.

Morton, T. A., Rabinovich, A., Marshall, D., & Bretschneider, P. (2011). The future that may (or may not) come: How framing changes responses to uncertainty in climate change communications. *Global Environmental Change*, *21*(1), 103–109.

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

Myers, T. A., Maibach, E., Peters, E., & Leiserowitz, A. (2015). **Simple messages help set the record straight about scientific agreement on human-caused climate change: The results of two experiments**. Online publication. *PloS One*, *10*(3), e0120985.

Myers, T. A., Nisbet, M. C., Maibach, E. W., & Leiserowitz, A. A. (2012). A public health frame arouses hopeful emotions about climate change. *Climatic Change*, *113*, 1105–1112.

date: 28 January 2018

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

Nisbet, E. C., Hart, P. S., Myers, T., & Ellithorpe, M. (2013). Attitude change in competitive framing environments? Open-/Closed-Mindedness, framing effects, and climate change. *Journal of Communication*, *63*, 766–785.

Nisbet, E. C., Cooper, K. E., & Ellithorpe, M. (2015). Ignorance or bias? Evaluating the ideological and informational drivers of communication gaps about climate change. *Public Understanding of Science*, *24*(3), 285–301.

Nisbet, M. C. (2009). Communicating climate change: Why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development*, *51*(2), 12–23.

Nisbet, M. C. (2014). Engaging in science policy controversies: Insights from the U.S. debate over climate change. In *The handbook of the public communication of science and technology* (2d ed., pp. 173–185). London: Routledge.

Nisbet, M. C., & Fahy, D. (2015). The need for knowledge-based journalism in politicized science debates. *Annals of the American Academy of Political and Social Science*, *658*(1), 223–235.

Nisbet, M. C., & Goidel, R. K. (2007). Understanding citizen perceptions of science controversy: Bridging the ethnographic; survey research divide. *Public Understanding of Science*, *16*, 421–440.

Nisbet, M. C., & Markowitz, E. M. (2015). Expertise in an age of polarization: evaluating scientists' political awareness and communication behaviors. *Annals of the American Academy of Political and Social Science*, *658*(1), 136–154.

Nisbet, M. C., & Mooney, C. (2007). Framing science. *Science*, *316*(5821), 56.

Nisbet, M. C., & Newman, T. P. (2015). Framing, the media, and environmental communication. In the *Routledge handbook of environment and communication* (pp. 325–338). London: Routledge.

Nyhan, B., & Reifler, J. (2010). When corrections fail: The persistence of political misperceptions. *Political Behavior*, *32*, 303–330.

O'Neill, S. J. (2013). Image matters: Climate change imagery in US, UK and Australian Newspapers. *Geoforum*, *49*, 10–19.

O'Neill, S. J., Boykoff, M., Niemeyer, S., & Day, S. A. (2013). On the use of imagery for climate change engagement. *Global Environmental Change*, *23*(2), 413–421.

O'Neill, S. J., & Hulme, M. (2009). An iconic approach for representing climate change. *Global Environmental Change*, *19*, 402–410.

date: 28 January 2018

O'Neill, S. & Nicholson-Cole, S. (2009). Fear won't do it: Promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, *30*(3), 355–379.

Oreskes, N., & Conway, E. C. (2010). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. London: Bloomsbury.

Pearson, A. R., & Schuldt, J. P. (2015). **Bridging climate communication divides beyond the partisan gap**. *Science Communication*, *37*(6), 805–812.

Pielke Jr, R. A. (2007). *The honest broker: Making sense of science in policy and politics*. Cambridge: Cambridge University Press.

Pidgeon, N., & Fischoff, B. (2011). The role of social and decision sciences in communicating uncertain climate risk. *Nature Climate Change*, *1*(1), 35–41.

Rodriguez, L. (2007). The impact of risk communication on the acceptance of irradiated food. *Science Communication*, *28*(4), 476–500.

Rothman, A. J., Bartels, R. D., Wlaschin, J., & Salovey, P. (2006). The strategic use of gain and loss-framed messages to promote healthy behavior: How can theory inform practice. *Journal of Communication*, *56*, S202–S220.

Scannell, L., & Gifford, R. (2013). Personally relevant climate change the role of place attachment and local versus global message framing in engagement. *Environment and Behavior*, *45*(1), 60–85.

Schuldt, J. P., Konrath, S. H., & Schwarz, N. (2011). **"Global warming" or "climate change"? Whether the planet is warming depends on question wording**. *Public Opinion Quarterly*, *75*(1), 115.

Schuldt, J. P., Roh, S., & Schwarz, N. (2015). Questionnaire design effects in climate change surveys: Implications for the partisan divide. *Annals of the American Academy of Political and Social Science*, *658*(1), 67–85.

Sisco, M. R., Bosetti, V., & Weber, E. U. (2016). Do extreme weather events generate attention to climate change? [FEEM Working Paper No. 53.2016; Columbia Business School Research Paper No. 16–62]. New York. Retrieved from **http://dx.doi.org/10.2139/ssrn.2830438**.

Spence, A., & Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change*, *20*, 656–667.

Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science*, *50*(3), 755–769.

date: 28 January 2018

van der Linden, S. (2015). A conceptual critique of the cultural cognition thesis. *Science Communication*, *38*(1), 128–138.

van der Linden, S. (2016). **A conceptual critique of the cultural cognition thesis**. *Science Communication*, *38*, 128–138.

van der Linden, S., Leiserowitz, A., & Maibach, E. W. (2016). Communicating the scientific consensus on human-caused climate change is an effective and depolarizing public engagement strategy: Experimental evidence from a large national replication study. Online publication [SSRN]. Retrieved from **http://dx.doi.org/10.2139/ssrn. 2733956**.

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

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). **The scientific consensus on climate change as a gateway belief: Experimental evidence**. Online publication *PloS One*, *10*(2), e0118489.

Villar, A., & Krosnick, J. A. (2011). Global warming vs. climate change, taxes vs. prices: Does word choice matter? *Climatic Change*, *105*, 1–12.

Whitmarsh, L. (2009). What's in a name? Commonalities and differences in public understanding of "climate change" and "global warming." *Public Understanding of Science*, *18*, 401–420.

Wood, D., & Vedlitz, A. (2007). Issue definition, information processing, and the politics of global warming. *American Journal of Political Science*, *51*, 552–568.

Zia, A., & Todd, A. (2010). Evaluating the effects of ideology on public understanding of climate change science: How to improve communication across ideological divides? *Public Understanding of Science*, *19*, 743–761.

Toby Bolsen

Department of Political Science, Georgia State University

Matthew A. Shapiro

Department of Social Science, Illinois Institute of Technology

date: 28 January 2018

date: 28 January 2018