

OF ACCESSIBILITY AND APPLICABILITY: HOW HEAT-RELATED CUES AFFECT BELIEF IN “GLOBAL WARMING” VERSUS “CLIMATE CHANGE”

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Research shows that exposure to heat-related cues (e.g., warm temperatures, “fry” and “boil”) influences the belief that global warming exists and poses a serious threat to humans. Drawing on social-cognitive principles of concept accessibility and applicability, we hypothesized that these effects may depend on how the issue is framed, given that heat-related concepts are more compatible with “global warming” than “climate change.” Exploring this possibility, we asked campus passersby about their belief in global warming or climate change shortly after a real-life unseasonably cold weather event (i.e., snowfall during Spring; Study 1). A controlled Web experiment posed the same questions after participants viewed photographs depicting either unseasonable or seasonable temperatures in their locale (Study 2). Results suggest that priming cold weather decreases belief in “global warming” but not “climate change” among likely climate skeptics (i.e., conservatives, the environmentally unconcerned). Implications for motivated reasoning and the climate debate are discussed.

In early February 2010, a major winter storm afflicted much of the southern and eastern United States, with parts of suburban Washington, D.C. receiving over two feet of snow in a matter of hours (Morello & Halsey, 2010). “Snowmagedon” and other portmanteaus (e.g., “Snowpocalypse,” “Snowzilla”) were popularized in the media and the blogosphere as monikers for the event, which rekindled the United States’ partisan debate over global climate change. Republican Senator Jim DeMint tweeted during the event that the snow would continue until “Al Gore cries ‘uncle,’” referencing the former Vice President’s work to raise awareness about global warming and its consequences (Condon, 2010), while Comedy Central’s

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left-leaning *The Daily Show with Jon Stewart* mocked the political right for using a blizzard to promote doubt about the phenomenon's existence.

The media reaction to Snowmageddon highlights two puzzles regarding global climate change beliefs. First, whether or not people believe that global climate change exists seems more of a social matter than a scientific one. While the science has become increasingly clear that anthropogenic greenhouse gas emissions, primarily from the burning of fossil fuels, are causing a host of potentially catastrophic climatic changes affecting humans, other animals species, and the health of the global ecosystem (Oreskes, 2004; Parmesan & Yohe, 2003; Solomon, Plattner, Knutti, & Friedlingstein, 2009; Thomas et al., 2004), many citizens continue to doubt the phenomenon's existence. For instance, a recent survey from the Pew Research Center finds that 26% of Americans believe there is no solid evidence that the "average temperature on earth has been getting warmer." Importantly, this figure varies dramatically across political groups, with only 7% of liberal Democrats but 51% of conservative Republicans endorsing the "no solid evidence" response (Pew Research Center for the People and the Press [Pew], 2012), highlighting a partisan divide that has been reliable for over a decade (Krosnick, Holbrook, & Visser, 2000; McCright & Dunlap, 2011). Second, people sometimes confuse weather with climate despite the fact that prevailing local weather conditions (e.g., day-to-day temperature fluctuations) are poor indicators of the existence or severity of global climate change (Bostrom, Morgan, Fischhoff, & Read, 1994; Read, Bostrom, Morgan, Fischhoff, & Smuts, 1994). However, given that global climate change is difficult to perceive through their everyday personal experiences, citizens may nevertheless be swayed by superficially relevant (but poorly diagnostic) indicators, such as prevailing weather, that are highly accessible at the time of judgment (Akerlof, Maibach, Fitzgerald, Ceden, & Neuman, 2013; Weber, 2010; Weber & Stern, 2011). Indeed, an emerging body of research suggests that citizens' direct experiences related to temperature, including local weather events and other heat-related cues, can exert a strong influence on climate judgments despite their limited relevance.

DIRECT EXPERIENCE: ACCESSIBILITY OF HEAT-RELATED CONCEPTS

Whereas earlier research on the factors underlying citizens' climate beliefs focused primarily on individual difference variables (e.g., political orientation, trust in science and the media; Corbett & Durfee, 2004; Krosnick et al., 2000), more recent work in the tradition of priming (e.g., Bargh, Chen, & Burrows, 1996; Dijksterhuis & Van Knippenberg, 2000) has tested whether fleeting cues associated with the concept "heat" might bolster beliefs and concerns about global climate change. In a sample of university students who participated at various points throughout the year, Joireman, Truelove, and Duell (2010) found a positive association between outdoor temperatures and belief in global warming, consistent with similar findings from the national survey context (Li, Johnson, & Zaval, 2011; Donner & McDaniels, 2013). Suggesting that the experience of warmth promotes increased belief independent of weather, Risen and Critcher (2011) found greater belief in global warming when students were questioned in a warm (27°C) versus cool (23°C) room. Moreover, work on embodied metaphors has revealed similar effects, such that participants assigned to taste "hot" cinnamon gum (vs. "cool" mint gum) reported greater belief in global warming and more willingness to take greenhouse gas reducing action (Lewandowski, Ciarocco, & Gately, 2012).

Although these findings would collectively appear to be rooted in the spreading activation of concepts (Collins & Loftus, 1975) semantically related to “heat,” thus rendering heat-related concepts highly accessible and consequently more likely to influence judgments in the moment, support for this account appears mixed.¹ Evidence in favor comes from Joireman et al. (2010; Study 2) who found greater belief in global warming following subtle exposure to heat-related words embedded in a word search task (e.g., “fry,” “boil”). Using similar methods, however, Risen and Critcher (2011; Study 4) found no effect of semantic primes, which they interpreted as suggesting that heat-related bodily states (i.e., the physical experience of warmth) are responsible for these effects. This explanation, however, does not appear to account for the varied findings referenced above (e.g., respondents typically complete surveys indoors; “hot” cinnamon gum is unlikely to appreciably raise body temperature), which collectively appear to suggest that heat-related input from multiple sensory modalities is capable of influencing beliefs about global warming *in situ*, presumably due to the resulting heightened cognitive accessibility of heat-related concepts.

BEYOND ACCESSIBILITY: APPLICABILITY TO COMMON FRAMES

The extant literature makes a compelling case that heat-related cues can heighten global warming beliefs and concerns in the moment. However, by exclusively asking participants about “global warming,” this work has overlooked what is likely an important factor in these effects—whether the issue is framed as “global warming” or as “climate change.” Although their technical meanings differ (i.e., global warming refers to increases in average global surface-level temperatures; in contrast, climate change encompasses myriad altered climatic patterns resulting from anthropogenic greenhouse gas emissions; Environmental Protection Agency [EPA], 2012), these terms are frequently used interchangeably in public discourse, including in news stories and national surveys on global climate change (e.g., Program on International Policy Attitudes [PIPA] and Knowledge Networks, 2005; Voorhees, 2012). Although used synonymously, research suggests that the public perceives these terms quite differently. Notably (but perhaps not surprisingly), “global warming” has been shown to evoke stronger connotations related to rising temperatures than does “climate change” (Whitmarsh, 2009). Thus, given their strong compatibility with the connotations of “global warming” in particular, we expect that heat-related primes will affect beliefs more strongly when the issue is framed in terms of global warming as opposed to climate change.

Supporting this prediction, a large literature in social cognition demonstrates that the influence of accessible concepts is constrained by their applicability to the judgment at hand. In a classic demonstration, Higgins, Rholes, and Jones (1977) asked participants to form an impression of a target person described in an ambiguously reckless way (“ . . . He had already climbed Mt. McKinley, shot the Colorado rapids in a kyack, driven in a demolition derby, and piloted a jet-powered boat—without knowing very much about boats . . . ”; p. 145) after being primed

1. We use the term “accessible” here in the sense of being activated or primed, as distinguished from the speed or ease with which concepts are retrieved from memory (or “availability”; Schwarz, Bless, Strack, Klumpp, Rittenauer-Schatka, & Simons, 1991; Tversky & Kahneman, 1973).

with positive or negative words that were highly applicable (e.g., *adventurous, reckless*) or not (*obedient, disrespectful*) to the person evaluation task. Highlighting the importance of concept applicability, results showed that the positive and negative primes influenced impressions of the target only when they were compatible with knowledge furnished about the target (see also Srull & Wyer, 1979). In related work, Schwarz and Clore (1983) conducted a telephone survey examining the effect of mood on life satisfaction and found greater overall life satisfaction on sunny days than on rainy days—unless respondents' attention was first directed to the incidental source (respondents were asked, "How's the weather there?"). Presumably, directing people's attention to the weather allowed them to attribute their mood to its true source and to realize weather's limited relevance to the life satisfaction judgment. More broadly, these findings highlight a couple of general lessons from social cognition research. First, people typically experience thoughts and feelings that happen to be accessible at the time of judgment as being "about" the target of judgment unless there is reason to doubt their relevance (Higgins, 1996). Second, how people use accessible information is as important as the information itself in predicting how priming will affect judgment and decision making (for a review, see Schwarz, Bless, Wanke, & Winkielman, 2003).

Whether or not accessible information is deemed applicable to the target may depend on how the target is framed. The interdisciplinary literature on framing effects (Chong & Druckman, 2007; Entman, 1993; Nelson, Oxley, & Clawson, 1997; Tversky & Kahneman, 1981) highlights how small changes in the ways that issues are presented can significantly impact judgments, including public opinion about consequential policy issues. For instance, emphasis framing—which refers to how the wording of issues encourages audiences to adopt some mindsets over others (Druckman, 2001b)—is seen when a spending initiative on the poor garners less support when described as a tax as opposed to an opportunity for advancement (Iyengar, 2010).

In light of the research summarized above, we suggest that "global warming" and "climate change" may represent emphasis frames that are capable of influencing important climate beliefs. Given the partisan nature of attitudes about global climate change in contemporary politics, however, we also expect that the influence of these frames will vary as a function of political variables that traditionally correlate with climate skepticism in the U.S. (e.g., liberalism–conservatism, environmental concern)—a prediction supported by the large literature on motivated biases in judgment and decision making.

MOTIVATED REASONING AND CLIMATE FRAMING

Decades of research in social cognition highlight how various types of judgments, from basic perceptual tasks to higher-order reasoning, are influenced by the needs and values of perceivers. In an early demonstration, Bruner and Goodman (1947) found that children of less wealthy families, in particular, tended to overestimate the size of coins but not of size-matched disks. Similar effects emerge when object desirability is experimentally induced—for example, thirsty participants (i.e., who were assigned to eat pretzels) judged a bottle of water to be more spatially proximal than did non-thirsty participants (Balcetis & Dunning, 2010; also Balcetis & Dunning, 2006). Beyond the valuation of objects, in general, people are far from

the impartial information processors that normative models would predict; rather, they appear to be motivated by various factors to reach conclusions that paint the self in a favorable light (Kunda, 1990). Given that people derive their self-esteem in part from the meaningful groups to which they belong (Cialdini et al., 1976; Tajfel & Turner, 1986), it is perhaps not surprising that group affiliation can bias partisans to perceive the same stimulus differently and to draw inferences that protect and promote the interests of their in-group (Hastorf & Cantril, 1954; Vallone, Ross, & Lepper, 1985).

The political domain, in particular, is one in which numerous studies have exposed the biasing effect of values and group membership on how information is processed and interpreted. Research suggests that a person's political leanings (e.g., Democrat or Republican, liberal or conservative) are shaped early in life (Sulloway, 1995) and have a genetic basis (Benjamin et al., 2012; Eaves & Eysenck, 1974) and that these preferences, once formed, can be remarkably stable over time (Jennings & Gregory, 1984; Newcomb, Koenig, Hacks, & Warwick, 1967) and shape information processing at multiple stages, from automatic affective responses evoked by politically relevant cues to more deliberative evaluations of the strength of political arguments (Lodge & Taber, 2005; Taber & Lodge, 2006). Recent research on information provision in science-related messages reveals similar effects, suggesting that perceivers' political values play a larger role than facts in the audience's response (Druckman & Bolsen, 2011). For instance, Hart and Nisbet (2012) report that the same message feature—depicting a victim of global climate change as socially distal (versus proximal)—caused Republicans but not Democrats to report less support for climate mitigation policy. Although mere exposure to messages about highly politicized issues may automatically activate perceivers' pre-existing beliefs and related value structures (Mutz, 2006), the evidence that liberals and conservatives emphasize different values when forming judgments (Graham, Haidt, & Nosek, 2009; Haidt & Graham, 2007; Lakoff, 2002) would suggest that the way an issue is framed matters, too (Chong & Druckman, 2007; Druckman, 2001a; Scheufele, 1999). For example, framing global climate change as an economic issue (say, as opposed to a public health issue) might encourage thinking about how climate mitigation could slow job creation and stifle economic growth, concerns that may resonate more strongly with political conservatives (Nisbet, 2010).

Recent data suggest that motivated reasoning may play a similar role when it comes to "global warming" versus "climate change" framing. In a national survey experiment, Schuldt, Konrath, and Schwarz (2011) found that Republicans (but not Democrats) reported significantly lower belief in global climate change when the issue was framed in terms of global warming as compared to climate change. Although the authors speculated that Republicans, as likely climate skeptics, might find it easier to discredit the phenomenon under a "global warming" frame—given that routine temperature experiences (e.g., an unseasonably cold day) may seem sharply incompatible with the frame's connotations of rising temperatures (Whitmarsh, 2009)—this hypothesis has not been tested directly.

Drawing on theories of motivated reasoning, we aim to address this empirical gap by testing whether likely climate skeptics, in particular, report less belief in "global warming" than "climate change" after being reminded about unseasonably cold weather events. Thus, we expect political orientation to be an important and largely overlooked factor in the effect of heat primes on climate beliefs, such that groups that typically express doubt that global climate change exists, is caused

by humans, and poses a serious threat (e.g., the environmentally unconcerned, conservatives, Republicans; Krosnick et al., 2000; McCright & Dunlap, 2000, 2011) will report less belief in “global warming” when reminded of cold weather. For their part, groups that are typically confident about the phenomenon’s existence and its human causes (e.g., the environmentally concerned, liberals, Democrats) may hold more crystallized beliefs that are generally less susceptible to priming and framing effects (e.g., Krosnick & Smith, 1994).

THE PRESENT WORK

Across two experimental studies, we test the prediction that priming unseasonably cold weather events will reduce belief in global climate change when it is framed as global warming (vs. climate change), particularly among groups that are traditionally skeptical of the phenomenon’s existence (the environmentally unconcerned, conservatives). In Study 1, campus passersby reported their belief in global climate change framed as either “global warming” or “climate change” after recalling a recent, unseasonably cold weather event that occurred on campus. In Study 2, university students participated in a Web experiment that depicted either unseasonable or seasonable temperature events on campus (that were ostensibly being considered for a campus calendar), before completing similar measures.

STUDY 1

As an initial test of the prediction that “global warming” framing will promote lower existence beliefs among likely climate skeptics when cold temperatures prevail, we took advantage of a real-life unseasonably cold weather event—namely, a heavy snowfall that blanketed the campus of a university in Upstate New York in late April, 2012—that was especially notable because it occurred on the heels of very mild temperatures and prompted much discussion and consternation among a campus community that was hungry for Spring (Bornfeld, 2012). Shortly thereafter (in early May), we conducted an intercept study with campus passersby to assess their belief in “global warming” versus “climate change” while the unseasonably cold weather was still fresh in memory.

METHOD

Participants. Sixty-one passersby (43 females and 18 males; mean age = 21.05 years, $SD = 1.99$) were approached on a major pedestrian thoroughfare on campus (a plaza in front of the main student union) and were asked to complete a short “opinion survey.”

Materials and Procedure. Given the challenges of conducting an experiment in a busy outdoor setting (e.g., failure to attend to stimuli, difficulty administering sensitive manipulation checks), we chose to employ a highly explicit weather cue in order to increase the likelihood that this information would be highly accessible when participants reported their existence belief. Specifically, the questionnaire displayed an image of a well-known campus landmark (a statue of the universi-

ty's founder) blanketed with snow. Directly beneath this image was the following text [alternative wording in brackets]:

Remember that . . . campus recently experienced unseasonably cold weather and snowfall during April. With this in mind, we are interested in your opinion about global warming [climate change].

Beneath this text was the key question assessing belief in global climate change worded in terms of "global warming" ($n = 30$) or "climate change" ($n = 31$), consistent with the above wording, adapted from previous surveys on global climate change (ABC News, Stanford University, & Time, 2006) and used in previous research on climate framing (Schuldt et al., 2011; formatting original):

You may have heard about the idea that the world's temperature may have been going up [changing] over the past 100 years, a phenomenon sometimes called "global warming" ["climate change"]. What is your personal opinion regarding whether or not this has been happening? (Definitely *has not been* happening; Probably *has not been* happening; Unsure, but leaning toward it *has not been* happening; Not sure either way; Unsure, but leaning toward it *has been* happening; Probably *has been* happening; Definitely *has been* happening).

Participants then reported standard demographics (e.g., age, sex). Importantly, because we expected these frames to exert more influence among likely climate skeptics, participants answered the following question near the end of the questionnaire as a brief measure of environmental concern: "Generally speaking, how concerned are you about the state of natural environment?" (1 = Not at all concerned to 7 = Very concerned). Participants were then thanked for their time. On average, the questionnaire took less than five minutes to complete.

RESULTS

To assess whether "global warming" versus "climate change" framing influences belief in global climate change following a real-life unseasonably cold weather event, we tested a regression model in which the belief variable (coded 1 to 7; 7 = Definitely has been happening) was regressed onto Frame (global warming vs. climate change; coded +.5 and -.5, respectively), Environmental Concern (mean-centered), and their interaction term. The analysis revealed a significant interaction, $b = .73$, $t(57) = 2.57$, $p = .01$ (see Table 1), which was diagnosed using techniques prescribed by Aiken and West (1991). This analysis revealed that participants low in environmental concern (operationalized as $M - 1 SD$) reported significantly less belief under the global warming frame ($M = 4.87$) than under the climate change frame ($M = 5.89$), $b = -1.02$, $t(57) = -2.02$, $p < .05$; in contrast, this effect was not observed among participants high in environmental concern ($M + 1 SD$; $M_{\text{global warming}} = 6.90$ and $M_{\text{climate change}} = 6.06$), $b = .84$, $t(57) = 1.65$, $p = .11$. Complementing this spotlight analysis, simple slopes analysis suggested that this interaction was driven primarily by judgments about "global warming": whereas environmental concern significantly predicted belief in the global warming condition ($b = .80$, $p <$

TABLE 1. OLS Regression Testing Frame and Environmental Concern as Predictors of Belief in Global Climate Change in Study 1

Predictors	Belief	
	<i>b</i> (<i>SE</i>)	<i>t</i>
Frame	-.09 (.36)	-.25
Environmental Concern (centered)	.43 (.14)	3.06**
Frame × Environmental Concern	.73 (.28)	2.57*
% explained R ²	24.5	

Note. Frame coded as -0.5 = Climate change, +0.5 = Global warming; * $p < .05$, ** $p < .01$.

.001), this relationship was not observed in the climate change condition ($b = .07$, ns ; Figure 1).

DISCUSSION

The present results are consistent with the notion that framing global climate change as global warming (vs. climate change) renders direct experience with prevailing temperatures more applicable to judgments about the existence of this potentially catastrophic threat. Specifically, participants low in environmental concern reported less belief when the issue was framed in terms of global warming as opposed to climate change after being reminded about an unseasonably cold weather event in their location; in contrast, the beliefs of participants high in environmental concern were unaffected by this framing. This pattern may reflect motivated reasoning among a group that is traditionally skeptical of the phenomenon and its human causes (McCright & Dunlap, 2000) and who may be inclined to see disconfirming evidence in information that is highly accessible and applicable to a currently activated, frame-based schema. At the same time, this pattern may reflect more crystallized opinions about global climate change among participants high in environmental concern, whose beliefs may be relatively robust to fleeting cues like weather and question wording.

Although the present findings are consistent with the hypothesis that heat-related cues exert more impact on beliefs about "global warming" than "climate change," the design of Study 1 had some important limitations. First, all participants were reminded about the unseasonably cold weather event before reporting their belief; because our design did not include a neutral control condition, it is unclear whether the unseasonably cold weather prime caused the lower beliefs in "global warming" that we observed among the environmentally unconcerned. Second, the present study featured a one-item measure of environmental concern for its brevity given the nature of the study (a short intercept study with campus passersby). A validated scale measure of environmental concern would increase confidence in the reliability of the observed moderation effect. Third, the highly explicit nature of the prime may raise concerns regarding possible demand effects. Although we see a demand account as unlikely given that we observed a moderation effect rather than a main effect, employing a less explicit cue would better align this work with past research on the role of heat-related cues in beliefs about global warming.

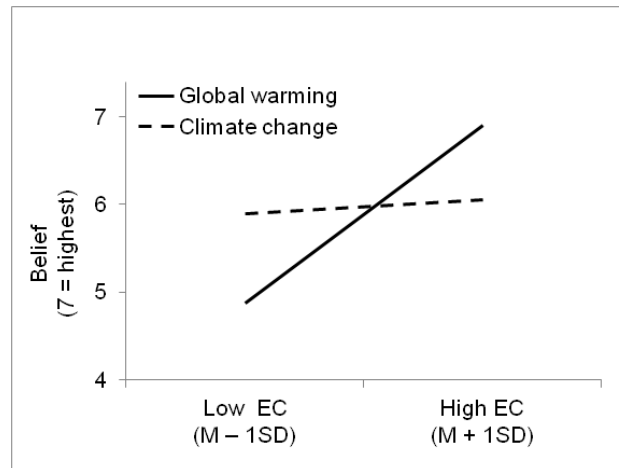


FIGURE 1. Graph depicting the interaction between frame (“Global warming” vs. “Climate change”) and environmental concern (EC) in Study 1.

Study 2 was designed to address these limitations. Specifically, we added a control condition in which participants were primed with seasonable temperatures, which allowed us to directly test the effect of priming unseasonably cold weather on beliefs. These cues were also less explicit: participants were exposed to the weather primes ostensibly as part of an unrelated task and were not specifically instructed to keep them in mind while completing the dependent variables. Finally, Study 2 featured a well-established scale measure of environmental concern (the New Ecological Paradigm; Dunlap, Van Liere, Mertig, & Jones, 2000), which allowed for testing whether the interaction between environmental concern and framing condition observed in Study 1 would replicate with a previously validated measure of this construct.

STUDY 2

To more directly test whether heat-related cues will affect belief in global climate change particularly when it is framed as global warming (vs. climate change), we conducted a Web experiment in which participants viewed a set of photographs that served to prime either unseasonable or seasonable temperatures before they reported their belief in either “global warming” or “climate change.” In addition to priming unseasonably cold weather, we also included an unseasonably *warm* condition in order to test whether reminders of warm weather events would differentially influence beliefs under these frames. Although we held no firm predictions about the effect of warm weather reminders among likely climate skeptics, we were interested in whether warm weather reminders might heighten the “global warming” beliefs of likely climate believers, given that this “evidence” might readily bolster their pre-existing belief under this frame in particular. On the other hand, however, these participants may be expected to hold highly crystallized, high levels of belief about global climate change that are robust to such subtle situational primes.

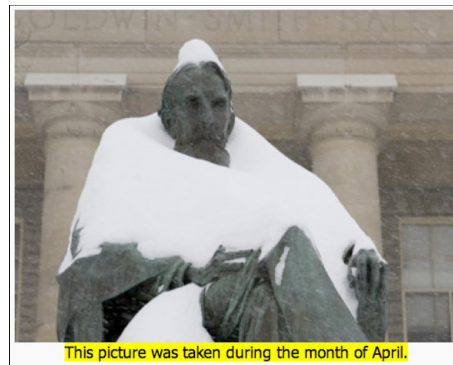


FIGURE 2. One of the three outdoor campus images used as primes in Study 2 (unseasonably cold condition displayed).

METHOD

Participants. One hundred and ninety-two students (147 females, 45 males; mean age = 19.62 years, $SD = 2.32$) from the same university in Upstate New York were recruited via undergraduate lecture classes to participate in a Web-based “opinion survey” in exchange for partial course credit.

Materials and Procedure. The study featured a 3 (Weather Prime: unseasonably cold, unseasonably warm, seasonable control) \times 2 (Frame: global warming, climate change) between-subjects factorial design. In the first part of the study (“Evaluating Photos for Campus Calendar”), participants were asked to carefully examine three photographs of outdoor spaces on campus, which were ostensibly being considered for a campus calendar. The instructions read:

In this task, you will view some photographs of . . . campus that are being considered for a campus calendar and the month they were taken. Please look over the photos and the accompanying information carefully. Later on, you will be asked some questions about what you saw.

Directly beneath each photograph was a sentence, highlighted in yellow, stating the month in which it was taken (e.g., “This picture was taken during the month of April”). Regardless of condition, participants viewed the same three photographs, which were vertically arrayed on a single Web page and randomly ordered for each participant. The manipulation was administered by varying the purported month in which the photographs were taken, to make either unseasonably cold, unseasonably warm, or seasonable temperatures accessible (see Figure 2 for an example). The three photographs depicted (1) a campus landmark covered in snow (i.e., the statue of the university’s founder used in Study 1), (2) a sunny scene with students studying outdoors among leafless trees, and (3) autumn trees displaying colorful foliage. In the unseasonably cold condition, the snowy photo was purportedly taken in April, whereas the other photos were labeled with seasonally consistent months (i.e., the sunny scene was labeled “March” and the colorful foliage image was labeled “September”). In the unseasonably warm condition, the sunny scene photo was purportedly taken in December, whereas the other photos were labeled with seasonally consistent months (i.e., the snowy scene was labeled “January” and the colorful foliage image was labeled “September”). In the

seasonable (control) condition, all photos were labeled with seasonally consistent months (i.e., the snowy photo was labeled “January,” the sunny scene was labeled “March,” and the colorful foliage image was labeled “September”).

On the top of the next Web page, participants were presented with the following instructions: “Before we ask you about the images you just saw, we would like to learn a little about you. Please answer the following questions.” The main dependent variable—belief in global climate change, framed as either “global warming” or “climate change” as in Study 1—was displayed directly beneath these instructions, followed by some additional questions related to global climate change not reported here. Participants next viewed a Web page displaying the same three photographs they recently viewed and were asked to indicate the month in which each was taken. This served as an instructional manipulation check (Oppenheimer, Meyvis, & Davidenko, 2009), allowing us to identify and exclude participants who did not pay sufficient attention to the materials, in order to reduce noise in the data. Following the manipulation check, participants were asked some additional questions probing their reactions to the photographs (to bolster the cover story) and then completed the 15-item New Ecological Paradigm (NEP) scale (Dunlap et al., 2000) to measure individual differences in environmental concern (sample items include “We are approaching the limit of the number of people the earth can support,” and “If things continue on their present course, we will soon experience a major ecological catastrophe”). Participants then completed a personal background questionnaire that included demographics (e.g., age, sex), political ideology (1 = Very Liberal to 7 = Very Conservative), and the single-item measure of environmental concern from Study 1, which allowed us to assess whether it was a reasonable proxy for the longer, validated measure (the NEP). Finally, we probed for awareness of the research hypothesis by asking participants what they thought the study was “really about” (none guessed correctly).

RESULTS

Thirty-nine participants (about 22%) failed to identify the correct month in which at least one of the photographs was purportedly taken and were thus excluded from the analysis.² The resulting working sample had 153 participants. This sample was predominately male (120 females, 33 males) and tended to be politically liberal ($M = 3.50$, $SD = 1.45$; 52% identified as *Very Liberal*, *Liberal*, or *Leaning Liberal*; 21% as *Moderate*; and 26% as *Leaning Conservative* or *Conservative*). Mean age was 19.61 years ($SD = 2.48$). Importantly, the two environmental concern measures correlated significantly at $r = .60$ ($p < .001$). We report results based on both measures of environmental concern, as well as political orientation, below.³

Our main analysis took the form of a multiple regression model in which the main belief variable was regressed onto Weather Prime (unseasonably cold, unsea-

2. This proportion of excluded participants is in line with other work employing instructional manipulation checks (Oppenheimer et al., 2009). Results do not change substantively when these participants are included in the analyses.

3. The 15-item NEP scale showed good internal reliability ($\alpha = .80$) and exploratory factor analysis suggested the presence of a single dominant factor, in line with previous analyses of these scale items (for discussion, see p. 435 in Dunlap et al., 2000). We therefore felt comfortable treating the NEP score as a unitary construct in our analyses.

TABLE 2. OLS Regression Testing Frame, Weather Prime, and Environmental Concern as Predictors of Belief in Global Climate Change in Study 2

Predictors	Belief	
	<i>b</i> (<i>SE</i>)	<i>t</i>
Frame	.04 (.26)	.14
Cold Prime (versus Seasonable)	-.00 (.18)	-.01
Warm Prime (versus Seasonable)	-.05 (.19)	-.23
Environmental Concern (centered) (EC)	.42 (.10)	4.15***
Frame × Cold Prime	-.32 (.36)	-.90
Frame × Warm Prime	-.23 (.39)	-.59
Frame × EC	-.51 (.20)	-2.51*
Cold Prime × EC	.19 (.14)	1.37
Warm Prime × EC	.34 (.18)	1.90
Frame × Cold Prime × EC	.84 (.27)	3.09**
Frame × Warm Prime × EC	1.28 (.36)	3.59***
% explained R ²	43.7	

Note. Frame coded as -0.5 = Climate change, +0.5 = Global warming; * $p < .05$, ** $p < .01$, *** $p < .001$.

sonably warm, seasonable; dummy-coded with seasonable as the referent group), Frame (global warming, climate change; coded +.5 and -.5, respectively), Environmental Concern (single-item measure, mean-centered), and all interaction terms. The model yielded a number of significant findings. First, the terms representing the three-way interaction between Weather Prime, Frame, and Environmental Concern were significant ($|b|s > .80$, $|t|s > 3.00$, $ps < .01$; see Table 2). In order to test the prediction that exposure to the unseasonably cold prime would reduce belief in “global warming” among participants low in environmental concern in particular, we conducted spotlight analyses to compare mean level belief in “global warming” following the cold weather versus seasonable weather primes at the $M - 1 SD$ and $M + 1 SD$ levels of environmental concern. This analysis revealed that viewing the unseasonably cold photographs led to significantly lower belief in “global warming” among participants low in environmental concern ($M_{\text{unseasonably cold}} = 4.90$ vs. $M_{\text{seasonable}} = 5.82$), $b = -.92$, $t(142) = -2.64$, $p < .01$; in contrast, this effect was not observed among participants high in environmental concern ($M_{\text{unseasonably cold}} = 6.83$ vs. $M_{\text{seasonable}} = 6.23$), $b = .60$, $t(142) = 1.71$, $p = .08$ (Figure 3). Moreover, no effect of the unseasonably cold prime was observed for “climate change” beliefs, either among participants low in environmental concern ($M_{\text{unseasonably cold}} = 5.60$ vs. $M_{\text{seasonable}} = 5.15$), $b = .45$, $t(142) = 1.35$, $p = .18$, or high in environmental concern ($M_{\text{unseasonably cold}} = 6.70$ vs. $M_{\text{seasonable}} = 6.83$), $b = -.13$, $t(142) = -.36$, $p = .72$. Complementing this spotlight analysis and consistent with our main prediction, simple slopes analysis revealed a strong relationship between environmental concern and existence beliefs when participants were asked about “global warming” following exposure to the unseasonably cold prime in particular, $b = .78$, $t(141) = 6.49$, $p < .001$.⁴

4. By comparison, this association was weaker in the “climate change” and unseasonably cold condition, $b = .44$, $t(141) = 3.21$, $p < .01$, and in the “climate change” and seasonable condition, $b = .68$, $t(141) = 4.56$, $p < .001$, and was not significant in the “global warming” and seasonable condition, $b = .17$, $t(141) = 1.20$, $p = .23$ (see Figure 3).

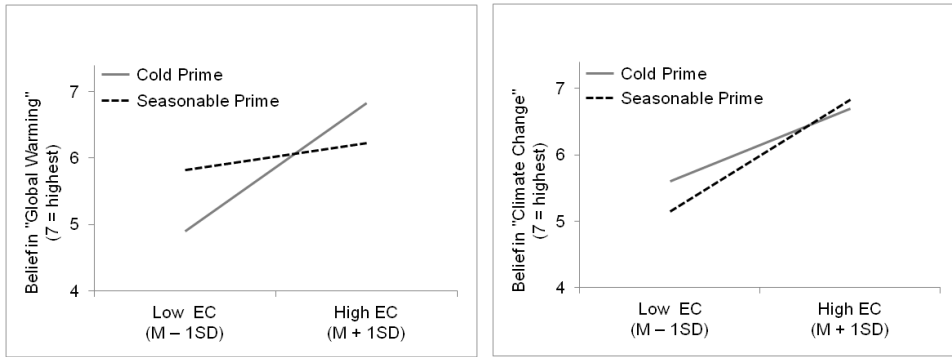


FIGURE 3. Graphs depicting the effect of unseasonably cold weather prime by frame (“Global warming” vs. “Climate change”) and environmental concern (EC) in Study 2.

Turning to the unseasonably *warm* prime, spotlight analyses revealed—some-what surprisingly—a similar effect to that observed in the cold prime condition.⁵ Compared to the seasonable prime, the unseasonably warm prime led to significantly lower belief in “global warming” among participants low in environmental concern ($M_{\text{unseasonably warm}} = 4.45$ vs. $M_{\text{seasonable}} = 5.82$), $b = -1.37$, $t(142) = -3.08$, $p < .01$, but *higher* belief among participants high in environmental concern ($M_{\text{unseasonably warm}} = 7.28$ vs. $M_{\text{seasonable}} = 6.23$), $b = 1.05$, $t(141) = 2.31$, $p < .05$ ⁶ (Figure 4). Moreover, no effect of the unseasonably warm prime was observed for “climate change” beliefs, either among participants low in environmental concern ($M_{\text{unseasonably warm}} = 5.59$ vs. $M_{\text{seasonable}} = 5.15$), $b = .44$, $t(141) = 1.12$, $p = .27$, or high in environmental concern ($M_{\text{unseasonably warm}} = 6.52$ vs. $M_{\text{seasonable}} = 6.83$; $b = -.31$, $t < 1$, ns). Although we did not expect this pattern to emerge for the unseasonably warm prime, we offer some possible explanations in the discussion.

We conducted a parallel set of analyses in which scores on the New Ecological Paradigm (NEP) were used in place of the single-item measure of environmental concern as the moderating variable. Results mirrored those reported above. First, the terms representing the three-way interaction between Weather Prime, Frame, and NEP were significant ($|b|s > .12$, $|t|s > 2.00$, $ps < .05$). Follow-up spotlight analyses again revealed that exposure to the unseasonably cold prime led to significantly lower belief in “global warming” among participants scoring low ($M - 1$ SD) on the NEP scale ($M_{\text{unseasonably cold}} = 5.05$ vs. $M_{\text{seasonable}} = 6.18$), $b = -1.13$, $t(141) = -2.89$, $p < .01$; in contrast, this effect was not observed among high-NEP participants ($M + 1$ SD; $M_{\text{unseasonably cold}} = 6.64$ vs. $M_{\text{seasonable}} = 5.99$), $b = .65$, $t(141) = 1.63$, $p = .11$. Turning to the unseasonably *warm* prime condition, results revealed lower belief in “global warming” among low-NEP participants ($M_{\text{unseasonably warm}} = 4.87$ vs. $M_{\text{seasonable}} = 6.18$), $b = -1.31$, $t(141) = -2.74$, $p < .01$; however, no significant effect of the warm prime on “global warming” beliefs was observed among high-NEP participants ($M_{\text{unseasonably warm}} = 6.52$ vs. $M_{\text{seasonable}} = 5.99$), $b = .53$, $t(141) = 1.16$, $p = .25$. Lastly, no effects on “climate change” beliefs emerged for either the cold or warm primes, consistent with the analysis presented above.

5. A follow-up spotlight analysis comparing the effects of the unseasonably warm and unseasonably cold prime on belief in “global warming” among participants low in environmental concern (i.e., $M - 1$ SD) was not significant, $b = -.451$, $t(141) = -1.12$, $p = .26$.

6. This test involves an extrapolated value (7.28; the scale maximum was 7.00).

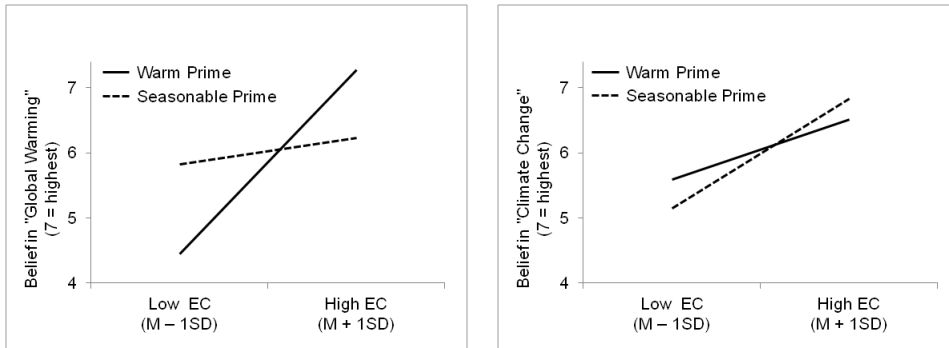


FIGURE 4. Graphs depicting the effect of warm weather prime by frame (“Global warming” vs. “Climate change”) and environmental concern (EC) in Study 2.

Finally, because we expected that unseasonably cold primes would result in lower belief in “global warming” among climate skeptics more generally (not just those low in environmental concern), we examined whether political orientation (from 1 = Very Liberal to 7 = Very Conservative) moderated this framing effect in the predicted manner. First, political conservatism correlated negatively with both measures of environmental concern ($r_s = -.35$ and $-.39$ for the single-item measure and the NEP, respectively; $p_s < .001$), echoing a familiar observation in the literature (e.g., Dunlap, Xiao, & McCright, 2001; Jones & Dunlap, 2010). When we re-ran the above analyses substituting political orientation for the environmental concern measures, results revealed a similar pattern. The terms representing the three-way interaction between Weather Prime, Frame, and Political Ideology were again significant ($|b|s > 1.00$, $|t|s > 2.20$, $p_s < .05$). Subsequent spotlight analysis revealed that more politically conservative participants (operationalized as $M + 1SD$) reported lower belief in “global warming” in both the unseasonably cold ($M = 5.19$) and unseasonably warm ($M = 4.55$) conditions, relative to the seasonable condition ($M = 5.92$), $b = -.73$, $t(141) = -1.85$, $p = .07$; and $b = -1.37$, $t(141) = -2.38$, $p = .02$ (respectively). In contrast, the “global warming” beliefs of more politically liberal participants ($M - 1SD$) were unaffected by the weather primes, and no interaction was observed between weather prime and political ideology on “climate change” beliefs ($t_s < 1$, ns).

DISCUSSION

The present results extend the observations from Study 1 in a number of important ways. First and most important, we replicated Study 1’s effect with a more comprehensive experimental design that included a control condition featuring reminders of seasonable weather (e.g., a snowy day in January). This allowed us to directly test the prediction that reminders of unseasonably cold weather (e.g., a snowy day in April) would reduce belief in “global warming” but not “climate change” among likely climate skeptics in particular. Indeed, the present findings support this hypothesis. Relative to those primed with seasonable weather, participants low in environmental concern or high in political conservatism reported less belief in “global warming” when primed with unseasonably cold weather. In

contrast, this effect did not emerge when global climate change was instead framed as “climate change.” Second, we found this effect while using more subtle weather cues than that employed in Study 1, in which participants were specifically instructed to think about a recent, unseasonably cold weather event while reporting their belief. In Study 2, rather, all participants viewed the same three photographs of their campus (with only the purported “month taken” labels manipulated, to imply unseasonable or seasonable weather), and did so as part of an ostensibly unrelated task (i.e., evaluating photographs for a campus calendar). Third, this effect emerged whether we used our brief, single-item measure of environmental concern from Study 1 or the more comprehensive and previously validated NEP scale (Dunlap et al., 2000), the two of which were found to be highly correlated.

We also found that priming unseasonably *warm* weather reduced belief in global warming among conservatives and those low in environmental concern. Although this finding was unexpected, we suggest that this too may reflect motivated reasoning among climate skeptics in a manner consistent with psychological reactance theories (e.g., Brehm, 1966; Brehm & Brehm, 1981; Dillard & Shen, 2005). For instance, such individuals may feel that their freedom to express an alternative viewpoint is constrained when they are confronted with a set of images in which the only unseasonable weather event depicted is a warm one (as opposed to a cold one), which may lead them to adhere even more strongly to their pre-existing views. Moreover, if local warming is perceived as compelling evidence because it is highly compatible with the connotations of “global warming,” skeptical groups may be inclined to report especially low belief under this frame in particular, as a way to affirm their values and meaningful group identities (Sherman, Nelson, & Steele, 2000). Among participants high in environmental concern (but, interestingly, not liberals), we found that priming unseasonably warm weather *increased* existence beliefs when the issue was framed as global warming. Presumably, this finding reflects motivated reasoning on the part of likely climate believers who may interpret unseasonably warm weather in their location as further evidence that the phenomenon exists, evidence that is more readily applicable under a “global warming” frame.

GENERAL DISCUSSION

Although scientists have sounded the alarm about the threat of global climate change, the general public seems less concerned. In the United States, a majority of citizens now report believing that anthropogenic greenhouse gas emissions are causing the planet to warm (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2012). And yet, the issue remains highly politicized, with liberals and Democrats consistently reporting greater belief and concern than conservatives and Republicans (Krosnick et al., 2000; McCright & Dunlap, 2011; Pew, 2012). This gap between scientists and the public has inspired research on the factors that underlie climate opinions, ranging from general characteristics of the threat, such as its difficulty to detect through personal experience (Weber, 2010), to a host of individual differences variables, such as political ideology, environmental concern, and trust in science (e.g., Corbett & Durfee, 2004; Krosnick, Holbrook, Lowe, & Visser, 2006).

More recently, research in social psychology has begun to explore the role of variables that are more fleeting and temporary. In general, these findings suggest

that subtle exposure to heat-related cues (e.g., warm temperatures, words like *fry* and *boil*) can promote greater belief in global warming (Joireman et al., 2010; Li et al., 2011), suggesting that citizens' climate beliefs are swayed by information that is highly accessible in mind at the time they are questioned, echoing a familiar observation from social cognition research (e.g., Higgins et al., 1977; Srull & Wyer, 1979; see Schwarz et al., 2003 for a review). A tacit assumption in the extant research on heat-related priming is that the observed effects derive from the cues themselves, overlooking the importance of the cue's applicability to the phenomenon as it is currently framed ("global warming"). In this vein, results from the present experiments suggest that the influence of heat-related cues on climate beliefs is constrained by how the phenomenon is framed in the question at hand, such that they influence beliefs when global climate change is referred to as "global warming" but not as "climate change."

In addition to highlighting the role of these common linguistic frames in everyday judgments about climate, the present work extends the literature in other important ways. In contrast to previous research, which has largely emphasized how direct experience with warming increases belief in global warming, we focused primarily on the converse: how direct experience with cooling *decreases* belief. This focus was inspired by the observation that unseasonably cold weather events tend to reignite the debate over global climate change in the United States, which can readily be seen in the headlines of partisan media (e.g., "Gore to warn of 'global warming' on New York City's coldest day in decades!"; Drudge, 2004). This focus also highlights the likely role of individual difference variables such as environmental concern and political orientation in these effects, given their longstanding association with climate skepticism. Suggesting that these variables do indeed play a significant role, participants low in environmental concern (but not participants high in environmental concern) reported less belief in "global warming" than in "climate change" after being reminded of a recent, unseasonable snowfall on their college campus (Study 1). Moreover, conservatives (in addition to the environmentally unconcerned) reported less belief in "global warming" (but not "climate change") after being exposed to photographs depicting unseasonably cold weather on campus, relative to those who viewed seasonable scenes; for their part, the environmentally concerned reported greater belief in "global warming" (but not "climate change") after being exposed to unseasonably warm weather photographs. Overall, these results reiterate the tendency for people to confuse weather with climate (Bostrom et al., 1994; Read et al., 1994) and point to motivated reasoning on the part of climate partisans, who appear inclined to use relatively routine temperature fluctuations as "evidence" that bolsters their pre-existing viewpoints when the active frame facilitates doing so.

As such, this work also contributes to the large literature on motivated processes in the fields of social psychology and communication, which emphasizes how a perceiver's needs and values shape basic perceptual processes (e.g., Balcetis & Dunning, 2010; Bruner & Goodman, 1947) as well as higher-order reasoning (e.g., Lord, Ross, & Lepper, 1979; Ross & Anderson, 1982; see Kunda, 1999 for a review). This includes recent work on how messages about the consequences of global climate change can lead to less support for climate mitigation policies among Re-

publicans but greater support among Democrats (Hart & Nisbet, 2012), as well as research demonstrating similar “boomerang” effects in other domains, notably health, where well-intentioned interventions can sometimes increase unhealthy behaviors like smoking and alcohol consumption (e.g., Byrne & Hart, 2009; Grandpre, Alvaro, Burgoon, Miller, & Hall, 2003; Wechsler, Lee, Nelson, & Kuo, 2002). Although our study did not feature a persuasive message *per se*, we suspect that a similar motivated process may explain why the unseasonably cold prime dramatically reduced belief in “global warming” among conservatives and those low in environmental concern. Faced with evidence that seemingly contradicts a pre-existing belief—especially one so imbued with social meaning and group identity (i.e., an identity marker; Hart & Nisbet, 2012; Kiely, Bechhofer, Stewart, & McCrone, 2001)—these participants may have taken a more extreme partisan position on this issue as a way to reaffirm their values, even in the absence of an explicit persuasive attempt (Mutz, 2006).

This work is not without limitations. Both studies featured convenience samples of undergraduate students, a group that is not representative of the American public and may differ appreciably in their political engagement (Hillygus, 2005). Perhaps more important, the presumed mediating variable for these effects—the cognitive accessibility of heat-related concepts—went unmeasured in both studies. Future work should measure activation of this concept directly (e.g., using a word fragment completion task; Tulving, Schacter, & Stark, 1982) to test whether such activation in fact mediates the moderation effects reported here. Additionally, we reiterate that this work was conducted in a broader political context, that of the United States, where global climate change is currently highly politicized. Given that climate politicization shifts over time (Krosnick et al., 2000; McCright & Dunlap, 2011) and across nations (e.g., Painter, 2010), the effects reported here are likely highly context-bound.

Finally, we note that these results may carry important practical implications for public discourse about global climate change and science communication more broadly. Whereas other research has explored the effects of framing global climate change in different conceptual terms (e.g., as a public health threat; Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010), our data suggest that more subtle and mundane differences in message wording can produce meaningful effects on citizens’ judgments about climate. To the extent that “global warming” prevails over “climate change” as the dominant frame in national surveys (Leiserowitz et al., 2012; Pew, 2012) and politics in general (as it may in the U.S. especially; Weingart, Engels, & Pansegrau, 2000), people’s day-to-day experiences related to heat might appreciably shift public opinion on climate. Our findings suggest that such haphazard influences may be diminished when the issue is instead framed in terms of climate change. Moreover, our results suggest that partisans may employ these frames strategically in order to encourage audiences to adopt specific policy preferences (Druckman, 2001b). Although there is some evidence that the use of these frames differs across partisans (Schuldt et al., 2011), further investigating the conditions under which these frames emerge in science and political communication is likely to be a fruitful avenue for future research.

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