

Visceral Fit: While in a Visceral State, Associated States of the World Seem More Likely

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We propose that visceral states can influence beliefs through “visceral fit”: People will judge states of the world associated with their current visceral experience as more likely. We found that warmth influenced belief in global warming (Studies 1–3) and that thirst impacted forecasts of drought and desertification (Study 5). These effects emerged in a naturalistic setting (Study 1) and in experimental lab settings (Studies 2, 3, and 5). Studies 2–6 distinguished between 3 mechanistic accounts: temperature as information (Studies 2 and 3), conceptual accessibility (Studies 4 and 5), and fluency of simulation (Studies 6a and 6b). Studies 2 and 3 ruled out the temperature as information account. Feeling warm enhanced belief in global warming even when temperature was manipulated in an uninformative indoor setting, when participants’ attention was first directed to the indoor temperature, and when participants’ belief about the current outdoor temperature was statistically controlled. Studies 4 and 5 ruled out conceptual accessibility as the key mediator: Priming the corresponding concepts did not produce analogous effects on judgment. Studies 6a and 6b used a causal chain design and found support for a “simulational fluency” account. Participants experiencing the visceral state of warmth constructed more fluent mental representations of hot (vs. cold) outdoor images, and those who were led to construe the same hot outdoor images more fluently believed more in global warming. Together, the results suggest that visceral states can influence one’s beliefs by making matching states of the world easier to simulate and therefore seem more likely.

Keywords: global warming, embodied cognition, fluency, visceral fit, simulation

In October 2007, Al Gore and the Intergovernmental Panel on Climate Change were awarded the Nobel Peace Prize for their efforts in “disseminating greater knowledge about man-made climate change” (Nobel Committee, 2007). Yet, according to a March 2010 Gallup Poll of American adults, only 52% of respondents believed that global warming is occurring, with 48% believing that the reality of global warming is “exaggerated” (Gallup, 2010). Given that people seem not to simply consult expert opinion on the matter, what variables impact people’s predictions for the future? Stable factors (e.g., political orientation) no doubt play a role. Exposure to scientific evidence likely produces both a durable and an ephemeral impact. But in addition, we predicted that a nonnormative ephemeral influence—the visceral state of heat—would influence belief by making the existence of global warming “feel” more or less intuitively plausible.

In the present research, we explore a novel route by which visceral states might influence judgment. We use the term *visceral state* much as Loewenstein (1996) did to refer to phenomenologically consuming bodily states (e.g., warmth, thirst, hunger, pain, sexual desire). We suggest that while experiencing a visceral state, people will judge future states of the world that fit with that experience to be more likely. In other words, when there is a congruency between one’s current visceral state and a considered state of the world, this experience of *visceral fit* will influence judgment. Thus, we predict that warm participants will believe that global warming is more likely to become a reality and that thirsty participants will believe that drought is more likely to occur.

Over the past few years, a handful of researchers have started to investigate whether global warming judgments can be influenced by local weather patterns, although such efforts have not tested whether visceral experience is responsible for shifts in beliefs. Researchers have examined whether people believe more in global warming when hot days are available in recent memory, and they have found some support for this proposition (Egan & Mullin, 2009; Li, Johnson, & Zaval, in press; Schuldt & Schwarz, 2008). In contrast, the present research focuses not on how people make inferences about long-term weather trends from local variation in weather patterns but on how the actual physical experience of heat (or thirst) can influence people’s belief in global warming (or drought). Although we are aware of no past research examining this phenomenon, our prediction that visceral fit will enhance belief in matching states of the world is rooted in several related lines of research.

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There is considerable evidence that when there is a match between one's state of mind or mental contents and a stimulus being evaluated, this fit leads to inferences of validity. First, when one contemplates the expected frequency of negative or positive events while experiencing a matching negative or positive mood, the event is judged as more likely (Johnson & Tversky, 1983). Second, when a statement is processed with greater fluency, it leads to an inference that the statement is valid (Schwarz, Sanna, Skurnik, & Yoon, 2007). Third, when one has mentally simulated an event, it seems more likely to occur (Carroll, 1978; Gregory, Cialdini, & Carpenter, 1982; Risen & Gilovich, 2007, 2008). Fourth, research on *regulatory fit* has shown that when there is a match between one's own regulatory orientation and the style in which a persuasive message is offered, the message seems more true (Cesario & Higgins, 2008; Higgins, 2005; Higgins & Scholer, 2009; Lee & Aaker, 2004). Explaining how regulatory fit may generate inferences of validity, Petty et al. speculated, "It may be that the processing fluency stemming from regulatory fit leads message thoughts to be held with more confidence" (Petty, Briñol, Tormala, & Wegener, 2007, p. 266).

Building on this work, we hypothesized that the experience of a visceral state would strengthen belief in states of the world that "fit" that visceral experience. The experience of heat fits with a belief in global warming, the experience of thirst fits with a belief in impending drought, and the experience of hunger fits with a belief in upcoming famine. In each case, the visceral state is congruent with the visceral state one anticipates feeling in the considered state of the world. Note that our definition of visceral fit relies on congruency rather than a loose association. For example, although people may associate the experience of hunger with eating a big meal (after all, they may be most hungry just before they consume a meal), the visceral state of hunger is not congruent with an abundance of food but the lack thereof. Thus, we predicted that the experience of hunger would lead people to believe that famine is more, rather than less, likely to occur.

Our primary goal in the current study was to test whether visceral fit leads people to believe more in matching states of the world. We tested whether feeling warm increases belief in global warming and whether feeling thirsty increases belief in upcoming drought and desertification. Our second goal was to investigate why this occurs. We suggest that there are at least three candidate explanations for why individuals who feel warm would believe more in global warming. One possibility is that people use their current visceral state as a source of diagnostic information (e.g., today's hot weather is diagnostic of the planet warming). A second possibility is that the visceral experience activates an abstract concept, which, in turn, influences belief. A third possibility, and the one we favor, is that it is easier to mentally simulate a world plagued by global warming when one is currently hot. In the remainder of the introduction, we discuss each explanation, starting with the one we favor. Then, we test for each account in a series of studies.

Simulational Fluency

We suggest that the elevated likelihood judgments that we hypothesize will occur during visceral fit result from the ease with which one can simulate a matching state of the world. In other words, an event feels intuitively more plausible because the vis-

ceral experience promotes a fluent mental representation of the matching state of the world. For example, we suggest that it is easier to mentally picture a famine in Africa while one is hungry but that this mental image may feel more distant and blurry while one is satiated (see Alter & Oppenheimer, 2008). Similarly, a mental vision of a dry, hot, and arid world plagued by global warming may be sharper and more fluent when one is warm.

The term *fluency* is typically short for *processing fluency* (Alter & Oppenheimer, 2009), which is the subjective experience of ease with which people process information. Because we focus on the fluency of simulating mental images rather than the fluency of processing external stimuli, we use the term *simulational fluency* to distinguish the constructs. Simulational fluency refers to the ability to easily simulate a mental image clearly or vividly.

Our focus on how visceral states influence the process of simulation builds on theoretical arguments made in the embodied cognition literature and most specifically by Barsalou and his colleagues (see, e.g., Barsalou, 1999, 2008; Niedenthal, Barsalou, Winkelman, Krauth-Gruber, & Ric, 2005). For example, Barsalou's (1999) theory of perceptual symbol systems argues that conceptual knowledge is distributed across different sensorimotor systems and that cognition relies on a process of simulation. From this perspective, when people are asked to think about the concept of global warming and determine whether global warming is likely to occur, they rely on a multimodal representation of the concept that is stored in memory to simulate the possibility. We suggest that the visceral experience of heat is one element in their representation such that when they are experiencing heat they can more fluently simulate a world plagued by global warming.

If people do indeed simulate future possibilities that fit their visceral state with increased fluency or clarity, it should follow that such fluency will translate into a sense of greater likelihood or validity. Similar effects have been demonstrated for processing fluency and for simulational fluency. Research on processing fluency has found, for example, that participants were more likely to believe statements that were presented in an easy-to-read color (against a white background) than a difficult-to-read color (Reber & Schwarz, 1999). Similarly, participants were more likely to believe linguistically fluent aphorisms (e.g., "What sobriety conceals, alcohol reveals") than disfluent aphorisms (e.g., "What sobriety conceals, alcohol unmasks"; McGlone & Tofiqbakhsh, 2000). Research on simulational fluency has found that mentally simulating an event makes it seem more likely to occur. Furthermore, this is especially true for events that are especially easy to imagine or simulate (Petrova & Cialdini, 2005; Sherman, Cialdini, Schwartzman, & Reynolds, 1985). For example, if people mentally simulate contracting a disease with easy-to-imagine symptoms (e.g., headaches or muscle aches) they believe that they are more likely to contract the disease than if they only read about the disease; this does not occur when people simulate contracting a disease with difficult-to-imagine symptoms (e.g., a malfunctioning nervous system or inflamed liver; Sherman et al., 1985).

If our hypothesis is correct—if people believe more in states of the world that match their visceral experience because of simulational fluency—a line of causality should emerge. Experiencing a visceral state should lead people to simulate a matching state of the world more fluently, which should then lead to an inference of validity. In other words, if warm individuals believe more in global warming because of simulational fluency, then (a) people who are

currently warm should mentally represent a “global warming world” more fluently than those who are not warm and (b) fluently representing such a “global warming world” should lead people to believe more in global warming.

Until now, fluency has been examined by manipulating the ease with which a stimulus is processed (often by manipulating the stimulus itself) and examining the consequences that unfold (for a review, see Alter & Oppenheimer, 2009). In the current work, we explore fluency as an explanation for visceral fit and therefore examine not merely a consequence of fluency but a cause as well. We draw on existing fluency research to suggest that fluently simulating a possible state of the world will lead to an inference of validity (prediction b above). But we also move beyond existing research to test whether a visceral experience will lead stimuli that fit the experience to be mentally represented or simulated more fluently (prediction a above).

Note that simulational fluency can arise for reasons other than visceral fit. For example, graduate students who marched in their college graduation may construct a clearer mental image for what it will be like to march in their PhD graduation. Or, it may be easier to simulate a job interview when one is wearing a tie than when one is lounging in sweats. In the current paper, however, we focus on how visceral states increase simulational fluency for matching states of the world and how that, in turn, influences judgment.

There are two alternative accounts of why visceral states may impact forecasts of matching states of the world. We discuss each possibility before presenting our studies that test for the impact of visceral fit.

Conceptual Accessibility

The past 25 years of social psychological research have repeatedly demonstrated that incidental environmental stimuli can influence people’s judgment and behavior without people being aware of the influence of the stimuli or even the stimuli themselves (Bargh & Williams, 2006; Chartrand & Bargh, 1996). Most of this research has relied on conceptual priming techniques, in which words, pictures, or symbols are used to prime traits, groups, or goals. For example, after being exposed to words related to hostility, people judge another person as more hostile (Srull & Wyer, 1979); after being exposed to words related to the elderly, people walk more slowly (Bargh, Chen, & Burrows, 1996); after being exposed to incidental numbers, people make judgments numerically closer to those numbers (Critcher & Gilovich, 2008); and after being primed with achievement-related words, people improve their performance on a word-search task (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trotschel, 2001). These effects are said to occur because the primes activate related concepts, thereby promoting behavior consistent with these primed concepts and leading ambiguous stimuli to be interpreted as consistent with them.

Historically, conceptual priming has relied on the presentation of visual symbols. Researchers have recently primed participants through nonvisual perceptual systems, such as smell or touch (Ahn, 2009; Holland, Hendriks, & Aarts, 2005; Williams & Bargh, 2008). From a traditional social cognition perspective, although the priming techniques are different (i.e., relying on visceral sensations like smell and touch instead of words or images), the underlying psychological process is the same. The scent or tactile sensation indirectly activates the concept, which in turn affects

judgment and behavior. For example, Williams and Bargh (2008) primed the concept of warmth by having participants hold either a hot or a cold cup of coffee. Because warmth was made conceptually accessible for those holding the hot cup, they judged an ambiguous target as “warmer” (e.g., more sociable and kind) than did those holding the cold cup. As in traditional conceptual priming studies, having a concept activated increases the tendency to interpret ambiguous behavior as fitting the concept. Just as a conceptual prime of hostility leads people to see a target as more hostile (Srull & Wyer, 1979), the prime of warmth leads people to see a target as warmer. Although Williams and Bargh cleverly primed the concept through the tactile sensation of physical warmth, the same results would be predicted if warmth were primed using a sentence unscrambling task, subliminal exposure to warmth-related words, or any other experimental technique for activating the concept of warmth.

Note that from an embodied cognition perspective, sensory primes or “embodied cues” may have their effect by routes other than an indirect activation of the abstract concept. For example, Williams and Bargh (2008) suggested that their effects may have emerged because of a shared representation of personal and physical warmth in the brain. Nevertheless, because visceral experiences activate abstract concepts, the psychological processes underlying visceral priming studies may be the same as those underlying conceptual priming studies.

Accordingly, it is possible that the experience of warmth could activate the abstract concept of warmth, and the accessibility of the concept could influence belief in global warming. This alternative account seems unlikely because although there is reason to predict that the accessibility of warmth will influence the perceived warmth of ambiguously warm people (Williams & Bargh, 2008), it is not clear why the conceptual prime of warmth should alter one’s belief that global warming is a well-substantiated scientific proposition. Research has shown that an accessible concept is likely to influence how bottom-up information about a target is categorized. We are not aware of research suggesting that accessibility of a concept increases the believability of abstract ideas that are semantically associated with that concept. Nevertheless, in the present paper we examine whether conceptual accessibility could reasonably explain our findings by priming the abstract concepts of warmth and thirst and testing whether it influences belief in global warming and drought, respectively. If conceptual accessibility mediates visceral fit, we should find that accessibility predicts the relevant judgments.

Source of Information

Visceral sensations have been shown to impact judgment not merely through conceptual accessibility but also by providing information. The experience of a full-fledged visceral state can be a powerful reminder of just how experientially powerful that particular state is (Loewenstein, 1996). Appreciation of this power has been shown to influence social judgments. For example, Nordgren, van der Pligt, and van Harreveld (2007) found that fatigued participants were more likely to excuse the offensive behavior of a fatigued parent than were nonfatigued participants or participants asked to imagine they were fatigued. The experience of fatigue influenced judgment by making it easier to appreciate the power of that particular state and its contaminating influence on behavior.

Also demonstrating this general principle, when people try to predict which of two visceral states will more powerfully impact someone else, they lean toward the one they are experiencing themselves (Van Boven & Loewenstein, 2003).

In addition to providing information about a visceral state's power, a visceral experience may also provide "diagnostic" information about a matching state of the world. That is, if people think that the outdoor temperature is diagnostic of the validity of global warming, they may intentionally use that information. For example, if an individual is experiencing warmth outdoors, he or she may overgeneralize from the current temperature and assume that global warming is real (even if this judgment strategy is not logically prudent).

According to an information account, people judge global warming to be more likely when they are hot because temperature is being used as a diagnostic cue. Thus, if a visceral state is clearly nondiagnostic, it should not affect judgment. If belief in global warming is affected by ambient temperature even when it cannot reasonably be seen as evidence of global warming (e.g., when experiencing warmth indoors), this would suggest that temperature is not having its effect through its perceived informational value.

Of course, it is possible that people unintentionally use indoor temperature as diagnostic evidence for global warming. In other words, it could be the case that people are so accustomed to applying the theory "heat = global warming" when they are outdoors that they also apply it indoors, failing to notice that their current source of warmth is an irrelevant source of information. Researchers who test for information accounts typically do so by drawing participants' attention to the irrelevant source of information (Berkowitz & Troccoli, 1990; DeSteno, Petty, Wegener, & Rucker, 2000; Schwarz & Clore, 1983). If a cue is unintentionally being used as a source of information, its influence will disappear when people's attention has been drawn to it. Thus, if indoor temperature is unintentionally being used as a source of information, the effects of visceral fit should be eliminated when participants' attention is drawn to the indoor temperature.

Finally, it is conceivable that people intentionally use indoor temperature as evidence for global warming. In other words, it is possible that an individual experiencing warmth indoors would assume that the indoor temperature is diagnostic of outdoor temperature and then overgeneralize from the estimated outdoor temperature. If people intentionally use indoor temperature as a source of information, warm participants could believe more in global warming even when their attention is drawn to the indoor temperature. But, if this is the mediating process, one's estimate of the outdoor temperature should mediate the effect of indoor temperature on belief in global warming.

Overview of Studies

We tested whether visceral states would influence judgment during "visceral fit" across seven studies. Study 1 was conducted outdoors. We expected that when it was warmer outside, participants would show increased belief in global warming. Studies 2–6 examined three competing accounts for the predicted effect. One possibility is that participants imputed the visceral state of heat with informational value (e.g., today's hot weather is diagnostic of the planet warming). Studies 2 and 3 tested this *temperature-as-information* account by manipulating temperature indoors, calling

participants' attention to the temperature in the room, and directly measuring the information that participants gleaned from the indoor temperature. A second explanation is that the visceral experience served as a sensory prime, activating the related concept, which in turn influenced belief. Studies 4 and 5 tested the *conceptual accessibility* account by comparing the impact of actually experiencing a visceral state to merely having the state conceptually primed. Also, Study 5 tested whether our findings could be extended to another visceral state (thirst) and a new forecast (the likelihood of drought and desertification). A third explanation, and the one we favor, is that as people tried to imagine the hot world implied by global warming, these mental images were simulated more fluently for those who were currently warm, which led to the inference that this hot world was more likely. Using a causal chain design (Spencer, Zanna, & Fong, 2005), Studies 6a and 6b tested the *simulational fluency* account by examining whether the experience of warmth influences the clarity with which participants mentally represent hot, arid outdoor scenes and whether the manipulated representational fluency of these scenes influences belief in global warming.

Study 1

Participants were taken outside to make a number of judgments. The critical item asked about belief in global warming. While the participant made the judgments, the experimenter recorded the outdoor temperature. We tested whether outside temperature influenced belief in global warming, whether it influenced liberals and conservatives differently, and whether it influenced beliefs about other issues.

Method

Participants. During the months of September and October, 67 students at Cornell University participated in exchange for extra credit in their psychology and human development courses.

Materials and procedure. Participants were taken outside under the pretense of judging the height of several campus landmarks. Next, participants completed a social/political questionnaire by indicating their degree of agreement with several political and social issues. The question about global warming was embedded within questions about four other current topics (firearm sales, charter schools, legalization of marijuana, and the firing of radio talk show host Don Imus). The critical question about global warming was adapted from a CNN poll (CNN/Opinion Research Corporation, 2007), "Which of the following statements comes closest to your view of global warming? Global warming is a proven fact. Global warming is a theory that has not yet been proven." For all questions, participants responded on an 11-point scale, with lower numbers corresponding to a proven fact and higher numbers corresponding to an unproven theory.¹

After completing the social/political questionnaire, participants indicated their political ideology and current physical state. Participants reported their political ideology by checking the terms they believed applied to them (*Republican, Democrat, Independent, Conservative, and Liberal*). For each term they checked, they

¹ Responses were reverse coded for Figure 1 and all analyses, so that higher numbers correspond to the belief that global warming is a proven fact.

rated the degree to which the term described them (7-point scales). We calculated a “left-wing index” for each participant by subtracting ratings of Republican and Conservative from ratings of Democrat and Liberal. Those higher on the left-wing index were expected, at baseline, to have a stronger belief that global warming is real (Malka, Krosnick, & Langer, 2009). If any term was not checked, it was scored a 0. The average ideology score was positive ($M = 4.84, SD = 5.59$), reflecting the slightly left-leaning nature of the university sample.

Participants reported their physical state by checking the terms they believed currently applied to them (*hungry, thirsty, warm, tired, and chilly*) and rating each of the checked terms (7-point scales). We calculated a “warmth” score for each participant by subtracting the chilly rating from the warm rating.

The experimenter recorded the outdoor temperature to the nearest degree Fahrenheit while the participant filled out the questionnaire. The temperature ranged from 9 °C (49 °F) to 32 °C (89 °F), with an average temperature of 24 °C (75 °F). As one would expect, participants’ state of warmth correlated with the outside temperature, $r(65) = .69, p < .001$.

Results and Discussion

We regressed the belief in global warming on the outside temperature, left-wing index, and the interaction term. We found that ambient temperature significantly predicted the belief in the validity of global warming, with participants reporting greater belief on warmer days (see Figure 1). In fact, the effect of temperature, $\beta = .24, t(63) = 2.04, p = .05$, was as strong as the effect of ideology, $\beta = .22, t(63) = 1.90, p = .06$, and was not qualified by it, $\beta = -.16, t(63) = 1.36, p > .17$. Thus, outside temperature influenced liberals and conservatives similarly. Also, there was no relationship between temperature and attitudes toward the four other issues ($ps > .21$), indicating that temperature did not shift participants’ political positions more generally.

We contend that the experience of temperature directly affected belief (i.e., it was easier for participants to conceptualize and simulate the global warming emergency while sitting outside on an uncomfortably warm day than while huddling for warmth in a nippy wind). It is possible, however, that heat exerted an indirect effect on belief by providing participants with information (we refer to this as the temperature-as-information account). Participants may have thought that the current temperature was a reasonable cue for determining the validity of global warming. In other words, they may have inferred a climate trend from the day’s temperature (i.e., overgeneralized the day’s weather to weather trends in general). After all, global warming by definition should produce warmer weather. Of course, global warming describes a gradual elevation in the earth’s average temperature, an effect that is small compared to the day-to-day (and seasonal) variation in atmospheric temperature. Accordingly, such a judgment strategy would not be logically prudent but may describe some of the psychology nonetheless.

If the results of Study 1 were due to the tendency to inappropriately treat the current temperature as diagnostic of long-term climate trends, there should be no such effect if participants’ current temperature was unquestionably nondiagnostic of long-term climate trends. By contrast, if the experience of heat exerts an effect on belief by changing the fluency with which a world affected by global warming is imagined, then even nondiagnostic variation in temperature should exert an influence on belief. Study 2 was designed to examine this possibility.

Study 2

In Study 2, participants were randomly assigned to complete the survey either in a small heated cubicle or in an identical nonheated cubicle. In this way, we varied the temperature people experienced in a climate-controlled setting where temperature was nondiagnostic as to the validity of global warming. According to the

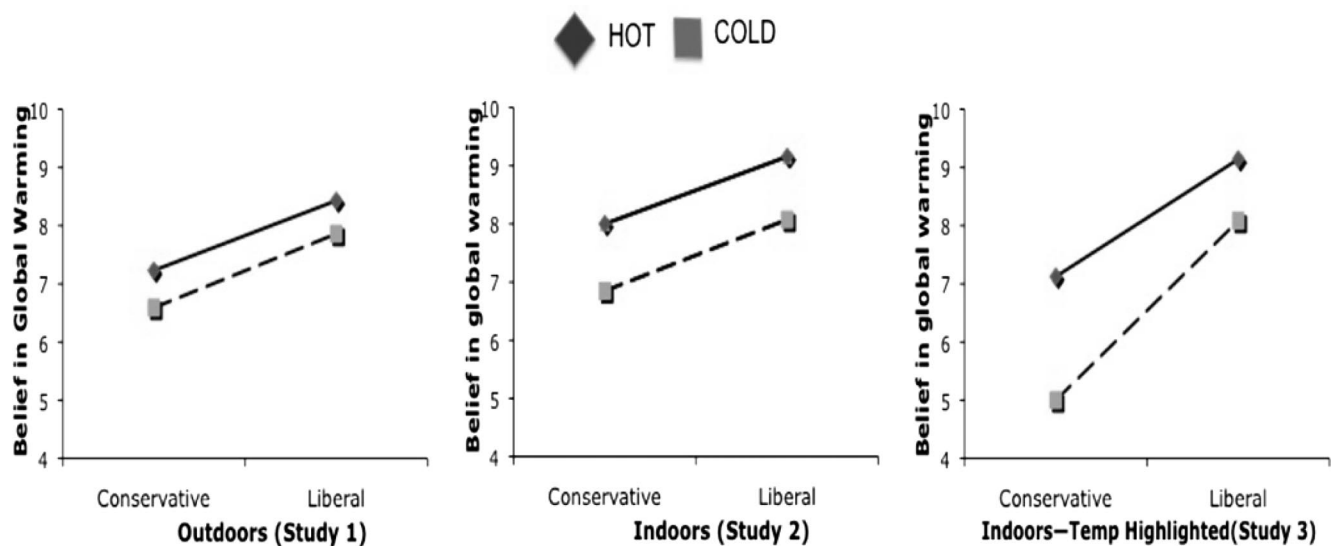


Figure 1. Belief in global warming, expressed on a scale from 0 (an unsubstantiated theory) to 10 (a proven fact). Depicted means for political orientation (Studies 1–3) and temperature (Study 1) were calculated following a mean split.

temperature-as-information account, there should no longer be an influence of heat on belief in global warming. But, because we suggest that visceral fit depends on the visceral state of warmth (and not on the perceived diagnosticity of the temperature), we predicted that those in a warmer room would believe more in global warming.

Method

Participants. Participants were 84 students at Cornell University who participated in exchange for extra credit in psychology or human development classes. One participant who expressed suspicion about the hypothesis was excluded from analyses.

Materials and procedure. Participants were randomly assigned to either the heat condition or the control condition. In the heat condition, participants completed the questionnaire in a small cubicle that was heated with a space heater for 15 min prior to participants' arrival. The space heater was removed before participants began the task. In the control condition, participants completed the survey in an identical nonheated cubicle. The temperature of the heated and control cubicles were approximately 27 °C (81 °F) and 23 °C (73 °F), respectively.

The social/political questionnaire was almost identical to the one used in Study 1. Two additional filler questions were included (assessing participants' views on Social Security and the death penalty). We included more filler items to provide a better test that the visceral experience of heat would impact only the global warming item and not the variety of other questions.

Participants reported their political ideology and physical state as they did in Study 1. Again, the average ideology score was positive ($M = 3.80$, $SD = 6.33$), reflecting the liberal leaning of the sample. As expected, the average warmth score for those in the heated cubicle was significantly greater than for those in a nonheated cubicle, $t(63.9) = 4.76$, $p < .001$. After they had completed the questionnaires, participants were debriefed.

Results and Discussion

We regressed belief in global warming on participants' experimental condition, their left-wing index, and the interaction term. As shown in Figure 1, participants who responded in the heated cubicle believed global warming was more of a fact than those who responded in the control cubicle, $\beta = .24$, $t(80) = 2.46$, $p = .02$; the effect of political ideology was also significant, $\beta = .39$, $t(80) = 3.98$, $p < .001$. As in Study 1, the two variables did not interact, $\beta = -.10$, $t(80) = 1.02$, $p > .31$; liberals and conservatives were similarly influenced by the ambient temperature. These results suggest that the mere experience of heat influenced belief in global warming. Even when the heat was nondiagnostic, people believed more in global warming when they were made hot than when they were not. Furthermore, as in Study 1, participants in the two cubicles did not differ on the other issues ($ps > .22$). This suggests that the effect of heat on belief in global warming was due to the specific match between feeling hot and judging the validity of global warming.

We moved Study 2 indoors so that the current temperature would not be seen as diagnostic of weather trends. In other words, we tried to rule out the temperature-as-information explanation by conducting the study in a context in which ambient temperature

should be seen as unrelated to global warming. But perhaps we did not do enough. Perhaps participants thought that the inside temperature was diagnostic of outside temperature (after all, it is more likely to be chilly in one's house in the winter than in the summer). If participants in a hot room intentionally relied on the indoor temperature because they thought it was currently hotter outside and they relied on that thought when evaluating the validity of global warming, that would support a temperature-as-information account. Study 3 included a direct measure of participants' belief about the outdoor temperature in order to address this possibility.

Even if participants were not intentionally relying upon indoor temperature to make an estimate of outdoor temperature (and, in turn, a belief in global warming), perhaps people are so accustomed to applying the theory that heat is a signal of global warming that participants did so without noticing that the heat was coming from a nonrelevant source. In Study 3, to rule out this possibility, we first had participants focus on the temperature of the room, so it would be apparent to them why they felt warm or cold. Schwarz and Clore (1983) popularized this method when exploring the relationship among weather, mood, and life satisfaction. They found that weather influenced subjective reports of well-being, such that people reported greater life satisfaction if they were asked on a sunny day than on a rainy day. Weather no longer influenced judgments of life satisfaction, however, when attention was called to the weather before participants made their judgment. Presumably, when their attention was directed to the weather, participants correctly attributed their mood to the weather rather than to their general life satisfaction. Thus, Schwarz and Clore (1983) concluded that weather did not directly influence life satisfaction reports: "Instead, it appeared to occur only insofar as these factors affected subjects' moods, and these moods were considered to provide reliable information about well-being" (p. 520).

According to a temperature-as-information account, if people are unintentionally relying on the indoor temperature as a source of information, calling attention to the irrelevant source of heat should eliminate the influence of heat on belief in global warming. In other words, if temperature is serving as a source of information, then as long as participants recognized that the current indoor temperature was not a reasonable diagnostic cue for judging the validity of global warming, drawing their attention to the irrelevant source of heat should eliminate its effect.

We suggest, however, that the effects of visceral fit depend on the actual visceral experience (and not the perceived diagnosticity of the experience). If people are not relying on their visceral experience in a diagnostic sense, drawing participants' attention to the irrelevant source of information should not eliminate the effect. Thus, we predicted that the influence of heat on belief in global warming would persist even once participants' attention had been drawn to the irrelevant source of heat.

Study 3

Study 3 was designed to replicate the results of Study 2 but also included two new features that could more conclusively rule out an alternative temperature-as-information model. First, participants estimated the outdoor temperature. Thus, even if participants were using the indoor temperature as a cue to the temperature outside (as when one wakes up very cold in the middle of the night and

assumes the temperature must have dropped precipitously), we hypothesized that assumptions of the outdoor temperature would neither correlate with belief in global warming nor explain the effect of the heat manipulation on that belief. Second, we focused all participants on the temperature in the room just before they made their judgments. We expected that increasing the salience of the source of participants' warmth would not eliminate the effect.

Method

Participants and design. Participants were 33 undergraduate students at Cornell University who received extra course credit. Participants were randomly assigned to complete the study in a small room that had been heated to approximately 27 °C (81 °F) or in a control room that was 23 °C (73 °F).

Materials and procedure. The materials were equivalent to those used in Study 2 with a few small changes. First, all participants began by answering the question, "Before you express your views toward the following issues . . . to what extent would you say the room feels hot or cold?" Participants responded on a scale from 1 (*cold*) to 8 (*warm*). Note that this question is more blatant (and therefore provides, for our purposes, a more conservative test) than the question used by Schwarz and Clore (1983). Schwarz and Clore asked participants what the current weather was and relied on participants holding and spontaneously applying the naive theory that weather impacted mood. In the present study, we blatantly noted that participants' current experience of heat was coming from an indoor source. Although the effect was not quite significant, those in the warm room condition tended to rate the room as hotter ($M = 4.47$, $SD = 1.46$) than did those in the control room ($M = 3.71$, $SD = 1.76$), $z = 1.50$, $p = .13$.

Next, participants expressed their position on seven issues, including their belief in global warming. Participants then indicated their political affiliation by indicating to what extent they were a Democrat or a Republican on a 9-point scale ranging from 1 (*completely Democrat*) to 9 (*completely Republican*). The average political affiliation score was less than 5 ($M = 3.63$, $SD = 2.11$), reflecting again the slightly left-leaning nature of the sample.

Finally, to determine whether the indoor temperature influenced participants' estimate of the current outdoor temperature and whether those estimates could explain the effect of heat on global warming judgments, participants answered the question "What temperature (in Fahrenheit) do you think it is outside at this very moment?" by typing a number into a provided blank.

Results and Discussion

We regressed participants' belief in global warming on condition (hot or control room), political affiliation, and the two-way interaction. Even with participants' attention directed to the temperature of the room, we found that participants in a hot room were more likely to indicate that global warming was a proven fact ($M = 8.44$, $SE = 0.46$) than were those in the control room ($M = 6.85$, $SE = 0.43$), $\beta = .37$, $t(28) = 2.54$, $p = .02$. As before, political affiliation also predicted belief, $\beta = -.66$, $t(28) = 4.44$, $p < .001$, but did not interact with the heat manipulation, $\beta = .21$, $t(28) = 1.47$, $p > .15$ (see Figure 1).

It was also the case that participants in the hot room estimated that the temperature was hotter outside ($M = 66.91$ °F,

$SE = 2.39$) than did those in the control room ($M = 56.96$ °F, $SE = 2.55$), $t(28) = 2.76$, $p = .01$. But these estimates did not predict belief in global warming ($r = .07$). Furthermore, when we controlled for the temperature participants believed it to be outside, the effect of the heat manipulation on belief in global warming remained significant, $\beta = .39$, $t(27) = 2.32$, $p = .03$. Thus, even though those in a hot room did believe it was hotter outside, this did not explain their increased belief in global warming.

The two new features of this study—explicitly focusing people on the experience of indoor temperature and directly measuring the inferences drawn about the heat—lend support to our account that it is the experience of heat, not the information it conveys, that impacts people's belief in global warming. In other words, the influence is not mediated through its perceived informational value. First, we found that the information people inferred about the outdoor temperature from the indoor temperature did not explain the effect of temperature on belief in global warming. Second, we found that the effect of temperature emerged even when participants' attention was directed to the source of the heat. If participants were using temperature as a source of information because they did not spontaneously consider that they only felt warm or cold because the room itself (and not the planet's atmosphere) was warm or cold, they would not have shown the effect after their attention had been drawn to the room's temperature. That is, if the results of Study 2 were due to people too eagerly applying the rule "If it's hot, it must be global warming!" and they only did so indoors because they forgot to consider that they were experiencing indoor, not outdoor, heat, we would not have replicated our results in Study 3. The replication suggests that participants were neither intentionally nor unintentionally relying on ambient temperature as a source of information for their assessment of global warming. Even in contexts where temperature's information value was discredited, the temperature reliably influenced people's judgments.

Although the first three studies are consistent with our notion of visceral fit and not with a temperature-as-information account, another alternative remains. It is possible that the experience of heat activated the concept of heat and that the accessibility of the concept, in turn, influenced belief. We refer to this as the conceptual accessibility account. As we explained in the introduction, this alternative account seems unlikely because we are not aware of research suggesting that accessibility of a concept increases the believability of abstract ideas that are semantically associated with that concept. Nevertheless, Studies 4 and 5 examined whether conceptually priming a visceral concept would have an influence on belief similar to that of experiencing that visceral state. If conceptual accessibility is the critical mediator, then it should.

Study 4

In Study 4, participants were randomly assigned to complete the same social/political survey after either being primed conceptually with heat or not being primed. In this way, we held the experience of heat constant while manipulating the accessibility of the con-

cept.² In order to test whether the prime was successful in activating the concept of heat, we included a letter-string task known to be influenced by conceptual priming (see Tulving, Schacter, & Stark, 1982). An observed dissociation—one in which conceptual priming influences the letter-string task but not belief in global warming—would suggest that the impact of feeling warm on belief in global warming is not mediated through the conceptual activation of heat.

Method

Participants. Participants were 52 students at the University of Chicago who participated in exchange for \$4. Participants were randomly assigned to one of two conceptual priming conditions: heat or control.

Materials and procedure. Participants completed a 28-item scrambled sentence task (see Srull & Wyer, 1979). For each item, participants received five words presented in a random order. Participants were to use four of the words to form a sentence. In the heat condition, 16 of these sentences related to heat (e.g., “The room is hot”; “The bacon is sizzling”). In the control condition, none of the sentences related to heat (e.g., “He can assemble it”). Afterward, participants completed the social/political survey used in Studies 2 and 3. To make sure that the scrambled sentence task successfully activated the concept of heat (and to test for one half of the predicted dissociation), we asked participants to fill in blank letter spaces to make words (e.g., _ T O R _). Five of the 10 letter strings could be completed with words related to the concept of heat (e.g., _ E A T could be HEAT and F _ A ME could be FLAME). None of the “heat” words were used in the scrambled sentence task. Finally, participants reported their political ideology and physical state as they had in Studies 1 and 2. Again, the average ideology score in the sample was positive ($M = 4.13$, $SD = 6.22$), reflecting the slightly left-leaning nature of the sample.

Results and Discussion

Participants in the heat condition generated more words related to heat ($M = 1.19$, $SD = 0.94$) than did those in the control condition ($M = 0.69$, $SD = 0.79$), $t(50) = 2.08$, $p = .04$, indicating that the task was successful in making the concept of heat accessible. But did these participants, for whom heat was more accessible, show an increased belief in the validity of global warming?

We regressed belief in global warming on condition, political ideology, and the interaction term. There was no effect of condition on belief ($t < 1$). Those in the heat prime condition ($M = 8.27$, $SE = 0.38$) and those in the control condition ($M = 8.54$, $SE = 0.38$) were equally likely to report that global warming was a fact (if anything, the direction of means was the opposite of that predicted by an accessibility argument). As in the previous studies, political ideology significantly predicted belief, $\beta = .46$, $t(48) = 3.39$, $p < .001$. Furthermore, as a stronger test of whether accessibility was related to belief in global warming (and to more directly observe the dissociation), we regressed belief in global warming on the number of heat words generated and political ideology. We found that measured accessibility of the heat concept was also not related to belief in global warming ($t < 1$).

These results demonstrate the predicted dissociation: The heat prime was successful in activating the concept of heat but not in

influencing belief in global warming. Participants believed in the validity of global warming to the same extent when the concept of heat was activated as when it was not. This suggests that the effects in Studies 1 through 3 were not due to an indirect method of activating the concept *heat*. Rather, it seems that it is the visceral fit between one’s current state and a future state to be judged that is responsible for the effect. Simply activating the concept is not sufficient.

Study 5

Study 5 was designed with three primary goals. The first two related to testing the conceptual accessibility account. First, we were interested in comparing the effect of a visceral experience to the effect of a conceptual prime in one sample of participants. We predicted that the visceral experience would affect belief (replicating Studies 1–3) but that the conceptual prime would not (replicating Study 4). Second, we measured the conceptual accessibility of the visceral state to test whether the influence of the visceral state on belief would remain, even when we controlled for differences in conceptual accessibility. Third, we moved to a new visceral state and another pressing environmental issue: we manipulated participants’ level of thirst and examined their belief in whether drought and desertification would increase.

Method

Participants. Participants were 85 students at the University of Chicago who participated in exchange for \$5. Participants were randomly assigned to one of three conditions: experienced thirst, conceptual thirst, or control. Two participants failed to complete the study, leaving 83 participants in the analyses reported below.

Materials and procedure. Participants were told that they would be completing a study on the media and challenges of the 21st century. They were told that the study required a break in the middle and that they would complete an unrelated task during the break. In reality, the 5-min “unrelated task” was used to introduce the condition-relevant thirst manipulation.

When participants arrived, they completed the baseline measure. They were given a list of nine possible challenges that may face the world in the 21st century (e.g., “Innocent homeowners will lose their homes”; “HIV will threaten people of developing nations”; “America will fall behind China and India in science and technology”). Participants rated each challenge for how valid they believed it was by drawing a vertical mark somewhere along a 125-mm horizontal line. The endpoints were labeled “Not valid”

² Note that Study 4 was designed to help interpret the mechanism at play in Studies 1–3 and was not designed to test whether a conceptual heat prime can ever influence belief in global warming. To determine whether a conceptual prime of heat can influence belief in global warming, we might use a 2 (conceptual prime: yes or no) \times 2 (visceral prime: yes or no) design. This would allow us to test whether conceptual priming can moderate the influence of a visceral prime. For example, Strahan, Spencer, and Zanna (2002, 2005) found that their thirst prime increased drinking only for thirsty participants and their hunger prime increased eating only for women chronically hungry from dieting. In contrast, the current design was chosen to test whether conceptual accessibility could plausibly have mediated the effect of the visceral prime in Studies 1–3.

and “Extremely valid.” The critical item was “Desertification and drought will threaten people’s ability to find fresh drinking water.”

Next, participants randomly assigned to the experienced thirst condition completed a “consumer task” that required them to eat two small bowls of pretzels and compare the two brands. Participants assigned to the conceptual thirst prime condition completed a different type of conceptual priming task than the sentence-scrambling task used in Study 4. For 99 trials, participants saw a fixation point (“---+---”) and then the letter string *oeurgtZzgdR*, and then they were asked to indicate whether the dash that replaced one of the letters appeared on the left half or the right half. Unbeknownst to participants, for one third of the trials, the word *thirst* was subliminally primed for 17 ms after the fixation point and before the letter string. If this conceptual priming task activated the concept but did not effect belief (as was found in Study 4), we can be more confident that the lack of conceptual priming effects are not due to idiosyncrasies of any specific priming procedure. Finally, participants in the control condition were asked to write an essay about the last time they rode in a taxi.

After completing the “unrelated task,” participants watched two short videos. The first video, *Peak Water*, presented information about droughts and the possibility of running out of freshwater. The second video was about endangered animals.

Next, participants were asked to rerate the validity of the nine issues that they had rated at the beginning of the study. They were told that it was not a memory task and that their ratings should be based on how they currently felt about the issues. Given that participants had received more information about the issue of droughts and limited water supplies, we expected that participants would be willing to provide responses that would depart from their initial judgments. Participants then reported their political ideology and their current physical state. The average ideology score in the sample was again positive ($M = 5.84$, $SD = 5.34$), reflecting a liberal bent.

Finally, to make sure that the visual perception task and the consumer pretzel task successfully activated the concept of thirst, we asked participants to fill in blank letter spaces to make words. Four of the 18 letter strings could be completed with words related to the concept of dryness (e.g., _ R Y could be DRY), four of the words were related to wetness (e.g., SOA _ _ D could be SOAKED), four of the words were related to the goal of quenching one’s thirst (D _ I _ _ could be DRINK), and six of the words were filler items. We predicted that participants in both thirst conditions (experienced and conceptual) would complete more letter strings related to the concept of thirst (i.e., more words related to dryness and thirst and fewer related to wetness) than would participants in the control condition. After they had completed the letter string task, participants reported whether they had any suspicions regarding the study before they were paid and debriefed.

Results and Discussion

Our key hypothesis was that participants would come to believe more in the validity of drought and desertification if they experienced thirst than if thirst were conceptually activated or if they completed a control essay. To test this, we first calculated a belief change score by subtracting participants’ initial judgments from their final judgments. Higher scores reflected an increased belief that drought and desertification would pose a threat to humanity.

To examine our key hypothesis, we first submitted these belief change scores to a planned contrast: experienced thirst (+2), conceptually activated thirst (−1), control essay (−1). The predicted pattern of means emerged, $t(80) = 2.13$, $p = .04$, and the residual variance was nonsignificant ($F < 1$). Those in the experienced thirst condition ($M = 1.06$, $SD = 2.70$) came to believe that a concern about drought and desertification was more valid than did those in the conceptual thirst condition ($M = -0.14$, $SD = 2.51$) and those in the control condition ($M = 0.07$, $SD = 1.12$). The conceptual thirst and control conditions did not differ ($t < 1$).

We also examined the change scores in each of the conditions separately. We expected that the experience of thirst should change beliefs but that neither the conceptual prime nor the control task would. To test this more specific hypothesis, we tested each condition mean against 0. As predicted, those in the experienced thirst condition came to see a risk of drought and desertification as a more valid concern, $t(27) = 2.09$, $p = .05$. In contrast, those in the conceptual thirst and control condition showed no shift in their beliefs ($t_s < 1$).³

To be sure that the concept was successfully primed in the relevant conditions and to assess how conceptual accessibility of thirst related to the belief in drought and desertification, we calculated a thirst accessibility measure by adding the number of “dry” words and “goal” words that participants completed and subtracting the number of “wet” words that participants completed. We submitted these scores to the planned contrast: experienced thirst (+1), conceptual thirst (+1), control condition (−2). The contrast was significant, $t(80) = 2.30$, $p = .02$, and the residual variance was nonsignificant, $F(1, 82) = 2.33$, $p > .13$. As predicted, thirst accessibility was higher for participants in the experienced thirst condition ($M = 2.07$, $SD = 1.27$) and for participants in the conceptual thirst condition ($M = 1.52$, $SD = 1.22$) than for participants in the control condition ($M = 1.10$, $SD = 1.37$). Those in the experienced thirst and conceptual thirst conditions did not differ on this index, $t(80) = 1.53$, $p > .13$.

Although not significant, this trend indicates that those who were actually thirsty may have experienced slightly more conceptual activation of thirst than did those for whom the concept had been primed. Therefore, to be sure that it was not the extra conceptual activation afforded by visceral thirst that was responsible for the impact of experienced thirst on belief change, we conducted two additional analyses. First, we correlated the change of belief score with the thirst activation index. Conceptually replicating Study 4, no correlation emerged ($r = -.04$). Second, we reconducted our analyses on change of belief while controlling for the conceptual activation of thirst. Far from being a plausible mediator, the thirst activation index covariate, if anything,

³ There were no conditional differences on seven of the eight filler items. There was an unexpected conditional difference for participants’ change of belief score regarding America falling behind in science and technology, such that participants in the control condition came to believe it was a less valid concern ($M = -1.34$, $SD = 3.59$), participants in the conceptual thirst condition came to believe it was a more valid concern ($M = 0.86$, $SD = 2.34$), and participants in the experienced thirst condition did not change their belief ($M = -0.08$, $SD = 1.79$).

strengthened the originally observed contrast, $t(82) = 2.22$, $p = .03$.

The results of Study 5 conceptually replicate the results of Studies 2 and 4 in a single sample. We found that the visceral experience of thirst affected participants' belief in drought and desertification and found that the conceptual activation of thirst did not affect belief. Furthermore, we could more directly show that conceptual activation did not mediate this effect. Thus, the influence of the visceral state on belief does not seem to be occurring by indirectly priming the concept. Instead, this pattern of results supports our hypothesis that the visceral (but not conceptual) fit between a visceral state and a possible state of the world increases the perceived likelihood or validity of that future possibility.

These results also generalize the phenomenon under investigation. Study 5 demonstrates that our effects are unique neither to the experience of warmth nor to the issue of global warming. By demonstrating the effect with a new visceral state and issue, these results support a more general process whereby one's own current state makes "matching" states of the world seem more intuitively valid.

Studies 6a and 6b

In Studies 1, 2, 3, and 5, we found that participants' physical state (e.g., warmth or thirst) influenced participants' judgments about matching states of the world (e.g., global warming or drought and desertification). This effect was present even when the visceral state could not be used as a source of information (Studies 2 and 3). However, it was not present when the concept (rather than the visceral experience) was made accessible (Studies 4 and 5). In a final set of studies, we examined whether simulational fluency could successfully account for the observed effects. That is, we suggest that while in a visceral state, people have a clearer or more fluent representation of possible states of the world that match that visceral state. Thus, we suspect that when walking home in January through a blustery, arctic wind, the mental image of sweating in the August sun may be fuzzy and unclear. By the same reasoning, when people consider the possibility that Earth may be heading toward a global warming disaster, the simulated image of an overheated world plagued by global warming may be experienced as sharper or more fluent when they are currently feeling hot. A clearer representation may then enhance the belief in global warming. Wyer, Hung, and Jiang (2008) stated that it is easier to construct a sharp mental image of a situation if one can draw from memory a matching representation to help clarify the visualization. We posit that it is easier to construct a sharp mental image of a situation if one can draw from one's present experience a matching visceral state to help clarify the visualization.

We used a novel methodological tool and a causal chain design (see Spencer et al., 2005) to test this causal pathway. Following the procedures laid out by Spencer et al., in Study 6a we manipulated the visceral experience of heat and used a novel technique to measure participants' simulational fluency for hot (vs. cold) outdoor scenes. In Study 6b, we led participants to think about the same hot outdoor scenes in a fluent or disfluent manner and measured the impact on belief in global warming. We predicted that experiencing heat would lead to more fluent simulations of a hot (but not a cold) world and that such clear simulations of a hot world would increase belief in global warming.

The (processing) fluency literature has shown an impressive variety of effects using almost exclusively a single methodological approach: An external stimulus is altered to facilitate or hinder the ease with which people process the stimulus, and the impact of fluency is assessed (for a review, see Alter & Oppenheimer, 2009). In other words, fluency is typically the independent variable. In Study 6a, we varied the heat of a room and measured fluency as the dependent variable. Participants were exposed to a number of partially degraded stimuli, including a number of hot or cold outdoor scenes. The hot scenes depicted what a world plagued by global warming might look like. In a surprise second task, participants saw the outdoor scenes again and had to literally adjust the sharpness of the external image until it matched the clarity of the image in their own heads. In this way, we could measure how clear participants' mental representations were of the hot and cold images. If heat leads participants to mentally construct heat-relevant images with greater representational clarity, hot participants should indicate that their mental representations of the hot images (but not of the cold images) were sharper and more fluent.

Study 6b completed the causal chain using a paradigm more typical of fluency experiments. We manipulated participants' simulational fluency for hot landscapes by exposing participants to clear or degraded versions of the stimuli used in Study 6a. We then measured belief in global warming. Thus, as participants contemplated whether global warming was a likely reality, they were led to simulate a hot world that was clear and sharp or disfluent and distorted. Given that fluently processed stimuli seem more true or likely (Schwarz et al., 2007), we expected that those led to consider a more fluent hot world would be more likely to think global warming was real. In combination, this would provide support for the simulational fluency mechanism: The experience of heat causes one to represent a hot world with greater mental clarity, which causes one to believe more in global warming.

We used an experimental causal chain to investigate the simulational fluency account because we were concerned that a single study would be vulnerable to a direction-of-causality criticism. In other words, if we conducted a single study and showed that simulational fluency mediated the impact of heat on belief in global warming, it would be unclear whether fluency enhanced belief in global warming or whether belief in global warming enhanced the fluency of hot images. Although both causal directions remain possible, the present experimental causal chain tests whether the experience of heat leads people to fluently represent hot landscapes and whether fluently representing hot landscapes enhances belief in global warming.

Study 6a

Method

Participants. Participants were 20 students at Cornell University who participated in exchange for extra credit in their psychology and human development courses.

Materials and procedure. Participants were randomly assigned to the heat condition or the control condition. In the heat condition, participants completed the study in a small cubicle that was heated to approximately 27 °C (81 °F), and in the control condition participants completed the study in an identical non-heated cubicle that was approximately 23 °C (73 °F).

In the first task, participants were exposed to 16 images and were asked to indicate whether they believed each image was real or was generated by a computer. Four of the images were “hot” landscapes. They had tones of yellow and red, showed hot and arid scenes, and were consistent with a basic intuition for what a world plagued by global warming might look like. Four of the images were “cold” images. They had tones of white and blue, showed scenes of snow and ice, and were chosen to be inconsistent with intuitions for a world plagued by global warming. These eight images are in Figure 2. The eight filler pictures were of dining rooms and classrooms. The 16 pictures were displayed in a random order and were presented for 5 s each. The hot and cold images were degraded to 50% transparency with Microsoft Office’s image editing features. The filler images were degraded between 40% and 60%. To make sure that participants were involved and attending to the images, after each image was presented, participants indicated whether they believed the image was real or computer generated (1 = *definitely fake*, 2 = *maybe fake*, 3 = *no idea/can’t tell*, 4 = *maybe real*, 5 = *definitely real*).

In the second task, participants were asked to indicate the clarity of the images that they had been shown. Participants were told, “In the previous task, you were presented with pictures of various locations. You may or may not have noticed that the clarity of the pictures varied. In this task, you will be presented with the same pictures. You should adjust the transparency of each picture so that it matches the transparency of the one you originally saw.” One picture appeared on each page. The images started at 100% transparency, so that the image itself was not visible. As they adjusted the transparency down, the image revealed itself, becoming clearer and clearer. Participants stopped when the clarity of the image in front of them matched their mental image. In this way, we could measure whether the heat led participants to represent the matching (hot landscape) images with more or less clarity.⁴

Results and Discussion

The simulational fluency account predicts that participants will have a more vivid mental representation of heat-relevant stimuli when they are in the hot room than the control room. In other words, if participants in the hot room simulate matching images more easily, they will represent the hot images with greater clarity than will participants in the control room.

As predicted, a 2(visceral state: hot vs. control) × 2 (images: hot vs. cold) repeated-measures analysis of variance returned a significant interaction, $F(1, 17) = 6.95, p = .02$. The hot images were adjusted to be clearer in the hot room ($M = 36.93, SE = 3.80$) than in the control room ($M = 48.89, SE = 4.00$), $t(17) = 2.17, p = .04$. The cold images were perceived as equally clear in the hot room and the cold room ($t < 1$).

Although not predicted a priori, participants’ beliefs about the reality (vs. fakeness) of the hot, cold, and control images varied by condition, $F(2, 16) = 5.85, p = .01$. In particular, participants in the hot room believed that the hot images were marginally more likely to be real ($M = 3.75, SE = 0.26$) than did those in the control room ($M = 2.97, SE = 0.28$), $t(17) = 2.02, p = .06$. There was no difference in the perceived realness of the cold or control images ($ts < 1$). Although this finding is intriguing (and loosely consistent with our general hypotheses), there was no correlation between the perceived realness of these images and the clarity with

which they were represented ($r = .27, p > .25$). Also, when we controlled for the difference in the perceived reality of the hot and cold images, the focal interaction (predicting simulational fluency) remained significant, $F(1, 16) = 5.68, p = .03$.

Our methods are not meant to suggest that simulational fluency can be captured only by the clarity of a visual mental image. To fluently simulate eating a freshly baked cookie, for example, one might rely on multiple sensory systems. We do suggest, however, that the visual sharpness or clarity of a mental image is one indicator of how fluently an individual is representing that event. As such, the results support the contention that the visceral experience of warmth can lead people to more fluently simulate images of hot landscapes. Note that the experience of heat did not impact the representational clarity of cold landscapes. Thus, to complete the causal chain, we tested whether representing hot landscapes more fluently leads people to believe more in the validity of global warming. Together, the two halves of the causal chain would provide mechanistic support for the simulational fluency account.

Study 6b

Method

Participants. Participants were 65 students at the University of Chicago and members of the surrounding community. All participants we paid \$2 for their time.

Materials and procedure. Participants completed an online pretest in which they responded to the seven questions from the social/political questionnaire (all responses were on 1–11 point scales) that was used in previous studies.

Participants came to the lab at least two days later and completed the same social/political scale on the computer. Each question appeared in the middle of the screen with a 1–9 point scale below. For each question, four topic-relevant images also appeared on the screen, in each of the four corners. For example, when participants were asked about charter schools, they were exposed to four different classroom images. When participants were asked about global warming, they were exposed to the same four hot images that were used in Study 6a. The questions were presented in a random order, with the constraint that the global warming question did not appear first.

Participants were randomly assigned to the fluent and disfluent conditions by exposing them to hot images that were entirely clear (0% transparency) or degraded (60% transparency; see Figure 3). The pictures for all of the filler items were degraded to 30% transparency. In this way, there was a clear absolute difference in fluency, and the fluency manipulation was made more powerful by having the global warming images be especially fluent or disfluent in contrast to the other images that were seen, capitalizing on what Laham, Alter, and Goodwin (2009) called *discrepant fluency*.

⁴ Alternatively, we could have omitted the initial presentation of the images and merely asked participants to adjust the clarity of each image until it “felt right.” We opted to incidentally expose participants to the images before measuring clarity because we expected the benefit that this initial exposure would have for constraining variation in the dependent measure outweighed the possible risk that it could impose too much of a “reality constraint” to permit much variation on the dependent measure.



Figure 2. “Hot” and “cold” images presented in Study 6a. Each image was presented at 50% transparency (as seen here).

After they had answered the seven questions, participants were paid and debriefed.

Results and Discussion

To complete the causal chain, we tested whether those who were led to represent hot landscapes with greater clarity would believe more in global warming. To test this, we ran a one-way analysis of covariance predicting participants’ belief in global warming from condition (clear or degraded), controlling for participants’ global warming beliefs reported in the pretest. We found that participants exposed to the clear, fluent images were more likely to indicate that global warming was a proven fact ($M = 7.65, SE = 0.28$) than

were those in the disfluent condition ($M = 6.87, SE = 0.26$), $F(1, 64) = 4.37, p = .04$.

Together, the results of Studies 6a and 6b suggest that visceral states may influence beliefs about matching states of the world through a process of simulational fluency. Those who were experiencing visceral heat possessed clearer mental representations of hot (but not cold) landscapes, and enhancing the clarity of hot landscapes led them to feel that global warming was more real.

Study 6a provided a direct test of simulational fluency, in which we examined the clarity of mental representations without changing anything about a stimulus to be processed. Study 6b used a manipulation more typical of processing fluency studies. This was done for three reasons. First, presenting an image as especially dull



Figure 3. Fluent (left) and degraded (right) versions of the global warming question used in Study 6b. The fluent images were presented at 0% transparency. The degraded images were presented at 60% transparency. The black borders were added here to highlight the border of the computer screen. When the question stretched across the screen, it was easy to read.

or sharp is a particularly straightforward way to manipulate the clarity with which a stimulus is represented. Of course, this “trick” is not new, which is why the first half of our causal chain reflects the more novel theoretical and methodological advance. Second, it was important that our manipulation affect the fluency of mental representation and not other potential mediators (e.g., conceptual accessibility or information about weather patterns; Bullock, Green, & Ha, 2010). Third, it was important to manipulate the mediator in a way that was similar to how we measured it. In Study 6a, we measured the fluency of participants’ mental representations by having participants adjust the transparency of the external stimuli. In Study 6b, we manipulated the transparency of the external stimuli because research suggests that changing an external stimulus impacts the fluency with which an image is represented (e.g., Petrova & Cialdini, 2005). Thus, the external stimuli that were presented in Study 6b differed along the same dimension as that they were measured by in Study 6a.

Study 6b also lends support to our assumption that even in a highly educated sample, people may assess the likelihood that global warming will befall humanity by considering how easy it is to imagine a hot world. A fluent image impacts judgments only for people who take an intuitive, as opposed to an analytical, approach to a judgment (Petrova & Cialdini, 2005). Petrova and Cialdini showed participants a travel advertisement that included a clear, sharp image of a travel destination or a dulled, less vivid version of the same image. When participants saw the disfluent image, they had a harder time imagining themselves “in the picture” and were then less interested in purchasing the vacation package. But, crucially, participants were impacted by the clarity of the image only when they were literally instructed to visualize themselves in the depicted travel destination (see also Cohen, Belyavsky, & Silk, 2008). In other words, people ordinarily do not assess their interest in a vacation by assessing the ease of imagining themselves in the picture. In contrast, past research suggests that people do approach certain questions by simulating an action or an event, even if the question does not specifically call for simulation. For example, when participants were asked to determine whether a cup was upside down or right side up, they were faster to respond when the handle of the cup was on the same side of the display as their response hand, suggesting that participants spontaneously approached the question by simulating how they would pick up the cup (Tucker & Ellis, 1998). The results of 6b suggest that many of our participants spontaneously approached the question of whether global warming or drought would ultimately occur by assessing the fluency of such simulations. Given this intuition-based approach, it is perhaps not surprising that such a gulf exists between laypeople and experts, who do not take such an intuitive approach to forecasting.

General Discussion

The present research demonstrates that visceral states can implicitly influence consequential scientific beliefs. When participants experienced visceral fit—a match between their own visceral state and a visceral state associated with an outcome they were judging—they believed that outcome was more likely. Participants who were experiencing the visceral state of warmth (Studies 1, 2,

and 3) or thirst (Study 5) were more likely to believe that global warming was a proven fact or that drought and desertification were looming crises. We observed parallel effects regardless of whether the visceral experience occurred naturalistically (Study 1) or due to experimental manipulation (Studies 2, 3, 5).

We tested between three possible explanations for this effect. Studies 2 and 3 addressed a temperature-as-information account, which suggests that participants relied on their current visceral state as though it were diagnostic of the event’s future occurrence. For example, one might contend that those outside on a particularly hot day may have concluded (albeit incorrectly) that the heat was a consequence of global warming and not merely variability in daily weather patterns. Study 2 moved indoors, where ambient temperature should have been more unquestionably nondiagnostic. But the influence of heat on belief in global warming remained. The effect size was even equivalent in the two studies ($\beta = .24$), consistent with our suggestion that the effect in Study 1 was also driven primarily by the mere visceral experience of heat. Study 3 provided an even more complete demonstration that temperature was not being used as a source of information. The influence of indoor heat on belief in global warming persisted even when we controlled for the assumed outdoor temperature and even when participants’ attention had been directed toward the ambient temperature before they made their judgments.

This, of course, does not mean that “information” provided by the current temperature never influences global warming judgments. Schuldt and Schwarz (2008) found that belief in global warming is predicted by the difference between the current day’s temperature and the previous day’s temperature. In addition, Li et al. (in press) found that belief in global warming is predicted by participants’ report of whether the current temperature in their city is colder or warmer than usual for the time of year. Along the same lines, Egan and Mullin (2009) found that for less educated people and for nonpartisans, when the day’s temperature was unseasonably warm, people were more likely to report that there was “solid evidence” for global warming. Thus, it seems that if the day’s temperature stands out compared to what is expected (based on yesterday’s temperature or the average temperature of that date), the unusual information is incorporated into some people’s global warming assessments. Thus, under some circumstances people may use temperature-related cues to form (unsound) inferences about global warming. But what is important for our claim is that the phenomenon of visceral fit exists and is not accounted for by an informational explanation.

Studies 4 and 5 focused on a second possible explanation: the conceptual accessibility account. According to this alternative, the experience of a visceral state served merely as an indirect way to activate the visceral concept, and it was this conceptual accessibility that produced the effects on judgment. Study 4 produced a dissociation, such that those who had been conceptually primed with heat were more likely to complete word strings with heat-related words (a known consequence of conceptual accessibility), but they were no more likely to believe in global warming. In Study 5, conceptually priming thirst did not increase belief in the likelihood of future droughts and desertification but viscerally experiencing thirst did. Furthermore, in Studies 4 and 5, the conceptual accessibility of the relevant visceral state did not correlate with the belief in global warming (Study 4) or drought and

desertification (Study 5). Thus, even though the experience of a visceral state can make the abstract concept accessible (Study 5), accessibility of the abstract concept does not influence judgments of validity.

The present research, in addition to establishing a new effect, has provided insight into the underlying mechanism. Our data consistently speak against information- or accessibility-based accounts. Instead, we find support for a simulational fluency account. The results of Studies 6a and 6b support our contention that visceral fit occurs because the visceral state leads people to fluently represent the matching state of the world, which leads to an inference of validity. We found that participants mentally reconstructed images of hot outdoor scenes as clearer when they were in a hot room than when they were in a control room, suggesting that warm participants had a more fluent or clear representation of heat-relevant stimuli. Completing the causal chain, we found that having participants consider fluent (degraded) versions of these hot outdoor scenes led them to be more (less) certain of global warming's existence.

Relation to Similar Work

That our results did not emerge from a temperature-as-information account distinguishes the present research from research examining the impact of mood on frequency estimates, which has relied on a mood- or emotion-as-information account. People think that negative events are more likely when they are in a negative mood and that sad events are more likely when they are in a sad mood (DeSteno et al., 2000; Johnson & Tversky, 1983). In that research, people use the emotion that is inspired by an event to infer the scope of that event (i.e., because more widespread tragedies inspire more sadness, my feeling of sadness when judging a tragic event is a signal to its frequency). This inference process would be quite reasonable if participants' current emotion were actually due to the event that participants were evaluating. If, for example, Christine experiences more fear when considering the possibility of a future terrorist attack on a major subway system than when considering the possibility of a future terrorist attack on a major train station, this may be a reasonable cue that—according to her intuitions—the former is more likely (Lerner, Gonzalez, Small, & Fischhoff, 2003; Skitka, Bauman, Aramovich, & Morgan, 2006). But when an experimenter manipulates participants' emotional states, their current emotion is not relevant. In these experiments, when their attention is first directed to their emotion or mood, participants recognize that this internal experience has been contaminated, and it no longer affects their judgment (Berkowitz & Troccoli, 1990; DeSteno et al., 2000). Describing why this supports a feelings-as-information account, DeSteno et al. (2000) stated, "The informativeness of mood is thought to be undermined (e.g., by making the irrelevant source of mood salient) and people are postulated to 'set mood aside' to calculate a judgment using alternative inputs" (p. 407). In contrast, in the present research we found that temperature influenced belief in global warming even when we directed participants' attention to the nondiagnostic indoor temperature, providing evidence against a temperature-as-information account.

Our results are also related to but quite distinct from predictions made by a social projection account (Van Boven & Loewenstein, 2003), which argues that people will project their

own characteristics and their own ephemeral sensations onto other people. A projection account predicts that thirsty participants will believe that a long hike will produce greater thirst than hunger or that warm participants will believe that sitting in the sun will make people feel especially warm. Instead, a visceral fit account posits that thirsty participants will believe that it is more likely that hikers will lose their way and thereby run out of fresh drinking water or that warm participants will believe that it is more likely that the air conditioning will break during a heat wave. In other words, we did not show a new psychological state that can be projected onto other people; we are instead proposing that certain states of the world (not personal sensations) are imagined or simulated more clearly to the extent they fit with one's current visceral state. Thus, our account does not rely on projection but instead the enhanced vividness with which people consider matching states of the world.

Finally, in related work on affective certainty and affective coherence, researchers have found that information processing and performance were improved when there was a match between one's chronic trait affect and current mood (Tamir, Robinson, & Clore, 2002) or between conceptual and experiential sources of affective information (Centerbar, Clore, Schnall, & Garvin, 2008). And although they did not directly test for it, the authors suggested that the affective coherence may have influenced performance by creating an experience of fluency (Centerbar et al., 2008). Despite apparent similarities between the present and past work (i.e., an effect of "fit" based on fluency), our programs of work have little in common. Both Centerbar et al. and Tamir et al. focused on generalized effects of affective fit or misfit. For example, Centerbar et al. argued that a mismatch between one's affective experience and accessible cognitions produces a generalized state of epistemic uncertainty and strain, thereby consuming attention and thus detracting from one's abilities to engage in other cognitively demanding tasks. In contrast, we do not find that visceral fit produces generalized effects on judgment. And although visceral fit does serve an epistemic function, it serves a very specific one: lending credibility to ideas that fit with one's visceral state.

Compared to previous demonstrations of the impact of fit, the present research offers evidence of a novel mediating process. Lee and Aaker (2004) found that a fit between one's regulatory orientation and the framing of a message led to attitude change that was mediated by the perceived believability of the message. We have gone beyond this demonstration, showing not merely that visceral fit enhances the believability of global warming but that this increase in believability occurs due to the enhanced representational fluency that visceral fit produces. By measuring and manipulating the fluency of participants' mental representations, we were able to establish a causal chain that demonstrates the role of representational fluency in the link between a visceral experience and an inference of validity. Cesario and Higgins (2008) explained, "When individuals experience regulatory fit, they feel right" (p. 416). We have identified a new way in which this feeling right can emerge (see also Higgins & Scholer, 2009). Thus, we suggest that hungry participants will believe that massive crop shortages are more likely and that tired participants will believe that the next generation will face a longer workweek. In each of these cases, we suggest that the matching visceral state will pro-

mote fluent mental representations and give a validity-lending oomph! to these contemplations.

Fit vs. Misfit

Note that this description frames our results as an impact of fit, as opposed to a disruption caused by a lack of fit. For example, Santelli, Struthers, and Eaton (2009) found that promotion-focused or prevention-focused repentance was more effective in assuaging a promotion-focused victim or a prevention-focused victim, respectively. But the inclusion of control conditions demonstrated that matching victim–transgressor orientations did not enhance the effectiveness of apologies. Instead, mismatching orientations disrupted apologies’ effectiveness. In this way, Santelli et al. demonstrated an effect of misfit instead of one of fit.

Two aspects of our data suggest that ours is an effect of fit, though one additional piece of evidence suggests it may also be an effect of misfit. First, participants in our control conditions did not experience an opposing visceral state. That is, participants were not placed in a particularly cold room (Studies 2, 3, 6a) nor were they overly sated (Study 5). Thus, the comparisons between our experimental and control conditions tested the effect of fit as opposed to the effect of misfit. Second, our mechanism study (Study 6a) found an effect of fit but not of misfit. That is, hot participants had more fluent representations of hot scenes but did not have more disfluent representations of cold scenes.

If there were no impact of misfit, however, one might expect that in our outdoor study (Study 1) the effect of temperature on belief in global warming would be more pronounced at warmer temperatures than at colder temperatures. In mathematical terms, one might expect a positive quadratic effect of temperature on belief in global warming. When we fit this model, there was no quadratic effect of temperature on belief in global warming ($\beta = -.11, t < 1$), suggesting there may have been an effect both of fit and of misfit. Taken together, the results support our interpretation that visceral fit can influence people’s beliefs in matching states of the world. Future work can examine whether visceral misfit can reliably influence belief as well.

Relation to Fluency

In recent years, fluency has become an increasingly common topic of study in social and cognitive psychology (see Alter & Oppenheimer, 2009). Because fluency refers to the metacognitive ease or difficulty with which a stimulus is processed, it is unsurprising that fluency is often manipulated by enhancing or degrading an externally presented stimulus. For example, fluency may be manipulated by making font easy or difficult to read (Alter, Oppenheimer, Epley, & Eyre, 2007; Simmons & Nelson, 2006), using words that are easy or difficult to pronounce (Alter & Oppenheimer, 2006, 2008), or presenting stimuli against a high-contrast or low-contrast background (Hansen, Dechêne, & Wänke, 2008; Laham et al., 2009; Reber & Schwarz, 1999). At other times, fluency is manipulated more indirectly, by using a stimulus-independent manipulation that affects processing ease. For example, the subjective sense of consternation caused by frowning one’s brow can be misinterpreted as processing disfluency (Alter et al., 2007; Tourangeau & Ellsworth, 1979), and the heightened

accessibility of a primed concept facilitates processing of words related to that concept (e.g., Schwartz & Metcalfe, 1992).

In each of these cases, fluency is manipulated, and a host of interesting consequences are observed. But because a simple self-report measure could confirm that a *gray font* is harder to read than **a bolded one** or that *Yaolumnix* is more difficult to pronounce than *Barnings* (see Alter & Oppenheimer, 2006), researchers have not tried to directly capture the subjective sense of clarity attached to a fluent stimulus.

In the present research, the most pressing theoretical question was not to determine a consequence of fluency but to measure whether a condition (i.e., visceral fit) led matching stimuli to be represented more fluently. In accomplishing this goal, we introduced a novel methodological tool that we believe could be of use beyond this specific research question. In Study 6a, instead of manipulating the clarity of externally presented stimuli, we (indirectly) assessed the clarity of mental representations by having participants enhance or degrade an image until it matched the image as they mentally represented it. We are not aware of any similar measure of representational fluency and, as such, hope that this method can be used to study fluency as a dependent variable, not merely as an independent variable.

Although we believe our results offer a qualitative advancement in the study of fluency, some readers may wonder how we reconcile one aspect of our findings with Alter and Oppenheimer’s (2009) recent unifying treatise on fluency. Alter and Oppenheimer included conceptual priming as one instantiation of fluency, whereas we have argued that our effects were due to simulational fluency but not due to conceptual priming. If instantiations of fluency are interchangeable, as Alter and Oppenheimer convincingly argued, how can this be explained?

We suspect that the difference lies in what is made fluent for people primed with a concept versus what is made fluent for people experiencing a visceral state. In the present research, experiencing a visceral state enhanced the fluency or clarity of a mental image or a simulation of a possible world. Because one would experience the visceral state if one were in that state of the world, the experience of the visceral state may make it feel closer and clearer. Concept priming, in contrast, has been shown to facilitate the processing of semantically related concepts. For example, Reder (1987) found that after participants had been primed with golf-related words, it was easier for them to process a golf-related question because the concepts had been recently retrieved. This suggests that participants who are primed with the abstract concept of warmth might find it easier to process a scientific report on global warming (a possibility that deserves future test), though it appears not to influence the fluency with which hot outdoor images are mentally simulated.

Conclusion

Scientists would like to believe that the public will heed the alarming, empirically based calls of the scientific community. People may want to believe that their judgments reflect their deliberate calculations. But many people do not heed the call of the scientific community, and judgments are influenced by more than careful deliberation. And though psychologists have recently examined how to motivate collective action to forestall future environmental calamities, even those efforts are premised on people

believing problems do lie ahead (Ferguson & Branscombe, 2010; Malka et al., 2009). We believe the present research is one answer to the American Psychological Association's (2009) call for more research on the public's muted response concerning climate change.

The present research found that what makes future events feel more real is not necessarily well-conducted research or impressive meta-analyses that speak to the event's likelihood of occurrence. Oftentimes, factors that facilitate the ability to picture what that future event would look and feel like may exert a strong (if not stronger) effect. We suggest that recognizing the influence of factors that promote the fluency of simulations may be key in predicting belief formation and acceptance.

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