Advanced Review

What shapes perceptions of climate change? New research since 2010

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Five years ago, an article in the first issue of *WIREs Climate Change* reviewed the factors that shape perceptions of climate change. Climate change is an abstract statistical phenomenon, namely a slow and gradual modification of average climate conditions, and thus a difficult phenomenon to detect and assess accurately based on personal experience. The current update of the original article—'new research since 2010'—revisits topics covered in the original contribution: the role of personal experience with climate change, in particular extreme weather events; the effects of psychological distance on climate change perception and action; the effects of political ideology, age, gender, and nationality, and situational influences; and the role of different processing modes in climate change perception and the low level of visceral response (dread) associated with climate change risks. In addition, the current article also addresses new topics since 2010: attribute substitution or the use of weather anomalies—'local' warming or cooling—when judging the likelihood of global warming; the effects of different labels for the phenomenon—global warming versus climate change—on perceptions of its likelihood and importance; and the effect and role of uncertainty about different aspects of climate change and its consequences and how it is communicated on perceptions and actions.

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INTRODUCTION

Five years ago, an article in the first issue of *WIREs Climate Change*[1] reviewed the factors that shape perceptions of climate change, describing it as an abstract statistical phenomenon, namely a slow and gradual modification of average climate conditions, and thus a difficult phenomenon to detect and assess accurately based on personal experience. The article identified insufficient visceral reaction to the risks of climate change and lack of trust as complicating the transfer of scientific descriptions of climate change and climate variability from scientists to the public, politicians, and policy makers. Worldview and political ideology, two elements of the cultural context of perceptions and action, were shown to shape expectations of climate change, in turn guiding the detection and interpretation of extreme weather and climate events and variation in climate change concern and action.

The article reviewed barriers to appropriate perception of climate change and protective or mitigation action against it for three different modes of processing that people have been shown to engage in. It argued that *affect-based* processing of climate

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change and its consequences are unlikely to motivate significant action, as climate change risk does not elicit a visceral response in politicians and the general public due to its statistical nature. *Analysis-based* decisions were also described as unlikely to result in significant reaction and action, because of large discounting of the uncertain future costs of climate risks compared to the certain and immediate costs of climate change mitigation. *Rule-based* decisions that determine behavior based on social responsibility or moral principles were seen as holding out the best prospects for appropriate perceptions and actions.

The original article ended by speculating on the practical takeaway of social science insights about the drivers of climate change perception and action. Proposed tools included: (a) more attention-catching and emotionally engaging informational interventions to generate the public concern necessary for individual or collective action in response to climate change, but cautioned about unintended side effects, including reductions in concern about other important risks (the finite pool of worry effect) and negative spillover (the single action bias)[2]; (b) making future events more concrete and moving them closer in time and space; (c) guided protocols, following query theory[3,4] by which decision makers consider arguments for energy conservation and climate change mitigation before being allowed to consider arguments against such actions to improve the balance between the desire for immediate gratification and the goal of sustainable development; and (d) for at least a subset of the public, better (environmental) science and statistics education to create familiarity with scientific presentation of information and mental habits that give greater weight to analytic processing, aligning the risk perceptions of the general public and its officials more closely to those of climate scientists.

The current update of the original article—'new research since 2010'—revisits topics covered in the original contribution: the role of personal experience with climate change, in particular extreme weather events (Box 1); the effects of psychological distance on climate change perception and action (Box 2); the effects of world view or political ideology; and the role of different processing modes in climate change perception and the low level of visceral response (dread) associated with climate change risks. In addition, the current article also addresses new topics since 2010: attribute substitution or the use of weather anomalies—'local' warming or cooling—when judging the likelihood of global warming; the effects of different labels for the phenomenon—global warming versus climate change—on perceptions of its likelihood and importance; and the effect and role of uncertainty on perceptions and actions. The article will first cover the new topics in this space and then revisit and update the earlier ones.

Both the original article and this update omit discussing the role of the media and other vested interests in shaping public perceptions of climate

BOX 1

SEEING IS BELIEVING? OR DO WE SEE SOMETHING BECAUSE WE BELIEVE IT?

The general public does not perceive the realities of a changing climate the same way that climate scientists do, a fact that has been attributed to the abstract statistical nature of the phenomenon.[33] The 'local warming' effect described below shows that the general public supplements statistical data with personally experienced information, e.g., a current temperature abnormality. Evidence for seeing-is-believing comes from studies in the United Kingdom,[34] United States,[35,36] and Sweden[37] that show that belief in climate change increases if and when people personally experiences climate change manifestations. A 24 - countries representative survey[21] used Heath & Gifford's[38] judgment scales and found that personal experience increased endorsements of climate change mitigation actions both within and across countries.

However, if people rationally updated prior beliefs based on shared personal experience, climate change beliefs ought to converge, rather than polarize as they appear to do.[39] Alternatively, stronger beliefs in the presence or absence of climate change may make it more likely that people will look for and thus see evidence supporting it.[40] Myers et al.[41] measured personal experience and belief certainty twice from the same UK respondents, 20 months apart, to distinguish between evidence-based belief revision and belief-motivated perception and found evidence supporting *both* of these processes. Respondents highly engaged with climate change (the Alarmed or Dismissive group of Global Warming's Six Americas[42] showed belief-consistent distortions of perception, whereas intermediate groups in degree of belief in climate change (the Concerned, Cautious, Disengaged, and Doubtful) showed belief revision in response to personal experience.

BOX 2

THE EFFECTS OF PSYCHOLOGICAL DISTANCE ON CC PERCEPTION

A major obstacle to motivating action on climate change is the fact that for many people the phenomenon appears not just abstract, but also personally distant in space and in time.[33,43] Construal level theory (CLT),[44] developed to account for a broad range of phenomena in social psychology and consumer psychology, connects these two facets of the general public's perception of climate change. CLT proposes that psychological distance from an object or event is related to the way people mentally represent it: distant events by abstract high-level construals (e.g., 'why' information) and close events by concrete low-level construals (e.g., 'how' information). Liberman and Trope[44] identified four dimensions of psychological distance (spatial or geographic, temporal, social, and uncertainty) and a typical CLT study manipulates construal level, e.g., by asking respondents first to generate arguments for why they would attend a future conference versus how they would attend it, and shows that people judge the conference to be further in the future in the abstract than the concrete construal condition.

The application of CLT to climate change perception and communication has recently been explored. For a large nationally representative sample of UK residents, lower psychological distance from climate change assessed on all four dimensions was associated with higher levels of concern.[45] For the 24 country nationally representative sample described in Box 1, specific intentions to act, a concrete low-level construal was strongly predicted by personal experience with climate change, which presumably reduces psychological distance to the phenomenon,[21] a result that the authors refer to as a compatibility effect and as correlational evidence for CLT. In an experimental study, Spence and Pidgeon[46] manipulated construal level for a sample of University of Bristol students by showing them identical maps of sea-level rise that ostensibly came from either Cardiff (local) or Rome (distant) and framed the outcomes of climate change mitigation actions either as losses or gains. Responses to the information received showed that gain frames increased positive attitudes toward climate change mitigation and also increased the perceived severity of climate change impacts. Distant frames produced higher judgments of the severity of climate change in comparison to local frames.

change. These topics are reviewed by other *WIREs Climate Change* articles (see Further Readings).

CLIMATE CHANGE AS GLOBAL WARMING VERSUS LOCAL WARMING

A large body of research has documented that perceptions and beliefs in many situations and domains are often malleable rather than fully formed and fixed.[5] Perceptions and beliefs about a complex and infrequently considered phenomenon like climate change in particular can be expected to be constructed or assembled at the time of being questioned, with the consequence that they may reflect irrelevant but salient information present at the time of questioning, such as abnormalities in the current day's temperature. Transient temperature variations have been shown to influence the public's opinion about global climate change in a growing list of studies.[6–8] Li et al.[6] asked residents of the United States and Australia to report their opinions about global warming and also (in counterbalanced order) whether the temperature on the day of the study was warmer or cooler than usual. Respondents who thought that the current day was warmer than usual believed more in global warming, expressed greater concern about it, and donated more money to a global-warming charity than did respondents who thought that the current day was colder than usual. Li et al.[6] labeled this effect 'local warming' and used instrumental variable regression to establish the causality of the local temperature abnormality in their correlational data. They explained the observed result as an example of attribute substitution,[9] where a relatively inaccessible target attribute (i.e., statistical information about trends in global climate variables) is replaced by a semantically and associatively related attribute that is highly accessible (i.e., local temperature abnormalities at the place and time of being asked about climate change), even though it may have only very limited predictive validity. Zaval, Keenan et al.[10] validated this interpretation and ruled out alternatives psychological mechanisms for the

local warming effect, including climate change labeling (see next section) and lay mental models, in particular incorrect beliefs that immediate ambient local temperature ought to be relevant for judgments about climate change. Risen and Critcher[11] manipulated the temperature in a lab where respondents were questioned about climate change and found that it affected climate change beliefs, providing further causal evidence for the attribute substitution account. In addition to finding local warming effects at the individual level, objective temperature deviations have also been tied to aggregate polling data on climate change.[12]

EFFECTS OF LABELING: GLOBAL WARMING VERSUS CLIMATE CHANGE

Even though climate scientists distinguish between climate change (CC) and global warming (GW) (with CC being the more general term that refers to changes in a broad range of climate conditions over time and GW referring to only the global earth temperature increase aspect of climate change), the general public and the media often use the two terms interchangeably.[13] It was a policy advisor to President G.W. Bush[14] who initially suggested switching from GW (a term coined by Columbia University climate scientist Wally Broecker) to CC. This was based on the well-founded belief that labels influence people's reactions and beliefs,[1,15,16] with *GW* being presumably more emotional and frightening, making the general public more likely to perceive it as a risk and demand policy interventions, an assumption that Whitmarsh[13] verified. In somewhat of a reversal, *GW* is the term that has since been used by climate change skeptics, because it primes association of heat-related impacts and rising temperatures[17] and thus appears more concretely to be proven wrong by temporary weather abnormalities like blizzards in Washington DC, as discussed in the previous section.

As discussed further below, ideological polarization on climate change perceptions and beliefs has increased over time.[18] Party affiliation has been reported to interact with the effect of labeling, with Republicans rating CC as a more serious problem than GW,[19,20] and Democrats rating GW as more serious.[20] In a careful and comprehensive study, Benjamin et al.[21] compared the effects of CC versus GW labeling on five judgment scales (general belief, personal experience, human causes, serious consequences, and self-efficacy) and two (general and specific) intentions to act, using a large nationally representative US panel. Respondents were cross classified by party affiliation (Democrat, Independent, and Republican) and climate change belief status (Believer, Neutral, and Non-Believer). Magnitude of all seven judgments followed both party lines and believer status in the directions that would be predicted, with greater seriousness judgments and intentions to act for Democrats than Republicans and for Believers versus Non-Believers. More interestingly, judgments on all seven scales showed ideological commitment overriding the effect of the CC versus GW label. That is, framing of the issue in the form of the CC label led to stronger perceptions and intentions than the GW label only for those not strongly committed to a position on this issue (similar to results discussed in Box 1), namely Independents as well as Democratic Non-Believers and Republican Believers, with no significant differences in judgments as a function of labeling for Democratic Believers and Republican Non-Believers. Hamilton and Stampone[22] similarly found that the contextual effect of local temperature anomalies on beliefs that humans are changing the climate, discussed in the previous section, was strongest among individuals who self-identified as Independents.

Survey research by Schuldt et al.[23] examines two types of perception of climate change, in particular belief that the phenomenon has been happening (or not) and the perception of scientists' consensus (or failure thereof) that climate change is occurring. Two US national surveys in the summers of 2009[23] and 2012 report results similar to Budescu and Por,[21] namely that beliefs that the phenomenon is happening follow party lines, with the CC versus GW label influencing the (albeit generally much reduced) perceptions of Republicans but not of Democrats. GW (vs CC) labeling reduced perceptions of scientist consensus for both groups, but vastly more among Republicans.

COMMUNICATION OF UNCERTAINTY

The assessment of current and prediction of future climate change, its causes, and its consequences, as summarized and communicated by the Fifth Assessment Report (FAR) of the Intergovernmental Panel on Climate change (IPCC) involves uncertainty from multiple sources.[24] The FAR suggests to move investigation and discussions of the effects of uncertainty on climate change perception and action away from its current almost exclusive focus on uncertainty in the responses of the climate system toward a broader

consideration of ecological, technological, economic, social, and psychological sources of uncertainty.[25] Within this wider uncertainty space, it is even more important how climate information and information about choice options is framed.[26] The IPCC's Fifth Assessment Report was the first to allow that climate change perceptions and responses may not solely guided by rational processes.[24] The review below on different modes of climate judgments and decisions addresses additional evidence on the consequences of promoting the processing of climate judgments and decisions by analysis, affect, or rules.

VERBAL VERSUS NUMERIC COMMUNICATION OF CC RISK AND UNCERTAINTY

Uncertainty about climate, environment, and social system responses means that forecasts in this space are at best probabilistic. Psychological research going back to the 1980s[27] has documented the pros and cons of communicating probability information using numerical expressions (e.g., '.90') versus verbal expressions (e.g., 'very likely'). Although verbal expressions may appear to be more accessible to the general public, there are large differences in the way people understand such phrases, and their use may thus lead to confusion and errors in communication. Without awareness of this very relevant body of work, the IPCC issued a set of guidelines in 2005[28] for the translation of ranges in numeric probability into seven verbal expressions (e.g., virtually certain, likely, extremely unlikely), to convey information with the level of precision warranted by the available evidence.

Recent research by Budescu, one of the authors of the original pioneering work on the interpretation of verbal probability expressions, has examined the effects of this policy on the understanding of climate change uncertainty by members of the general public.[29,30] Budescu and colleagues find that when people were asked to read sentences from the 2007 IPCC report and assign numerical values to the probability terms, their judgments deviated significantly from the IPCC guidelines, even when they had direct access to these guidelines. In contrast, a dual (verbal–numeric) scale increased the level of differentiation between the seven expressions, increased the consistency of their interpretation, and the level of consistency with the IPCC guidelines, regardless of respondents ideological and environmental views.

Two recent papers examine the effect of communicating other aspects of CC in a numeric versus verbal fashion. Hart[31] found that scientific predictions about the effects of CC on the number of polar bears dying ('most' vs '12,000 out of 18,000') changed worry and concern for respondents low in numeracy, i.e., the ability to understand numeric information, but not for respondents high in numeracy. Myers et al.[32] show that respondents rate scientific consensus on CC higher and are more confident in this estimate when they read an article that describes consensus numerically (97.5, 97, or 97 out of 100%) than non-numerically ('an overwhelming majority').

The remaining sections will revisit and update topics already described in the original version of this article.[1]

INDIVIDUAL, GROUP, AND SITUATIONAL CORRELATES OF CLIMATE CHANGE PERCEPTIONS

Ideology

Ideological polarization on climate change perceptions and beliefs has continued to increase over time,[47] with additional evidence that this may be the result of motivated reasoning.[48,49] Feygina et al.[50] tie the influence of ideology on environmental perceptions to the broader research literature on beliefs and actions, by demonstrating that system justification tendencies, the motivation to defend and justify the societal status, are associated with greater denial of ecological problems and less willingness to take proenvironmental actions. They also show that differences in system justification explain or mediate the effects of political orientation, national identification, and gender on these dependent measures.

Gender and Age

When it comes to the effects of gender and age, recent surveys in the United Kingdom[51] confirm earlier results that men are more skeptical about climate change than women and that older people are more skeptical than younger people. In the United States, also consistent with previous work, younger adults showed stronger proenvironmental attitudes than older adults and believed that the consequences of global warming should be taken more seriously. However, no age differences were found for overall belief that global warming is occurring.[52]

Nationality

Two recent studies examined different facets of perceptions of CC in a large number of countries around the world. In the context of comparing the effectiveness of verbal versus numeric expressions of

uncertainty (discussed above) in adult samples of respondents in 24 countries around the world and 17 languages, Budescu et al.[53] found not only that their US results of the joint verbal/numeric format of communicating uncertainty providing greatest accuracy of interpretation generalized to all 24 countries, but also that between-country variations in CC perceptions and beliefs were far smaller than within-country variation. Bostrom et al.[54] report a similar result based on a survey of undergraduate student respondents in six countries, finding smaller between-country than within-country variation in various perceptions of climate risks and of the effectiveness of CC mitigation policies.

Situational Difference or Choice Context

Recent studies have examined new chronic or situational factors that may contribute to individual- and country-level differences in climate change beliefs and actions, motivated in part by research showing that people show reduced discounting of future benefits and costs in intertemporal decisions when they are first focused on these future outcomes by making the delayed outcome choice option to the default.[4]

There is growing evidence that other ways of increasing focus on the future and future generations appear to have similar effects, i.e., appear to decrease people's discounting of future costs and benefits. One such way is to activate people's legacy motivation. An emerging body of research suggests that people's desire to extend themselves into the future by creating a legacy is a deep and strong impetus for proenvironmental action.[55] Zaval et al.[56] examined ways in which long-term goals and motives can be made more salient and used to shift attention to the future, thus increasing engagement with climate change and other environmental problems. Priming legacy motives increased donations to an environmental charity, proenvironmental intentions, and climate change beliefs.[56]

Yet a third way of increasing focus on the future is to use Gott's[57] principle which suggests that citizens may use perceptions of their country's age to predict its future continuation, with longer pasts predicting longer futures. Using country- and individual-level analyses, Hershfield et al.[58] showed that longer perceived pasts resulted in longer perceived futures, which in turn motivated concern for continued environmental quality. Objectively older countries scored higher on an environmental performance index, even when controlling for country-level differences in gross-domestic product and governance. When the United States was framed as an old country (vs a young one) in an experiment, participants were willing to donate more money to an environmental organization, a result mediated by perceiving one's country to have a longer future.

DIFFERENT MODES OF CLIMATE JUDGMENTS AND DECISIONS

The most recent IPCC Fifth Assessment Report has been the first to address the possibility of nonrational judgment and choice processes.[59] Its framing chapter on climate change mitigation as risk management[24] contrasts the traditional and typically implicit assumption that rational cost-benefit analysis lies at the basis of perceptions of climate risks and decisions to counter those risks with several alternatives, discussed already in the older version of this article. These include heuristic versions of calculation-based decisions, conducted by boundedly rational decision makers who use short cuts to reduce processing load and exhibit systematic biases (including loss aversion, cognitive myopia, and status-quo bias) that result from the use of such short cuts.[5]

These alternative decision modes also include affect-based processing, where choices are guided by approach or avoidance responses that arise in response to visceral reactions to choice options. Recent evidence[60] provides support to Weber's[2] hypothesis that climate change risks fail to elicit the level of visceral response (i.e., dread) that appears to be associated with risks that people are willing to take action on: traditionally nuclear power, in the 5classic work on psychological risk dimensions by Slovic et al.[61] and more recently terrorism.[62] Use of an affect-based mode to judge climate change risks is also consistent with the observed age effects discussed above. Zaval and Weber[56] provide evidence for such decision-mode mediation, by showing that younger adults expressed heightened emotional reactions associated with climate change, including greater feelings of guilt and sadness. There is additional evidence for the fact that fear-inducing representations of climate change are not only ineffective, but may also actually backfire because people see no way out of the negative mood state that is induced, reducing perceived efficacy and inviting denial.[62]

A final alternative mode of making climate change judgments and choices involves the use of rules of conduct that derive from the decision maker's social identity.

In part because professional or personal moral or ethical codes of conduct do not require (and in fact discourage) detailed evaluations of costs and

benefits of action, which tend to be myopic,[39] the previous version of this article suggested that rule-based decisions based on social responsibility or moral principles (viz-a-viz planet Earth or future generations) may hold out the best prospects for appropriate climate change perceptions and actions. However, in a thoughtful and thorough review of behavioral and neuroscience evidence on this topic, Markowitz and Shariff[63] find that the human moral judgment system may not be well equipped to identify climate change as a moral imperative, in part because it is seen as an at best unintentionally caused phenomenon. They suggest that enhancing moral intuitions about climate change may motivate greater support for ameliorative actions and policies. One major initiative along this line is the recent encyclical issued by Pope Francis[64] that reframes climate change and other ecological challenges from economic and technological issues to one of the moral stewardship of public goods. Personifying Earth as Sister Earth puts the planet on equal footing with us (two of God's creations), rather than subordinating it to humankind, and also moves it psychologically closer.

DECISIONS FROM EXPERIENCE VERSUS DESCRIPTION

Box 1 on seeing-is-believing can be read as an update of sorts on the distinction made in the original paper between learning about climate change based on personal experience versus from statistical description.[1] Seeing-is-believing evidence described in Box 1 confirms earlier reports that in the domain of climate change as in other areas, vivid personal experience often dominates pallid statistical information. Judgments and decisions based on infrequent events from experience tend to underestimate the true probability and show strong recency effects, thus making them more volatile than judgments and decisions from statistical description.[65] Empirical evidence for this pattern of response comes from an analysis of changes in property prices in Albany, Georgia.[66] Atreya and Feirera[66] contrast changes in single residence house prices pre and post a major flood in 2004 in areas within or outside a designated floodplain ('description') and for properties that were or were not inundated by the flood ('experience'). They find that property prices decreased for inundated properties, whether inside or outside the floodplain, and that the decrease in price vanished after a few years, precisely the pattern of responses predicted by decisions from experience.

CONCLUSIONS

New research since 2010 confirms and amplifies earlier accounts that perceptions of climate change are influenced and shaped by a broad range of structural, psychological, social, and cultural factors and processes that have diverse goals.[1,2] Scientific accuracy is just one of many objectives and one that is frequently overshadowed by the expression of ideological and wishful thinking in the face of a massive problem without obvious solution.[29,39] Gifford[67] refers to these psychological barriers that limit appropriate action on climate change as the dragons of inaction. He and others (see Further Readings) offer numerous suggestions, from the use of role models to strategic reframing of issues and choice options, on how these dragons may be tamed. Accurate models of the determinants and processes that give rise to (mis)perceptions of climate change and its consequences can lead the way to interventions in the way relevant information about issues and solutions is framed and presented.

FURTHER READINGS

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