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Perspective

Leveraging Social Science to Generate Lasting Engagement with Climate Change Solutions

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SUMMARY

Action on climate change is urgently needed. Because the climate crisis is a wicked problem driven by human activities, it requires social solutions. Although previous research has led to significant progress in our understanding of how to effectively communicate the existence and seriousness of climate change—and how to motivate people to behave in ways that help mitigate it—relatively little research has investigated the factors that lead to *enduring* change. In this Perspective, we highlight three promising areas of research that can inform efforts to answer the question of how to generate enduring change—deep engagement, general mental models, and social norms—and propose a research agenda aimed at generating enduring motivation to act on climate change.

INTRODUCTION

Climate change is an enormous global threat.[1] Mitigating climate change requires swift action on all levels, from individuals, communities, and governments. Because it is a problem driven by the activities of people[1,2] and the resources on which they depend, solutions must therefore revolve around the actions and demands of people. Thus, we need to engage in *social* climate science.[3]

Researchers and advocates have made significant progress in understanding what shapes people's beliefs, risk perceptions, and behaviors regarding climate change. This progress includes research on improving messaging strategies based on the messenger used,[4,5] understanding affective associations with the issue,[6] tailoring messaging interventions to key audiences,[7] using social norms to encourage pro-environmental behavior,[8,9] understanding how to best communicate visual climate change data,[10] and much more. Research in these topic areas is crucial and should grow further to meet the complex challenges of motivating people and governments to take action on climate change.

However, most research effort has been dedicated to understanding people's immediate responses to messaging or other interventions, with less emphasis placed on understanding what creates *enduring change*. Yet, understanding how to create enduring change is of paramount practical importance, because it is often infeasible for interventions to continue indefinitely.

By enduring change, we mean durable changes in attitudes, norms, affect, and behavior. That is, people remain motivated to think, feel, and act in ways that aim to address climate change long after the intervention is complete. Furthermore, enduring change implies effects that are resistant to competing information.[11] As such, enduring change is change that is consistent across time and information contexts.

There are likely many different approaches to producing the enduring social change that is needed to tackle climate change, but few studies investigate the long-term effects of their interventions. Moreover, a recent meta-analysis of behavior change interventions in the context of climate change mitigation concludes that there is "no evidence of sustained positive effects once the intervention ends."[12]

In this Perspective, we highlight three overarching themes of research that show promise for generating enduring change: deep engagement, general mental models, and social norms. Although this is certainly not an exhaustive list, we argue that these interrelated research areas constitute strong footing for informing important open questions regarding how to generate durable change in climate change beliefs, attitudes, and behaviors.

DEEP ENGAGEMENT

The persuasion literature provides strong evidence suggesting that lasting changes in attitudes are more likely to result from deep (as opposed to shallow) engagement with a message via issue-relevant thinking. Prominent theories propose that elements of a message that lead to persuasion lie on a continuum, ranging from shallow processing (i.e., relying heavily on cognitive shortcuts) to deep processing (i.e., relying on careful consideration of the arguments in the message).[13–15]

Persuasion that occurs via shallow processing is proposed to be susceptible to counter-persuasion. For example, people might be more persuaded by an argument because it comes from a credible source,[16] an in-group member,[4,5,17,18] or is

presented in a video rather than text.[19] However, because persuasion via shallow processing often occurs with little issue-relevant thinking, it is difficult for people to defend the attitude when that attitude is challenged.[13,20,21] For example, although elite cues can effectively persuade people, their effects can be canceled out by conversations with others who advocate an opposing position.[22]

Conversely, persuasion via deep processing is more likely to lead to enduring attitude change.[13] This is because thoughtful evaluation of the merits of the message leads to attitudes higher in certainty, accessibility, and importance.[23] Furthermore, attitudes formed via deep evaluation are often more consistently organized around core principles in one's belief system.[24]

Similarly, resistance to persuasion is more likely to occur when people have deeply engaged with issue-relevant arguments, such as when they practice defending their beliefs.[13,20,21] For example, inoculation theory[25] posits that just as exposure to weakened doses of a pathogen triggers antibodies in the immune system to confer resistance against future infection, the same can be achieved with information. Several studies have found that preemptively warning and exposing people to weakened doses of climate disinformation can enhance immunity against fake news.[26,27]

Subsequent research using game-based interventions lets players actively generate their own antibodies against misinformation in a simulated social media environment,[28] which is proposed to strengthen associative memory networks and facilitate deep processing. Active inoculation also enhances people's level of confidence in their own judgments and beliefs, which is important for withstanding future persuasion attempts.[29] This research highlights the importance of generating persuasive messaging campaigns that not only persuade, but also resist counterarguments. Put simply, effectively fostering deep engagement with climate change requires playing offense *and* defense.

Researchers leveraged deep engagement for prejudice reduction in a door-to-door canvassing intervention aimed at reducing transphobia.[30] The researchers adopted a strategy of getting people to think non-prejudicial thoughts actively and deeply. To achieve this, canvassers asked their conversation partner to think about a time when others judged them negatively because they were different. This opened the opportunity for canvassers to encourage respondents to take the perspective of transgender people. Then, canvassers completed the intervention by further encouraging active and deep processing of this new perspective by asking if and how the intervention changed their mind. The treatment had notable effects in the days after the intervention (0.29 standard deviation) and, importantly, demonstrated durability: (1) the effect persisted for at least 3 months and (2) the intervention was resistant to attacks.

Three additional field experiments using similar techniques showed positive treatment effects, albeit with much smaller effect sizes.[31] Effects were also robust across different media, including in-person conversations, conversations over the phone, and video, and remained several months after the intervention.

One key point to emphasize here is that deep engagement does not necessarily mean that engagement must be for a long time or require significant effort. In the previous example, interventions were often conversations that typically lasted about 10 minutes. It is noteworthy that these interventions were effective and long-lasting even though they were delivered by strangers who met respondents via unsolicited door-knocking.

A distinguishing attribute of this kind of deep engagement is that active thinking about the issue is generated by the *target* of persuasion. That is, through discussion, the person attempting to persuade the other asks their conversation partner to connect *themselves* to the issue, rather than doing so through a persuasive appeal. When deploying this strategy in service of climate action, this might include probing people about how caring for the natural environment aligns with their religious faith,[18,32–34] racial, ethnic, gender, or socio-economic identity,[35–41] or any other issue of high personal importance. Another promising approach, as we discuss in the next section, is to encourage people to reflect on their own legacy.[42] Having people take the perspective of their children or future generations, for example, might build enduring motivation to act on climate change.

These potential strategies for using deep engagement to generate enduring change raise important research questions that deserve attention. For example, are messaging campaigns more effective when messages encourage people to make their *own* connections between climate change and their values, identity, or another issue they deeply care about? Furthermore, what is the role of *close* relationship networks (i.e., friends and family) in driving climate action, and are messaging effects through these relationships more enduring? Although a large literature shows that information with personal relevance (e.g., in topic, situation, values, or consequence) is significantly more likely to lead to deep processing (and therefore enduring change) than information with less personal relevance,[13,43] there is still much to learn about how to generate deep engagement specifically with climate change and its solutions, and how to do so outside of controlled laboratory settings. Answers to these questions are crucial for growing our understanding of deep engagement and how to deploy it at scale in service of climate action.

One way to advance such research is to gain a deeper understanding of people's *full* information environment beyond individual sources of information. That is, people's views and desire for action on climate change are likely shaped by several additive factors in their information environment, including their perception of social norms, media consumption, and conversations with close others in their social network.

An illustrative example is a study[44] that tracked changes in public awareness of and support for the Green New Deal—a nascent policy agenda proposed by liberal US lawmakers designed to mitigate global warming and catalyze sustainable economic development. The study found that political polarization over the Green New Deal increased dramatically over the span of just 4 months (Figure 1). A flood of media coverage by partisan news outlets[45,46] likely contributed to a rapid rise in public familiarity with the issue, and the findings of the study indicate that exposure to partisan media corresponds with the opinion polarization that ensued[44] (Figure 2). Although this study is unable to isolate the precise causes of the observed polarization, these findings illustrate the *scale* and *speed* of polarization, and the additive effects of multiple influences over time.

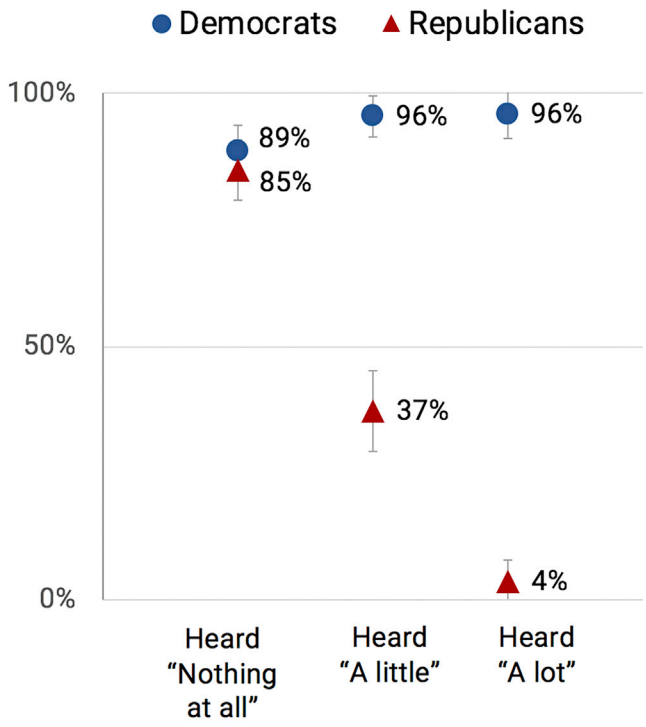

Figure 1. Support for the Green New Deal
The proportion of Democrats and Republicans who supported the Green New Deal in April 2019, split by how much they had heard about it. Data are from registered voters only. Support (y value) is the percentage of people responding either "strongly support" or "somewhat support." Error bars represent 95% confidence intervals. This figure was produced using data from Gustafson et al.[44]

This large and rapid degree of polarization was likely driven by a variety of factors, not just media exposure alone. For example, other research suggests that partisan media works *in combination* with interpersonal discussion to shape people's attitudes.[47] In one experiment, researchers manipulated whether people were exposed to partisan media, and also manipulated whether people discussed the issue with a homogeneous group (i.e., all fellow Republicans or Democrats) or a heterogeneous group of people (i.e., a mix of Republicans and Democrats). Results showed that exposure to partisan media caused people to have more extreme attitudes in favor of the positions taken by the corresponding media source. However, when exposure to partisan media was followed by exposure to opposing arguments and information via interpersonal discussion (i.e., in a heterogeneous discussion group), people's attitudes were far less extreme. Interestingly, interpersonal discussion with a homogeneous group alone was substantially *more* influential than exposure to partisan media itself. People who were exposed to partisan media as well as a homogeneous group discussion with like-minded others were similarly influenced as people who only engaged in a homogeneous discussion.

It is important to note that the effects of homogeneous discussion observed in this experiment are very large by social science standards,[48,49] with effects nearly 1.5 standard deviations in size. This points to the practical importance of pairing messaging campaigns with in-person, deep discussions with people who are appropriately alarmed about climate change. Put simply, climate messaging campaigns need to be both top-down *and* bottom-up.

This experiment[47] is an excellent example of research that captures more than just a single source of information, and also emphasizes the role of the deep engagement that is likely needed to motivate people to participate in and demand action on climate change. Certainly, the role of information exposure, how it is framed, and other facets of messaging are crucial, but this work points to the importance of considering the larger picture of the interplay of diverse forces. For example, a specific kind of message (e.g., matching a message to the target audience's moral values) might be shown to be effective, but efforts to deploy it might have a small or zero net effect if the message is easily countered by motivated opponents of climate action (see, e.g., Chong and Druckman[50]). By taking a multifaceted approach to social influence, messaging campaigns may have more of a lasting impact if the messages are further bolstered by deep, interpersonal discussion with close others. Furthermore, it is likely that this combination of repeated deep engagement with pro-climate information through multiple channels (e.g., mass messaging, interpersonal discussion) sustains the accessibility of pro-climate affect, cognitions, and behavioral intentions—perhaps making this accessibility automatic in specific contexts.[51]

Together, this body of research sheds light on the importance of using deep engagement to motivate action on climate change, and on the open questions that remain. Fortunately, efforts to engage the American public have been successful in creating a critical mass of Americans that are willing to engage deeply with the issue of climate change, take action themselves, and encourage others to take action. For example, nearly one-third (31%) of Americans are now "alarmed" about climate change.[52] However, 59% of Americans "rarely" or "never" discuss the issue with family and friends.[53,54] The challenge now is gaining a better understanding of how to bridge this gap, grow climate coalitions at local, national, and international levels, and convert beliefs into action.[55]

GENERAL MENTAL MODELS

Another promising strategy for generating enduring change is to restructure people's underlying mental models of climate change. People make sense of a complex world by using familiar mental models as guides. Through prior experience, we develop *schemas*—organizing mental models of what something is and how it relates to other things—that help us respond to new situations.[56,57] We also create and consume popular *narratives*, which are simple explanatory stories about how and why things happen. In the aggregate, popular narratives can steer mass opinion, societal behavior, and even global economic systems.[58] Similarly, issues are communicated and perceived through *frames*—an interpretive lens that emphasizes a select angle of an issue or a set of its components—which can influence how we process and respond to the issue.[59,60] Although schemas, narratives, and frames are distinct concepts, they are related in that together they comprise the general mental models people use to understand and navigate the world.

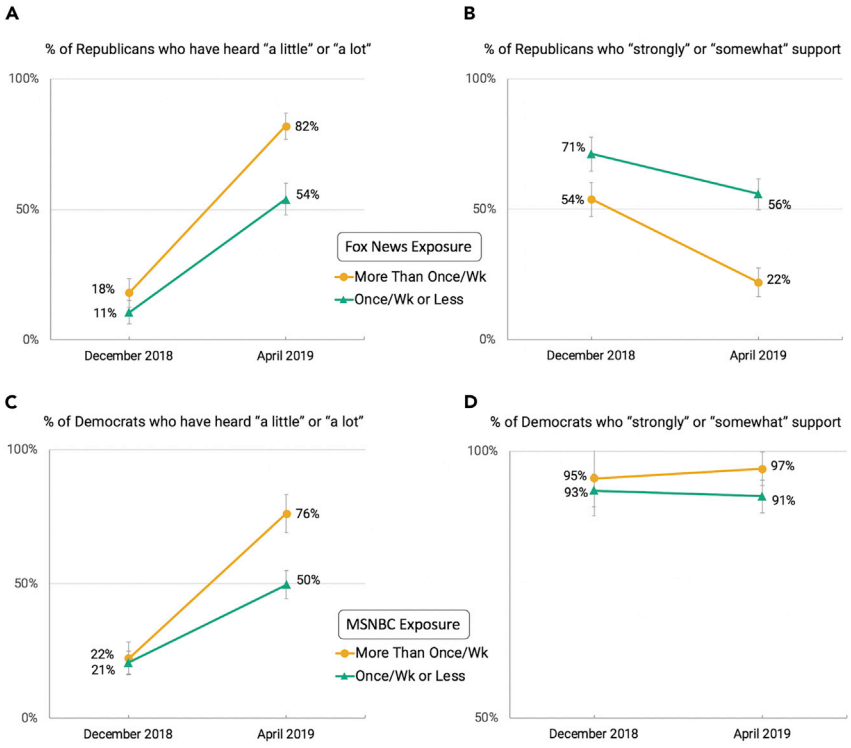

Figure 2. Changes in Awareness of and Support for the Green New Deal

Republicans' changes in (A) awareness and (B) support by frequency of Fox News exposure, and Democrats' changes in (C) awareness and (D) support by MSNBC exposure. Data are from registered voters only. Error bars represent 95% confidence intervals. This figure was produced using data from Gustafson et al.[44]

In the context of climate change, a promising avenue for fostering enduring change is to construct and proliferate the mental models of climate change that are most conducive to perceiving it as a serious threat and to motivating large-scale action. Research indicates that there is considerable variation in people's primary mental models of the issue of climate change and, correspondingly, in their responses to it.[6] Some people may primarily conceptualize the issue of climate change as a political drama of competing ideologies. Other people may primarily envision an esoteric science of ice melt and atmospheric composition. Some people may think the threat is distant in time and space, while others perceive immediate danger. Some see it as a wrong committed by malignant actors, while others see it as a natural process. The schemas, narratives, and frames of climate change that span these diverse conceptualizations of the issue can determine which impacts of global warming reside at the top of mind, which technological and political solutions are deemed appropriate, and which actors are ascribed responsibility for those problems and the necessary solutions.[61,62]

Because these cognitive structures can guide our attitudes and actions, we can seek to advance mental models and activate frames of climate change that are more conducive to pro-environmental attitudes and actions. The effects of such efforts may continue long after the intervention or campaign has completed because these structures are stored in the mind for future use, are readily accessible, and are often activated automatically.[63,64] Here, we discuss how lasting engagement with climate change can result from fundamentally changing key mental models, making them more durably accessible, and making them more applicable to other key beliefs and knowledge structures (for a theoretical perspective on this approach, see Baden and Lecheler[65] and Coppock[66]).

A Threat to Self and Others

When researchers asked US adults to state the first thing that comes to mind when they think of the issue of global warming, they found a predominant focus on distant impacts, such as melting ice and endangered animal species.[6,67] This may be in part because climate change imagery in the public sphere has historically placed a heavy focus on distant, non-human impacts, such as polar bears and melting ice.[68] It is no surprise, then, that people tend to think that climate change will have more serious impacts on places, people, and things that are distant from themselves.[69–72] Indeed, a strong majority of Americans think climate change will harm plants and animals (73%), future generations of people (72%), and people in developing countries (68%), but far fewer think it will harm their family (49%) or them personally (43%).[53]

Of course, it is true that climate change will *also* have significant impacts that are distant in time and space. But people's perceptions of the nature of the threat inform how they respond with their attitudes and behaviors. When people perceive climate dangers to be far away in time and space, they tend to be less concerned about it.[72–74] Thus, an understanding that this issue is one that touches our own communities and lifestyles—not just those of polar bears—may be effective in motivating broader engagement.[75] Fundamental change in society's response to climate change may be fostered through a fundamentally different understanding of *what kind of threat* climate change is.

A Moral Issue

The moral dimensions of climate change are undeniable, encompassing ethics, such as caring for the helpless, protecting people from harm, preserving purity in nature, leaving a legacy for future generations, heeding scientific authority, and pursuing prevention or redress of unjust behavior[76–79] (Box 1). Morality, broadly, is an "interlocking sets of values, practices, institutions, and evolved psychological mechanisms that work together to suppress or regulate selfishness and make social life possible."[80] Many studies indicate that moral judgments inform and strengthen attitudes and behaviors,[81,82] and people who see environmental issues through a moral lens tend to hold stronger pro-environmental attitudes and behavioral intentions.[83,84]

Box 1. Using Moral Messages to Engage People with the Issue of Climate Change

There are myriad ways to invoke moral imperatives of climate change that resonate with the values of particular audience segments. For example, a common Christian ethic is "stewardship of the Earth," such that humans have been given the responsibility to care for it. Pope Francis advanced this doctrine in his 2015 encyclical, and argued for the ethical imperative of protecting the well-being of people at greatest risk from climate impacts. Research indicates that such appeals can move Christians' beliefs and attitudes about climate change and environmental protection, specifically by increasing perceptions that these are moral issues.[18,34,85] Although few messengers have the same authority as the Pope does for Catholics, it is still likely that other trusted in-group leaders and organizations will be influential in advocating for the moral obligation to care for the environment and address climate change.[86] Research is needed to confirm (1) how long the effects of moral-matching messages last and (2) how well they resist opposing information over time.[11,50]

Recognition of the moral implications of climate change would likely fundamentally alter the motivations for, and frequency of, climate-friendly attitudes and behaviors. Consider, as an example, the issue of littering. In many cultures, littering is seen as taboo with near total social consensus, but this is likely not entirely (or even primarily) because of pro-environmental motives. Rather, it is likely more because of moral motives: it is (in those cultures) considered to be disrespectful, selfish, lazy, unclean, offensive, and *just a bad thing to do*.[9] In such situations, littering has transcended the label of an environmental issue, and its status as a matter of ethics has been accompanied by overwhelming social consensus.

Although many people may not be predisposed to view climate change through a moral lens,[87,88] research has found that matching moral appeals to existing moral values is an effective strategy for increasing pro-environmental attitudes.[89–91] For example, Feinberg and Willer[92] tested the effects of moral framing of environmental messaging and found that emphasizing "purity"—a moral dimension often related to conservative ideology—significantly increased conservatives' pro-environmental attitudes and effectively eliminated the partisan divide. A critical open question on this front is how effective these moral frames are for generating enduring change, especially when repeated often by a variety of trusted messengers.[93]

Another promising moral appeal is an appeal to one's personal or collective legacy. A common ethic is to "leave it better than you found it," and research indicates that in the US, the reason to reduce global warming that is most frequently selected as most important is to "provide a better life for our children and grandchildren."[94] Furthermore, for Christians, a top reason to reduce global warming is to "protect God's creation."[18] More directly, experimental research shows that increasing people's thoughts about their legacy leads them to report higher pro-climate beliefs and behavioral intentions.[42]

In sum, emphasizing moral dimensions of climate change can result in more people seeing the issue from a moral perspective, which can restructure the fundamental motives for environmental attitudes and action. Furthermore, such moral messages are unlikely to lead to backlash effects,[18,91,95] and have been shown to be especially effective in contexts when people are motivated to affirm their moral values.[96] Future research could test which moral appeals resonate best with different audience segments, whether moral appeals can reduce counterarguing, and how the effectiveness of moral appeals interacts with characteristics of the messenger or source.

An Interconnected System

Another mental model that is conducive to appreciating the nature and effects of climate change is "systems thinking": a cognitive paradigm of recognizing that people (and everything else in the world) exist in an interconnected system of complex and dynamic relationships.[97]

People who tend toward systems thinking are also more pro-environment in their attitudes and values.[98–101] This may be because they have a readily available mental model for understanding how distant, abstract, small, or seemingly unrelated events can have cascading effects throughout the rest of the system. Applied to climate change, developing a systems thinking perspective may make it more intuitive that an invisible phenomenon like increasing CO_2 concentration can proliferate into a variety of tangible impacts like flooding, economic recessions, and mass migrations. Systems thinking interventions may also be a particularly valuable strategy because positive responses to them do not require prior pro-climate beliefs, and the interventions need not explicitly mention climate change. Improving people's understanding that the world is an interdependent system can set the stage for a deeper understanding and a willingness to accept that, for example, the products we buy, the infrastructure we depend on, and the food we eat are all connected to environmental impacts. As such, improving systems thinking may be able to function as a back door through which to shift the ways in which various audiences conceptualize the issue of climate change.

One study found that systems thinking predicts climate change beliefs, and that this relationship can be explained by its relationship with a pro-environmental worldview.[98] While this evidence is not sufficient to conclude that these relationships are causal, these preliminary findings hint at a potential pathway to affecting climate change beliefs via fostering a mental model of systems thinking. Educators and public communicators could consider utilizing messages, frames, and even activities that foster a systems thinking mindset. For example, the *Systems Thinking Playbook* provides a diverse set of systems thinking exemplars, metaphors, and games that are applicable to a wide range of audiences and contexts.[102] Future research is needed to test the effectiveness of systems thinking interventions as a way to inspire pro-environmental values and sustainable behaviors.

There are many ways to revise or create schemas, narratives, and issue frames that could be more conducive to widespread climate action, just three of which are summarized here. Specifically, we argue that people may be more open to supporting and

engaging in climate solutions if they perceived climate change as a proximate threat requiring systemic solutions, considered it to be a moral issue, and envisioned it as a system of interconnected causes and effects. Affecting these dominant mental models of what climate change is and what it implies may have enduring effects because these cognitive structures are stored for future use and thus can continue to have cascading effects on future attitudes and behaviors.

There is ample opportunity for research on many other mental models of climate change. For example, about one-third of Republicans believe that protecting the environment reduces economic growth and costs jobs.[94] This reveals that a mental model entailing a zero-sum tradeoff between environmental protection and economic growth is common, even though this assumption is false.[103] We hope that this discussion motivates more research and practice that seeks to develop and popularize more productive mental models of climate change, recognizing that the discussion here does not represent an exhaustive list. Rather, we present these exemplars as being indicative of the principle that the underlying mental models of climate change are valuable targets for communication campaigns because their positive effects can have lasting benefits.

SOCIAL NORMS

Systematic reviews and meta-analyses of the behavioral science literature have repeatedly shown that social norms are among the most powerful interventions for encouraging pro-environmental behaviors.[8,12,104–108] Although interventions that use social norms are generally effective, treatment effects are heterogeneous, and therefore it is important to consider important details, such as the type of norm, who is communicating it, how they are communicating it, and in what context.

Following the seminal work of Cialdini and colleagues,[9] behavioral scientists generally distinguish between *descriptive* norms (i.e., information about what other people do) and *injunctive* norms (i.e., information about what other people think you *should* do). Descriptive norms typically leverage informational influence, whereas injunctive norms typically encourage conformity with social expectations.[109]

A rigorous large-scale illustration of how descriptive and injunctive norms can be leveraged in practice is the Opower field experiment.[110] The largest behavioral science experiment conducted at the time, a company (then called Opower) started sending out personalized home energy reports to their customers. The reports simply revealed how much energy a household consumed relative to their neighbors over the same period. Results showed that people adjust their own consumption levels to match the norm. This is both a positive and negative lever. For example, one key finding around the use of descriptive norms (alone) is the "boomerang effect"—if people realize that they are being more efficient than their neighbors, they will *increase* their own consumption to match the norm. To counteract this trend, later reports included either a smiling or a frowning face, which was meant to additionally convey an injunctive norm to reinforce social expectations to save energy.[111] An evaluation of 600,000 treatment and control households showed that the use of social norms resulted in an average decrease in energy consumption of about 2%.[110] Although this may sound small, when scaled across hundreds of thousands of households, small effects can have a large impact. For example, the observed effect size is about the equivalent of an alternative price-based intervention that would raise electricity prices by 11%–20% in the short-term or about 5.2% in the longer term.[110]

Although social norm interventions are cited as a powerful lever for social change, we identify a major challenge for theorists and practitioners in using social norms to enact system-wide societal change: typical social norm interventions may be unlikely to generate deep and lasting changes in personal behavior or private attitudes.

Short-Term Compliance versus Long-Term Conformity

In one quasi-field experiment, a "save energy" campaign called "do-it-in-the-dark" was launched at Princeton University as part of a larger nationwide initiative where students, using an application on their phone (or leaderboard at their college), could see how much energy their college was consuming relative to other colleges at the university. Real-time energy consumption was measured across the colleges for approximately 2 months. Results showed a decrease in aggregate energy consumption across the university while social comparison information was present and the campaign was salient. That is, students were conforming to the new "save energy" norm. However, as soon as the campaign ended and the normative information was removed, energy consumption quickly reverted back to levels observed before the campaign.[112]

This trend was also observed for the 2014 ALS "Ice Bucket Challenge," in which people would post a video online where they either poured a bucket of ice-cold water over their head or donated to organizations aiming to cure or treat ALS, and nominated others to do the same. Similar to the Princeton campaign to reduce energy consumption, conformity to the norm was pronounced during the period in which the campaign was active, but tapered off quickly once the campaign ended.[113]

Jointly, these studies point toward an important conclusion: norms can be incredibly effective levers of social influence, but deep and lasting change does not necessarily happen when people do not internalize the norms. In other words, people might conform publicly or update their perceptions about what is normative, but may not change their private views or behavior in the long run. How long do people need to be exposed to a new norm in order for them to internalize the norm and continue the behavior without an external social cue? At which point does social pressure to behave pro-environmentally transition into a self-sustaining personal norm? For example, it is possible that internalization may happen more quickly if the norm is strongly endorsed by close relationship partners, who may continue to be influential. These are the questions that lie at the frontier of research on climate change and environmental communication.

The Opower field experiment offers insights from a relatively rare investigation. After 2 years of being exposed to the personalized home energy reports, a random subset of the treatment homes was selected to stop receiving the reports. Initial findings indicated the typical high-frequency "action-backslide" trend, but after 2 years of exposure when the social norm cues were discontinued, effects persisted, decaying at about 10%–20% per year.[114] Similar social feedback interventions have found that identification with the referent group (similar households)

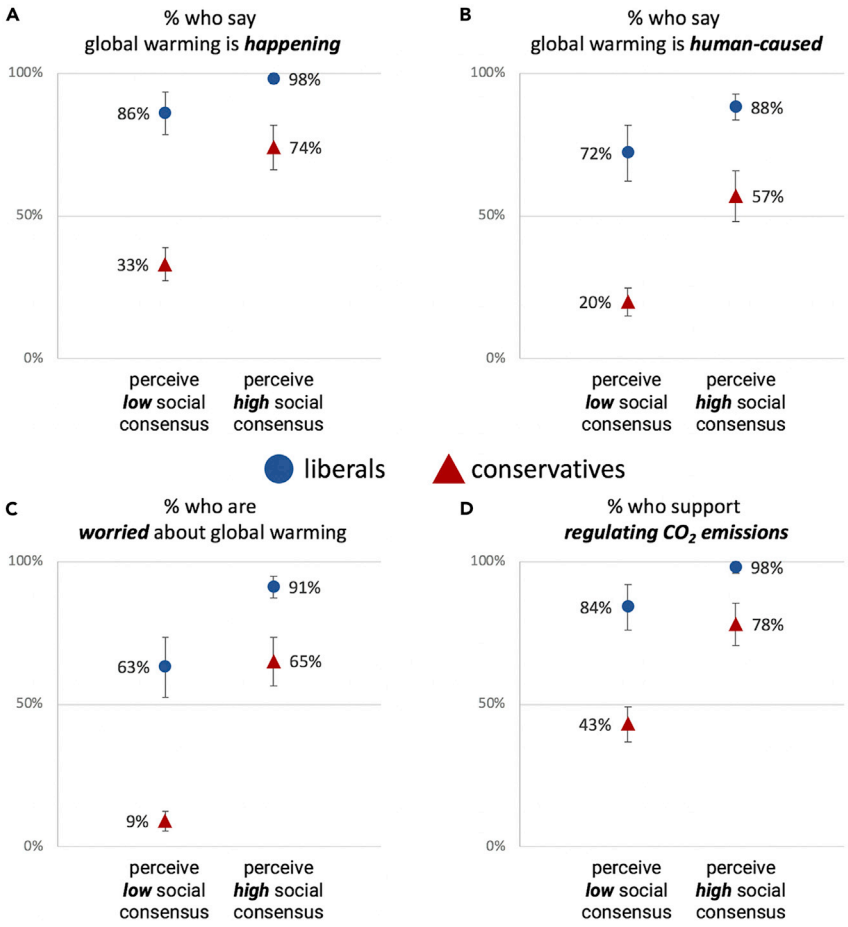

Figure 3. Global Warming Beliefs, Worry, and Policy Support

Liberals' and conservatives' beliefs that (A) global warming is happening, (B) global warming is human-caused, (C) worry about global warming, and (D) support for regulating CO_2 emissions, as a function of perceived social consensus. Error bars represent 95% confidence intervals. This figure was produced using the most recent data from Goldberg et al.[121]

enhances the likelihood that effects will persist for several years.[115] An easy way to reconcile these findings with contradictory evidence from van der Linden[112,113] is the difference in exposure time: a few months versus 2 years. Although promising, these estimates suggest that people may need to be exposed to social norm interventions for years in order to produce sustained effects once the norm is no longer salient.

Alternatively, future research should aim to uncover methods for communicating social norms in ways that are more likely to have long-lasting effects. One notable advantage of using *close* social networks (friends and family) to communicate pro-climate norms is that people remain in contact with those social network members, which likely keeps the norm more salient than a referent group that otherwise would not be chronically salient (e.g., neighbors). Research is needed to understand how norms operate in this context to influence beliefs about climate change, pro-climate action, and policy support.

Second-Order Normative Beliefs as a Gateway to Change

Another analysis of the Opower data showed that second-order normative beliefs (e.g., beliefs about the extent to which peers think saving energy helps the environment) predicted people's energy savings while people's personal (i.e., first-order) beliefs did not.[116] Similarly, a large field experiment demonstrated that people's decision to install solar panels (an uncommon behavior) was predicted by beliefs about what *other* people believe, in this case, whether the community advocates themselves thought it was worth installing solar panels.[117] Because people frequently underestimate pro-climate norms,[118] correcting people's *perception* of the norm is a powerful "gateway" to social change.[119,120]

A recent study by Goldberg and colleagues[121] examined the ideological divide on climate change in the US and how it differs dramatically depending on perceived social norms. Specifically, the researchers examined nine nationally representative surveys (N = 16,168) and found that ideological differences in climate change beliefs, worry, and policy support between liberals and conservatives are significantly smaller for individuals who perceive social consensus on climate change among their social network of close friends and family (Figure 3).

Researchers have started to theorize how second-order normative beliefs relate to private attitudes and personal policy support. For instance, the Gateway Belief Model postulates a two-step process where updating people's perception of a norm (e.g., that 97% of climate scientists agree that humans are causing global warming) leads to subsequent (smaller) changes in private attitudes (e.g., the belief that climate change is happening), which in turn predict support for climate change mitigation policies[122] (Figure 4). A large body of experimental research has found that communicating descriptive norms about the scientific consensus on climate change leads to subsequent smaller changes in private attitudes about the issue, which in turn directly and indirectly predict support for public action.[120,123–125]

Importantly, recent longitudinal follow-up studies have found that perceptions of the scientific consensus at one time point predicts changes in private beliefs months later.[126] Of course, equally important is the question of how norms spread. Related research has found that one route is through discussion with peers in one's social network. That is, people can learn from network members about the consensus among scientists, and in turn, higher perceptions of the scientific consensus predict increased global warming discussion months later,[127] highlighting the recursive nature of social normative processes.

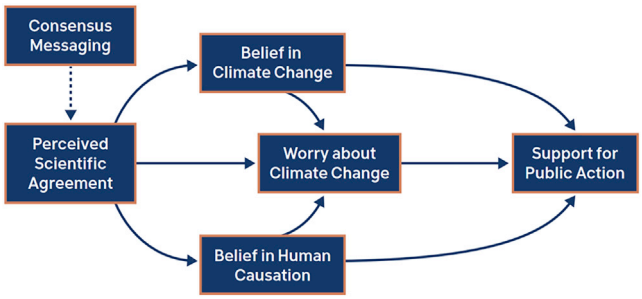

Figure 4. Gateway Belief Model (GBM)
The model shows that communicating the scientific consensus on climate change corrects people's misperceptions about the consensus, which leads to increases in the belief that climate change is happening, human-caused, worry about it, and support for public action. This figure is reused with permission from Cook et al. (2018).

A Path Forward: From Social to Personal Norms

On a societal level, norms can be thought of as vicious and virtuous cycles of collective behavior.[106] For example, the current norm is that most people do not talk to their friends and family about climate change.[53] Fortunately, norms are dynamic and change over time. Even when the existing norm is not favorable, minority trends can be used as a lever for changing counter-normative behavior.[128] For example, messages suggesting that "more and more people" are eating less meat can reduce meat consumption by highlighting a trend toward less meat consumption.[129] Yet, to break unsustainable norms and generate momentum for more sustainable patterns of behavior, people need to not only respond to normative cues once in public but they also need to internalize the norm in order to foster enough motivation to continue the behavior on their own. This will increase the signal of the norm, attract more followers, and ultimately build enough momentum for large-scale societal change.

"Sticky" social norms interventions are those whose effects last over time even when the norm is no longer active and salient. However, it is not sufficient for interventions to demonstrate the durability of an effect. Research should better conceptualize how the process of normative change is related to changes in private attitudes, worldviews, and behaviors over time, paying particular attention to the identity of the referent group. What once started out as a response to an external social cue to act on climate change (perceived social pressure) could eventually become an intrinsic motivation (a guiding inner voice). Although it is often assumed that personal norms are internalized social norms, and as such, a more powerful agent of change,[130] this assumption remains largely unverified.[131] Even when people have pronounced personal norms, they may not always act on them.[132] How do people decide whether to personally adopt or reject new norms? A priority for behavioral science research should therefore be to decode this conceptual process and offer concrete guidelines for how different groups and individuals in society decide—over time—not only which norms to follow, but also which norms to ultimately make their own.

CONNECTING THE PIECES

In this Perspective article, we have taken a broad view of what it takes, and what we need to learn, to create sustained engagement with the issue of climate change. Although the approaches we describe in this article are by no means comprehensive, they represent key areas of research we believe can further an understanding of how to cultivate lasting pro-climate beliefs and action. Specifically, we argue that leveraging deep engagement, underlying mental models, and social norms is crucial for generating lasting social change. However, there are several additional points worth considering regarding how these different approaches fit together, and how they fit into our broader understanding of persuasion and behavior maintenance.

First, the three broad categories we have detailed in the article are not mutually exclusive, but rather can be used in combination to generate enduring effects. For example, people might change their mental models through deep discussions with close social network members, thereby harnessing the power of deep engagement, general mental models, and social norms at the same time. This multidimensional approach to social influence is evident in research showing that, although partisan media have a relatively small audience, their effects are widespread because people who consume such media use that information to persuade others.[47] Research of this kind—which investigates the interplay between different approaches to generating enduring change—is essential because it more closely mimics the world outside the laboratory. In fact, we call for research to break down false dichotomies between "cognition" and "motivation"[133] as we recognize that human behavior is complex and multi-determined.

Although we have argued here that significantly more research effort should be dedicated to understanding how to generate enduring change, research on the immediate effects of different types of narratives, messages, and messengers remains critically important as well. Insights from this kind of research can serve as inputs for studying enduring change. That is, such studies inform research questions at the very core of the research areas we have discussed: What are the best paths to deep engagement? Which general mental models are most helpful, and which are most detrimental? And finally, are certain kinds of norms, or norms of particular referent groups more likely be influential on this issue? Research on immediate *and* enduring effects is critical to answering these questions.

A common question posed by researchers and advocates is whether we should focus more on *cognitive* approaches to fostering engagement (e.g., by changing beliefs and attitudes) or on *affective* approaches (e.g., by changing feelings and emotions)? We argue that both of these broad approaches are essential and are inherently interdependent. For example, many people recognize that climate change is a problem, but lack a visceral motivation to address it (see, e.g., Weber[75]). On the other hand, people may feel negative emotions toward climate change, but without specific knowledge about solutions, people will be less likely to connect their feelings to concrete action. Put simply, the insights in this article should be used to increase pro-climate affect *and* cognition, as both are key predictors of policy support[6,134] and are drivers of advocacy behavior.[135]

The open questions raised in this article highlight the need for a more comprehensive model of attitude and behavior maintenance, and for broader application and adaptation of existing models. Promising examples are available in the health psychology literature. For example, the Health Action Process Approach

(HAPA) distinguishes between people who do not intend to adopt a given health behavior, those who intend to, and those who are currently taking action.[136] People in these different stages of the model require different interventions. The HAPA model and corresponding evidence shows that motivating behavior change must be supplemented with behavior maintenance strategies that equip people with a plan for how, where, and when to enact the new behavior, and how to deal with setbacks when they arise. Further developing and applying these models to engaging people with the issue of climate change seems especially fruitful.

A final important consideration is how researchers should go about choosing which questions to investigate or behaviors to target when attempting to understand what leads to enduring change. For example, how much should researchers focus on *activating* already-engaged segments of the population, as opposed to convincing people that the problem exists, or limiting the influence of politically motivated actors who are hostile to climate action? Is deep engagement more important for repeated or one-off behaviors? We believe that the insights described in this article are applicable to each of these questions, but researchers should think critically about which questions to prioritize, and which insights are worth deploying at city, state, national, or international scales. As we have detailed throughout, enduring change is going to require multidimensional solutions from the top-down as well as the bottom-up. We hope this Perspective will catalyze research dedicated to understanding these questions, and inspire insights that can be used to generate enduring change in the years to come.

AUTHOR CONTRIBUTIONS

M.H.G., A.G., and S.v.d.L. collectively conceptualized the ideas, drafted the manuscript, contributed revisions and critical comments, and approved of the final version of the manuscript.

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