Annual Review of Environment and Resources

Communication, Climate Mitigation, and Behavior Change Interventions: Understanding Message Design and Digital Media Technologies

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Annu. Rev. Environ. Resour. 2024. 49:655–72

First published as a Review in Advance on August 2, 2024

The *Annual Review of Environment and Resources* is online at environ.annualreviews.org

https://doi.org/10.1146/annurev-environ-121322-070317

Keywords

behavior change communication, climate change, message design, digital media, mitigation

Abstract

Using the socio-ecological model of social and behavior change communication, our review highlights current trends in understanding message design factors and media technologies promoting proenvironment and climate mitigative behaviors. We explain that much of this research has focused on the individual level, and relatively few studies have been conducted at the interpersonal and community levels. With respect to changing communication ecology, we note the potential for research on the use of social media platforms to influence positive behavior changes and, conversely, the challenges of misinformation and its impact on behavior shifts. This area requires further investigation as these communication platforms transform and become increasingly relevant. Additionally, we need to explicate the long-term shifts and impacts of behavior change interventions as well as track behaviors over time. Overall, our review underscores the continued need for research across different geographical, sociopolitical, and technological contexts.

Contents

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) (1) notes the important role of communication and media platforms, especially social media, in disseminating information, conveying social norms, and creating networks among citizens locally and globally, which can help with the diffusion and adoption of promising climate change mitigation approaches (2). In this review, we propose using a socio-ecological approach (3) to understand current research on the role of communication interventions in promoting social and behavior change, (4, 5). We focus on the potential of new and digital media technologies to facilitate adoption of climate mitigative and/or adaptive behavior (1). The IPCC emphasizes that climate adaptation and mitigation are enabled not only by policies, political capacities, finances, and technologies but also through social and behavior changes (6), highlighting that emissions mitigation is achievable through behavior changes and technology adoption (6). While adaptation is "the process of adjustment to actual or expected climate and its effects," mitigation focuses on "human intervention to reduce emissions or enhance the sinks of GHGs [greenhouse gases]" (6, p. 126).

Going beyond simplistic information deficit models (7, 8) that focus on a lack of knowledge as a barrier to individual behavior change, this framework acknowledges that (*a*) multiple contexts influence behavior from the individual to the macro level, (*b*) these contexts in turn are interrelated and have an impact on one another, and (*c*) the role of communication in these contexts—specifically, aspects of message design and research related to media channels/platforms—shapes adaptive and mitigative behavior outcomes (5).

Drivers of behavior change can exist across multiple levels (**Figure 1**). At the individual level, factors typically consist of individuals' personality traits, beliefs, and attitudes, which have been a long-standing focus of behavior change scholarship. Beyond the individual level is the interpersonal realm or the immediate social environment, consisting of family and friends and, one layer out, the community. The outermost level is the macro level (i.e., the exosystem), or the broader social context including institutions and systems where people are embedded into the media and political system: "[T]he macrosystem refers to broader shared societal and cultural norms, values, and ideologies" (5, p. 135).

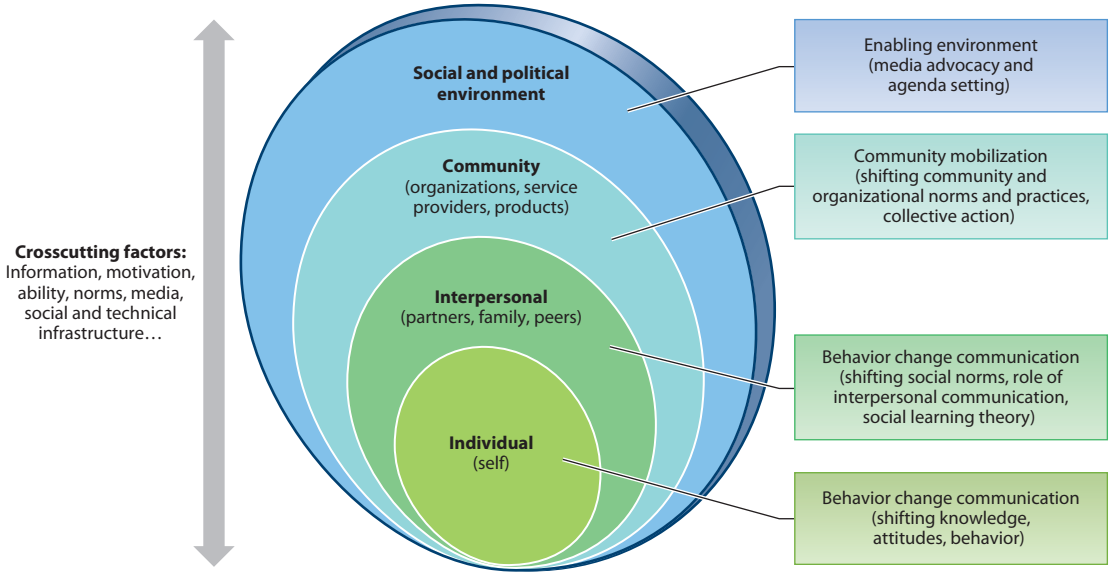

Figure 1

Socio-ecological model of social and behavior change communication. The figure depicts drivers of behavior change that can be understood using a socio-ecological model (3) and seen across multiple levels; it represents the embedded nature of the contexts that influence behavior. Each concentric circle represents a different sociological level. At the core, the individual-level factors typically consist of an individual's personality traits, beliefs, and attitudes (3–5). Beyond the individual level is the interpersonal realm or the immediate social environment consisting of family and friends (3–5). The next layer is the community. The outermost level is the macro level or the broader shared social context ranging from institutions and political systems to shared societal values and ideologies (3–5). On the left, the gray diagonal double-sided arrow represents crosscutting factors such as information, norms, and social infrastructures that influence across levels. On the right, the colored boxes connected to each level detail potential communication intervention focuses. The figure is based on Bronfenbrenner's (3) socio-ecological conceptualization, specifically the model described in Reference 4.

Message Design and Behavior Change Communication

Message design is a central area of research in the communication discipline and in the design of campaigns for behavior change (9–12). Such studies range from research into message choices, such as narrative versus nonnarrative format and emotional appeal, to word choices and use of visual communication. Communication researchers have explored "these variations using theoretically-driven and methodologically rigorous approaches to determine which variations matter for whom and in what contexts, with the ultimate goal of designing more effective persuasive messages to have a positive impact on. . .behavior" (7, p. 1). In other words, investigations of nuanced and varied strategies of message design hold promising insights for influencing knowledge, attitudes, norms, and behaviors at the individual, meso, and macro levels.

Role of Digital Media Technologies and Platforms in Behavior Change Communication

The penetration of the Internet and the widespread adoption of digital media technologies, including social networking platforms, have created new opportunities for research. These include aggregating and analyzing data on climate change news and information sharing, such as on social network sites (13), as well as tailoring and targeting media interventions to particular audiences, such as youths (14, 15). Interestingly, traditional (mass) media no longer dominate agenda setting in the online public sphere; rather, there is a complex and dynamic relationship between traditional

and online media, with "patterns of leading and lagging indicators in both social and traditional media" (16).

Building on these developments, this review highlights relevant trends or innovations related to the influence of digital media platforms on climate mitigative and adaptive behavior adoption, with a focus on message design aspects. Given the vast array of literature on climate change communication and the role of the Internet broadly or social media specifically, the scope of this review is the domain of understanding behavior change communication and insights into climate mitigative and/or adaptive behavior promotion.

We structure our review analytically using the socio-ecological model of social and behavior change communication. We categorize the literature according to the factors driving behavior change across individual, interpersonal, community, and macro (social and political environment) levels and summarize the overarching trends found in the literature. To this end, we first searched for climate intervention and behavior change studies published in communication journals and then looked at environment and climate journals for communication-related investigations, thereby building an interdisciplinary perspective on behavior change interventions and digital communication technologies.

SOCIO-ECOLOGICAL MODEL OF SOCIAL AND BEHAVIOR CHANGE COMMUNICATION

Overall, we find that more research focuses on individual-level behavior change, with studies explicating multiple drivers of individual behavior change. Studies use a range of theories that highlight interdependent and contextual factors.

Individual Level

Thematically, at the individual level we find that three factors—knowledge; beliefs, values, and attitudes; and emotion—represent the focus of research on behavior change. We explore how these factors drive action or inaction (17–21).

Knowledge has been long understood as foundational to effecting behavior change. The digital age has given rise to many new ways for people to search, aggregate, and analyze information on climate change on an unprecedented scale (13). However, misinformation and disinformation have proliferated at the same rate (22). Thus, knowledge and information are again key to behavior change. People are influenced according to whether they receive correct information, which may further shape their risk perception and subsequent actions. For instance, farmers who receive accurate climate information are more likely to adopt climate adaptive behaviors ranging from purchasing of tools to prepare for extreme weather events to practicing farming methods that save and recycle water (23). In contrast, those who receive misinformation may adopt maladaptive practices or evidence no shift in behavior and may come to believe that climate change is outside their control (23).

Digital platforms allow for widespread dissemination of information and, consequently, are an important methodological tool. In an online experiment involving more than 3,000 households in China, Gao & Tavoni (24) measured the long-term effects of information provision. People were provided information about the monetary and climate benefits of low-carbon lightbulbs, and their purchasing behavior was then observed for 10 months. People with prior knowledge showed a temporary impact when provided with information on personal and social benefits by increasing the saliency of the information. However, those who were previously uninformed demonstrated a more persistent shift in behavior, suggesting the twofold role played by information dissemination and potential short- and long-term behavior changes based on audience.

An increasing number of studies find that, globally, there are multiple aggressive and effective online climate misinformation and disinformation campaigns. In the United States, for instance, a study found high levels of misinformation available across both traditional media (mass media) and new media (digital platforms), particularly in politically conservative outlets (25). Similar trends were also observed in a study on German websites; the researchers found that more than 40% of climate change–related comments on the websites' comment sections were misinformation (26).

Online astroturfing is a digital communication strategy that uses websites and bots on social media platforms to create the false impression that some belief or opinion has extensive public support (27). An experimental study demonstrated that strategies such as astroturfing comments can shift audiences' beliefs on climate change and increase uncertainty. Importantly, even those who received inoculation messages (i.e., a forewarning of misinformation) prior to exposure were still affected (27). Online misinformation can influence audiences and increase their skepticism about climate change regardless of their level of education, especially if these misinformation and disinformation campaigns make them question the validity of scientific data and models (28). Even word choice and the use of metaphor in online platforms and user comments can have effects ranging from greater policy support, where war metaphors were used in discussions of climate change, to higher skepticism and a lack of urgency, with the use of religious metaphors (29). In this context, the use of metaphor in debates also prevented elaboration of nuanced arguments (29).

Thus, in the age of information overload and climate disinformation, communicating accurate knowledge for behavior changes requires nuanced skill, with many message design aspects to be considered and tailored for success. Studies such as those highlighted above also underscore the need for continuous engagement with broader media literacy efforts as well as issue-specific interventions to combat misinformation and disinformation (e.g., topic-specific versus abstract inoculation messages) in order to promote climate mitigative behavior (23, 27, 28).

Furthermore, at the individual level, research has repeatedly demonstrated the importance of values, beliefs, and attitudes in promoting behavior change (18, 20, 30–35). Studies have shown that values and norms related to consumption, including consumerism, hedonism, and materialism, may cause people to increase their consumption and lower their willingness to adopt emissions mitigative behaviors. In other words, values that promote personal gain and comfort over the well-being of the environment can contribute to the adoption and promotion of environmentally unfriendly behaviors, such as the use of air conditioning, driven by concerns about personal comfort rather than emissions costs (36, 37). Conversely, individuals who reject such values are more likely to adopt and practice mitigative behaviors (30). Additionally, altruism and ecocentrism are values that may promote adaptive and/or mitigative behavior change (18, 31). People with higher altruism and ecocentrism values are more likely to be positively influenced by climate change mitigation messages and to demonstrate increased policy support and shifts in individual behavior (18).

Beliefs and attitudes are not static and can be subject to change. Aspects of message design, including framing, are important factors in overcoming attitudinal barriers or influencing shifts in beliefs that, in turn, lead to change in intentions and behaviors. Research across domains has shown that the way the message is framed affects the attribution of responsibility for social conditions and remedial actions (38, 39); that is, frames define problems, diagnose causes, make moral judgments, suggest remedies, and predict their likely effects (40). For instance, in the United States, where climate change policy support is often influenced by political identification, a study demonstrated that framing the issue in terms of air pollution was more effective than a climate change framing in influencing intentions to support emissions mitigation policies via increasing perceived benefits, irrespective of political affiliation (41). Framing, however, may not always successfully

overcome predispositions and previous message exposure, as individuals may reject information on mitigation policies regardless of framing (42).

The influence of design factors such as visuals (43), text (44), or comparisons (44) on individuals' knowledge, attitudes, and behaviors has also been investigated. In an illustrative study (44) on the comparative effects of text- and image-based information about climate change on people's mitigative behavioral intentions, text-only information that focused on actions to respond to climate change had the greatest impact, followed by text-only information that paired action along with information about the impacts of climate change. In both scenarios, participants' efficacious beliefs were influenced, which in turn influenced their behavioral intentions. Images overall had a lower impact on efficacious beliefs, except for solar panel images (44). Similarly, research indicates that people who process (new) information heuristically, especially those with preexisting negative attitudes toward climate change, are less likely to shift their support to climate mitigation policies. In other words, messages (e.g., climate change information) that are more likely to trigger cognitive elaboration and processing increase support toward behavior change (18).

Studies have also repeatedly demonstrated the power of storytelling in causing behavior changes by shifting attitudes, norms, and beliefs in various domains, such as health promotion (45, 46). Narrative persuasion—in particular, the use of fictional narratives—is increasingly being considered as a message design factor, warranting further empirical investigation in terms of sustainability and proenvironment behaviors (47). Studies explicating narrative persuasion show that stories can present climate information in engaging ways that help audiences relate to the information (48–50). Additional design factors, such as the temporality of the stories, narrator perspective, realism, or the moral values appealed to, can affect engagement and the persuasiveness of such interventions (48, 50).

New media, such as digital games on online platforms, also demonstrate significant potential for influencing social and behavior change (51, 52). Games whose design features cooperation (versus competition) can increase players' self- and collective efficacy and sense of collective action. Games as a communication medium are particularly effective in promoting climate change mitigation information and behavior or a mix of both mitigative and adaptive behaviors (53).

Finally, emotions are among the most frequently studied concepts at the individual level in relation to behavior change. Emotions can influence proenvironment behavior across a multitude of interventions, particularly in relation to risk communication, public engagement, and climate decision-making; therefore, they are a critical factor in behavior shift (54, 55). Emotions can also play a role in individuals' moral deliberation, which in turn affects behavior change.

Fear is a commonly used emotion in framing climate change issues—a seemingly obvious choice, considering the catastrophic effects that climate change portends for people and the environment. However, while fear can motivate behavior change, it can also cause inaction (55). Visual and iconic representation, including images of natural disasters, can lead to fear and generalized concern, especially when combined with the use of shock and sensational messaging. While such messaging can capture a person's attention and invoke an emotional response, it does not cause long-term behavior changes, as the person may feel hopeless and overwhelmed by the threat or, relatedly, reduce their self-efficacy and motivation to act (56, 57). However, in the context of climate adaptive behavior, when people are experiencing heightened feelings of impending disaster or imminent personal danger and death (e.g., potential impact of floods), they are moved to make adaptive behavior changes based on warning messages (58).

Similar to fear, hope can affect engagement and action and work in complex ways. In a study conducted in Spain, researchers found that the risk communication approach used by the local government encouraged people living in floodplains to prepare and adopt adaptation techniques for managing flash floods; paradoxically, this approach lowered their long-term risk perception

levels compared with those who did not engage (59). Other studies have similarly demonstrated how positive images that were intended to inspire hope in the aftermath of a climate disaster event (versus negative images of the impact) led respondents to disengage (57).

In the era of digital platforms and disinformation, the absence of hope can be exploited by climate skeptics. A study on the Russian blogosphere found that blogs were used as echo chambers by climate deniers, who employed provocative language in combination with alarmist and conspiracist messages to increase readers' feelings of hopelessness (60). Anger, too, is a strong negative emotion that climate skeptics frequently employ on online platforms. Anger can influence respondents' intention to speak about climate change issues—that is, exposure to provocative online comments that led to heightened feelings of anger increased respondents' intention to speak about climate change, regardless of their perspective on the issue.

Among positive emotions, the effect of humor has been studied in depth in relation to shifting or adopting climate mitigative and adaptive behaviors. Communicators use humor to convey messages in a lighthearted tone to help circumvent the negative effects of fear, guilt, and powerlessness (56). For instance, satirical news about current events (including climate change) on mass media platforms helped change engagement levels among viewers who may previously have had low interest in the subject, and it also lowered confirmation bias in news consumption (61). The use of satire in a theatrical (stage-play) format was also an effective way to increase public engagement in debates about climate change adaptation (62). The double-edged nature of humor and related types of entertainment means that they can both be an effective gateway for deeper conversations and also minimize the issues and cause them to be perceived as mere entertainment. Use of humor in entertainment formats must therefore be fine-tuned to achieve the intended changes among the audience (63, 64).

Construal level theory posits that when humans encounter psychological distance arising from temporal, spatial, or social location and hypotheticality, they construe the subject matter abstractly (65). For instance, a UK-based study (66) demonstrated the relationship between distance and intentions toward mitigative behavior change in reduction of energy use. They found that connecting a local issue to global climate change phenomena produces a broader perspective on the impact of the issue and reduces psychological distance. Psychological closeness can also yield similar results because respondents perceive that the issue has greater relevance to themselves.

The relationship between emotions and distance is complex, as certain emotions may arise in response to specific construal distances and are susceptible to influence by other personal traits (65, 67). Additionally, while there are reoccurring patterns in relationship between emotions and distance, these relations are not fixed. In a US-based survey on empathetic and objective perspectives, Swim & Bloodhart (68) found that long-distance feelings of hope and empathy, influenced by the person's own empathic conditions, made both environmentalists and nonenvironmentalists donate to environmental causes. Similarly, another study on compassion for climate change victims, and its relationship to mitigation policy, found that a long-distance message from a malnourished East African child evoked compassion, resulting in greater belief in anthropogenic causes of climate change and increasing policy support for politically conservative and moderate respondents (32).

Anxiety and fear are concrete, close-distance emotions that arise when individuals face an imminent threat or experience an immediate survival response (67). Studies have found that residents of areas afflicted by extreme weather, especially those who experienced personal harm regardless of their political beliefs, had higher support for mitigation policy (21). However, while direct personal harm motivates change, an imminent threat combined with efficacy seemed to have the opposite effect; in other words, when people feel that a threat is imminent, they feel hopeless and their mitigative intentions are discouraged because they feel less self-efficacy (67). Interestingly, anger,

a concrete emotion associated with close distance, can be generated at long distance. Research on public health framing of climate and emotion in the United States found that respondents reacted angrily to the government's lack of climate action when climate change was framed as a national security issue (69). This study also found that a public health framing engendered hope, which led to support for mitigation and adaptation measures (69).

Interpersonal Level

In our globalized and digitized world, individual experiences are influenced by interpersonal and communal constructs. Thus, the individual level should not be the only focus of studies on behavior change communication (70). Many studies have demonstrated that people's willingness to commit to change is influenced via interpersonal interactions.

Studies have illuminated the role that peer and normative influence can play in promoting trust and mitigative behavior. For instance, people are more willing to use ride-sharing when other people in their organization use it, and they will use digital food platforms or eco-friendly technologies that they learn about through word of mouth via peers and families (71). Interpersonal discussions among families and friends—that is, in social circles where individuals feel equal—about mitigative behavior changes, such as adoption of green technology, can create or shift norms and influence individuals' willingness to adopt these behavior changes (72). Interestingly, studies suggest that people are more likely to discuss energy consumption with close ties, such as family members, friends, and business colleagues, and less likely to discuss them with neighbors and wider social groups (73, 74).

Research on adolescent proenvironment behaviors and actions underscores that youths are influenced by their friends, teachers, and parents (75). Both the number of influencers and the nature of their relationship with the individual matter. Having more people in one's social circle who are committed to proenvironment behaviors helps normalize the culture. Parents are the most important influence on increasing adolescents' overall environmental engagement (75).

Thus, promoting widespread discussion in social networks with both strong and weak ties can strategically amplify interpersonal communication and positively shift norms and behaviors.

Community Level

Community-level action focuses on collective action at the community (local) level, rather than the national or international level, and can help empower people (63, 69). Individuals' participation and status within a community can lead to a feeling of having an interconnected identity, which, when combined with their personal identity, increases their sense of agency (76).

Like self-efficacy at the individual level, collective efficacy is a crucial component of behavior change, and the two are closely linked. Increasing the perception of a group member's ability to deal with climate change threat increases their feelings of self-efficacy and self-empowerment. When people perceive that their individual actions, such as ride-sharing, cycling, or monitoring their carbon footprint, are effective responses to issues beyond their personal capacity, it enhances their self-efficacy and contributes to collective efficacy, generating further proenvironment support and behavior (77).

Environmental organizations often employ top-down approaches in their interventions, which may cause them to miss out on local perspectives. Bottom-up, grassroots approaches that focus on generating public demand and acceptance of mitigation policies through reason, emotion, and politics are viable ways to enact social and behavior change (78). More empirical studies are required in order to understand how culturally nuanced critical thinking and education about sustainable lifestyles can guide carbon reduction and sustainable policies and community actions (79).

Social and Political Environment

With regard to the outermost ring of the social and behavior change model, we consider the role of social movements, advocacy, and the potential of digital technologies to inform shifts in knowledge, policies, and practices. For example, in a study of two environmental social movement organizations and their social media use, Mercea (80) found that these organizations use their online platforms for mobilization efforts such as influencing unaffiliated people, providing them with information, and mobilizing their attendance at events. However, this study also underscored that mobilization for high-risk protest events depended largely on offline socialization. Similarly, other studies of climate change advocacy organizations have demonstrated the effectiveness of their digital communication platforms (including websites) in helping to organize their members and using motivational framing to create awareness and garner media attention to underrepresented issues (81). Such digital strategies are also effective in influencing policy debates. Conversely, the broader political environment surrounding socioeconomic disparities, rights, freedom of speech, and other contextual factors can constrain online activism and reduce the effectiveness of social movement organizations' ability to leverage digital media to promote their cause (82).

A content review of US newspapers from 1985 to 2017 found that climate change became increasingly politicized and polarized over time, with political actors dominating the discourse and fewer mentions of scientists (83). This trend indicates that people are more likely to encounter biased climate change news. Online platforms and forums complicate the picture on news coverage and media consumption, in that online spheres and discussions of climate change are complex phenomena that cross borders. A review by Walter et al. (84) on echo chambers in comment sections of US, UK, German, Indian, and Swiss websites notes that positions on climate at the country level may not represent public opinion, as the Internet helps create microspheres for different communities, include communities of skeptics. Thus, climate advocates may need to study and engage with climate change skeptic sites when aiming to influence climate skeptics.

A key area of emergent research with respect to online communication is the spread of misinformation in various social and political contexts. For instance, the use of bots to spread misinformation (astroturfing) and the formation of coalitions of skeptics to "brigade" online comment sections in order to discredit information can act as a negative barrier to (or influence on) behavior change (25–27, 84). In other words, the use of online communication platforms, including social media sites, to shift individual and community behaviors requires a holistic approach to understanding the multiple layers and contexts in which such communications are embedded.

DISCUSSION

Using the socio-ecological model of social and behavior change communication, our review highlights current trends in understanding message design factors and media technologies that promote proenvironment and climate mitigative behavior. Much of this research has focused on the individual level, and relatively few studies have been conducted at the interpersonal and community levels. Far less attention has been paid to the interrelations between the contexts and significance of climate change communication interventions and campaign design. Such mesosystem (i.e., cross-level interactions and connections) studies are imperative for understanding the communicative connections between the different levels and complex communication ecologies and for developing holistic approaches to the promotion of sustained behavior shifts.

Media Technologies

Notwithstanding the recent trend of online/digital technologies toward videos and visual media, overall, research is increasingly emphasizing text-based online media such as news articles, blogs,

comments, and so forth (16, 25, 85), followed by audiovisual media such as television programs and online videos (61, 86, 87). Studies that expand on the use of innovative or unique types of media for climate change–related behavior change include those by Bore & Reid (62) on a stage play, Ouariachi et al. (53) on video games, and Gao & Tavoni (24) on the use of product advertisements to provide information to the consumer. Furthermore, as highlighted above, most studies of the effects of media focus on the individual level.

With respect to the changing communication ecosystem and the rapid expansion and adoption of social media platforms, research on the use of such platforms in behavior change communication has found that opportunities to influence positive behavior changes both at the individual level and within the macro social and political environment arise when advocates are able to frame and raise awareness on underrepresented environmental issues and generate participation and action from unaffiliated users (61, 80, 81, 88). Conversely, some studies have identified challenges in shifting behavior using social media, especially for individuals with entrenched (negative) climate change perceptions and opinions or strong skepticism (84, 85, 89–91).

Studies on social media and climate change research have focused on online discourse. Examples include research by Stier et al. (92) on how citizens, nongovernmental organizations, politicians, and traditional media frame climate change; Cargnino & Neubaum (91) on exposure to congruent and incongruent climate change opinions on social network platforms; and Treen et al. (22) on spheres and echo chambers of climate change discussions on Reddit and Twitter/X. Studies on factors that drive people to be vocal (or intend to be vocal) online include those by Masullo et al. (93) on emotions and the spiral of silence in climate change discussions and Walter et al. (84) on what causes skeptics and supporters alike to post in website comment sections. Studies focusing on skeptics and misinformation include those by Yuan et al. (94) on the spread of climate denial tweets, Kaiser (26) on climate denier brigading efforts in news article comments, Elgesem et al. (95) on engagement between climate accepters and skeptics, and Matthews (28) on the backgrounds of climate change deniers who comment on blogs. Platform-specific studies include those by Newell & Dale (96) on climate change topics and content types on Facebook and YouTube in relation to engagement and Shapiro & Park (97) on hierarchies among supporter and skeptic commenters on YouTube.

The link between online discourse and offline behavior change, particularly how social network platforms and their affordances can be leveraged to promote climate supportive behavior interventions, remains a comparatively underresearched area. Future research could aim to engage in behavior change intervention using social media; specifically, communication campaign designers could investigate message and campaign design and the link between shifting online discourses and lasting normative and behavior change effects. Research on the nexus between climate behavior change communication and social media platforms on the one hand and their rapidly changing environments and use behaviors on the other remains a fruitful area for further exploration.

Behavior Domains

Behavior change interventions range across adaptive and mitigative behaviors; more studies have understandably focused on mitigation-related behaviors. Adaptation-related behaviors typically involve extreme weather event and disaster preparedness (23, 58, 59). Mitigative behaviors vary widely, and a range of such behaviors have been investigated. For example, energy use behaviors include conserving energy (98), turning off lights (67), not turning on the heater too high during winter (99), purchasing light-emitting diodes for efficient energy consumption (24), and reducing offshore drilling (21). Investigations of mitigative behavioral intentions include those on energy reduction (66), reduction in energy consumption (44), and intentions to adopt energy-saving

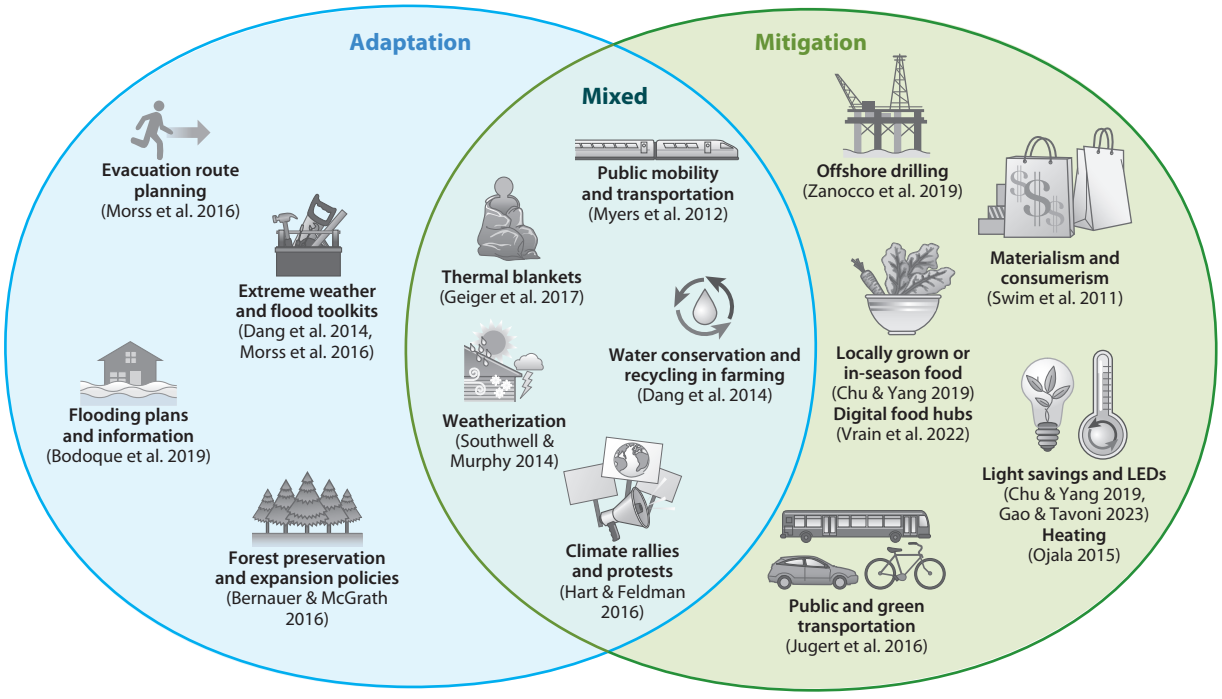

Figure 2

Examples of the varied research topics covered by behavior change communication studies in relation to climate action. The Venn diagram shows exemplars of different topics addressed by behavior change communication research studies and interventions in relation to climate action. Illustrative studies are noted via the citations. The blue circle contains examples of behavior change studies related to climate adaptation. The green circle contains examples of studies focused on mitigation action. The overlap in the middle contains examples of studies with both mitigation and action aspects. Note that this is not an exhaustive list; it is meant to be illustrative of the range of topics covered across studies.

practices such as energy-sharing services (74). Transportation- and mobility-based behavior shifts include carpooling and use of public transportation (44, 67, 75, 77), ride-sharing (71, 77), and carbon emissions monitoring (77). Dietary behavior change is another area of investigation, including studies on the promotion of locally grown or in-season food (67) and the use of digital food hubs (71). Other investigators have looked at broader domains of climate change information seeking (100) in relation to mitigative behavior and the promotion of cultural values and norms related to consumption, hedonism, and materialism in relation to willingness to mitigate (30). Many studies target a combination of adaptive and mitigative behaviors, especially in relation to advocacy or policy support and voting behavior (34, 42, 57, 70, 71). **Figure 2** depicts examples of the domains covered by behavior change communication studies in relation to climate action.

Given the complexity of designing interventions, most studies are primarily cross-sectional, with few longitudinal examples. Some behaviors are easier to change than others, and some changes are longer lasting than others. Environmental communication studies need to continue to explore ways in which campaign and message design factors can influence long-term versus short-term behavior change. Without long-term behavior change, climate goals are unattainable. Thus, there remains a need to explicate long-term shifts and impacts of behavior change interventions and track behaviors over time. Such behavioral data, including changes over time, are relevant for

cross-disciplinary research and for developing indicators and measures as well as modeling the impact of behavior change and how it can help achieve climate goals.

Plurality of Contexts and Populations

The last research gap that we argue needs to be addressed involves the need for more contextual studies based in diverse locations and populations. Most studies are conducted in the Global North, specifically, the United States. From a socio-ecological perspective, this limitation skews our understanding of communication strategies and relevant insights for different communities and cultures, as some groups are overrepresented and their sociopolitical context may not be applicable elsewhere. For example, the politicization of climate change and certain populations' distrust of the government affect climate policy support in those contexts (42), but in other countries, citizens' higher level of trust in the authorities imparts a feeling of greater collective efficacy with relation to governmental and climate action (94), and in still other countries, people face difficulties in promoting and practicing climate behavior changes as a result of political constraints. In addition, we need a more nuanced and sustained focus on socioeconomically vulnerable populations, especially given the variable impact of climate change.

Most studies have focused on college-age and college-going students and/or middle-income individuals. We need further research incorporating gender, race, ethnicity, and indigeneity—an intersectional lens—to help us understand the nuanced ways in which historical and structural marginalization may create disparities, as well as the role that communication interventions can play in reducing these disparities in the climate context (101, 102) to address sustainable, equitable, and just social change. In summary, this review has underscored the need to expand research on behavior change communication and climate mitigative and/or adaptive behavior across disparate populations to find what frames, information, and message attributes can have a positive impact in different sociopolitical and technological contexts.

SUMMARY POINTS

1. Using the socio-ecological model for social and behavior change communication, our review highlights that proenvironment and climate mitigative behavior change research has focused primarily on the individual level and less on the interpersonal and community levels.
2. Thematically, at the individual level, three factors—knowledge; beliefs, values, and attitudes; and emotion—have been the focus of research on behavior change and on how these factors drive action and inaction.
3. Behavior change interventions have been applied to both climate adaptive and climate mitigative behavior, with more focusing on mitigation-related behavior.
4. With regard to online and digital technologies, research continues to emphasize text-based online media such as news articles, blogs, and comments, with less of a focus on audiovisual media such as television programs, online videos, and games.
5. The link between online discourse and offline behavior changes, particularly how social network platforms and their affordances can be leveraged to promote climate supportive behavior interventions, remains a comparatively underresearched area.
6. Most studies are still conducted in the Global North, specifically in the United States. Within a socio-ecological approach, this narrow focus skews our understanding of

communication strategies and relevant insights for different communities and cultures, as certain groups and sociopolitical contexts are overrepresented and the findings from these studies may not be applicable elsewhere.

FUTURE ISSUES

1. Research on mesosystem studies (cross-level interactions and connections) is imperative for understanding the communicative connections among the individual, interpersonal, and community levels and complex communication ecologies, as well as for guiding holistic strategies to promote sustained behavior shifts.
2. Research on communication about climate behavior changes and social media platforms, and their rapidly changing environments and use behaviors, remains a fruitful area for further exploration. Such studies can provide further insights into the links between shifting online discourses and lasting normative and behavior change effects.
3. Environmental communication studies need to continue to explore ways in which campaign and message design factors can influence long-term versus short-term behavior change. There remains a need to both explicate the long-term shifts and impacts of behavior change interventions and track behaviors over time.
4. Further research is needed incorporating gender, race, ethnicity, and indigeneity—an intersectional lens—to help us understand the nuanced ways in which historical and structural marginalization may create disparities, as well as the role that communication interventions can play in reducing those disparities in the climate context to address sustainable, equitable, and just social change.
5. More contextual studies conducted in diverse locations and populations are needed to identify the frames, information, and message attributes that can have a positive impact in different sociopolitical and technological contexts.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

AUTHOR CONTRIBUTIONS

J.S.C. led the conceptualization, data analysis, and drafting of the review. S.T. managed the collaboration and contributed to the data gathering and analysis and the drafting of the review. S.S. contributed to the data gathering and analysis and the drafting of the review.

ACKNOWLEDGMENTS

The authors acknowledge the invaluable role of their colleagues at the SMARTS Center of the Asian Institute of Technology for providing all kinds of support—academic, infrastructural, intellectual, and above all financial under the EDIT-AIT project. The EDIT-AIT project received funding from the Energy Demand Changes Induced by Technological and Social Innovations (EDITS) project, which is part of the global initiative coordinated by the Research Institute of

Innovative Technology for the Earth and the International Institute for Applied Systems Analysis (and funded by the Ministry of Economy, Trade and Industry of Japan).

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