
Psychology's Contributions to Understanding and Addressing Global Climate Change

Janet K. Swim
Paul C. Stern
Thomas J. Doherty

Susan Clayton
Joseph P. Reser
Elke U. Weber
Robert Gifford
George S. Howard

*Pennsylvania State University
National Research Council
Lewis & Clark Graduate School of Education and
Counseling
College of Wooster
Griffith University
Columbia University
University of Victoria
University of Notre Dame*

Global climate change poses one of the greatest challenges facing humanity in this century. This article, which introduces the American Psychologist special issue on global climate change, follows from the report of the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change. In this article, we place psychological dimensions of climate change within the broader context of human dimensions of climate change by addressing (a) human causes of, consequences of, and responses (adaptation and mitigation) to climate change and (b) the links between these aspects of climate change and cognitive, affective, motivational, interpersonal, and organizational responses and processes. Characteristics of psychology that cross content domains and that make the field well suited for providing an understanding of climate change and addressing its challenges are highlighted. We also consider ethical imperatives for psychologists' involvement and provide suggestions for ways to increase psychologists' contribution to the science of climate change.

Keywords: climate change, interdisciplinary research, human–environment relations, sustainability, psychological dimensions

Global climate change poses one of the greatest challenges facing humanity in this century. Earth's climate has changed in many ways over geological time, but for the first time, over the past century, human activity has become a significant cause of climate change. By burning fossil fuels, cutting and burning forests, and engaging in other environment-impacting activities, humans have changed the heat balance of Earth sufficiently that the global average temperature has moved outside the range that has characterized the 10,000 years of recorded human history (Intergovernmental Panel on Climate Change, 2007a). This climate change “poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems” (National Research Council, 2010a, p. 2). Because of physical time lags

in the climate system, the impacts and human consequences of climate change will continue for many decades and, in some cases, many centuries (Solomon, Plattner, Knutti, & Friedlingstein, 2009). Moreover, climate change will take place in the context of the other sweeping social, technological, and ecological transitions of the 21st century (e.g., increases in population, urbanization, and disparities in wealth; Stokols, Misra, Runnerstrom & Hipp, 2009), making confident anticipation of its effects especially problematic. The current state of scientific knowledge on the causes and consequences of climate change is summarized in two recent major studies (Karl, Melillo, & Peterson, 2009; National Research Council, 2010a).

Climate change is sometimes equated with global warming, but it involves much more than temperature change. The human activities that cause temperature change set in motion a series of associated phenomena: sea level rise, loss of polar sea ice, melting of continental glaciers, changes in precipitation patterns, progressive shifting in the habitats of species and the boundaries of ecosystems, acidification of the oceans, and more (Intergovernmental Panel on Climate Change, 2007a, 2007b; National Research Council, 2010b). These changes and impacts in turn create increasing risks to the planet's life

Janet K. Swim, Department of Psychology, Pennsylvania State University; Paul C. Stern, Committee on the Human Dimensions of Global Change, Division of Behavioral and Social Sciences and Education, National Research Council, Washington, DC; Thomas J. Doherty, Department of Counseling Psychology, Lewis & Clark Graduate School of Education and Counseling; Susan Clayton, Department of Psychology, College of Wooster; Joseph P. Reser, School of Psychology, Griffith University, Gold Coast Campus, Queensland, Australia; Elke U. Weber, Department of Psychology and Center for Research on Environmental Decisions, Graduate School of Business, Columbia University; Robert Gifford, Department of Psychology, University of Victoria, Victoria, British Columbia, Canada; George S. Howard, Department of Psychology, University of Notre Dame.

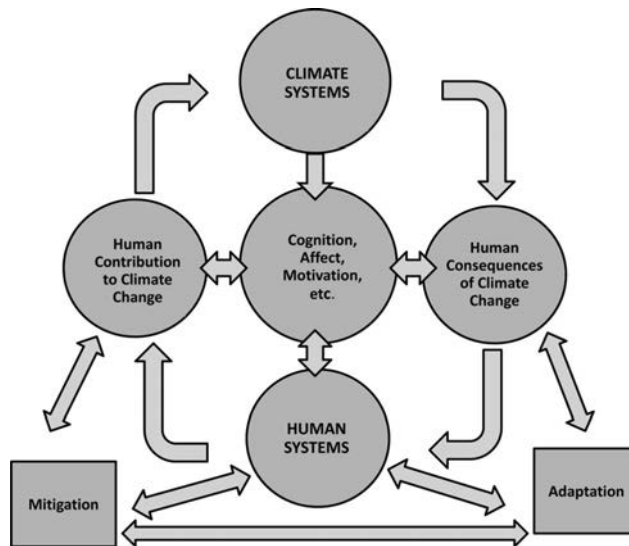
Correspondence concerning this article should be addressed to Janet K. Swim, Department of Psychology, Pennsylvania State University, 515 Moore Building, University Park, PA 16802-3106. E-mail: jks4@psu.edu

support systems and to a myriad of species, including humankind.

The natural sciences have long been engaged in studying environmental systems, including the physical and chemical processes that change Earth's heat balance, the ways in which these processes affect other parts of the global climate system, and the consequences of all these changes for physical and biological processes on land and in the waters. However, a second science of climate change has been developing for over a quarter of a century: the science of the "human dimensions" of climate change (Chen, Boulding, & Schneider 1983; National Research Council, 1992; Stern, 1993). This field of science seeks to understand human activities that affect climate change, consequences of climate change that directly and indirectly affect people, human responses to anticipated and experienced climate change, and ways to help people respond effectively. Psychological dimensions are integral to human dimensions of climate change and have been a part of broader efforts by psychologists, perhaps most noticeably environmental psychologists, over the course of several decades to understand and address a range of environmental changes and problems (e.g., Gardner & Stern, 2002; Koger & Winter, 2010; Nickerson, 2003; Schmuck & Schultz, 2002; Swim, Markowitz, & Bloodhart, in press). A summary of relevant psychological research was provided in the report of the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change (2009). The articles in this special issue follow from this task force report. The present article provides an overview of these articles, a model that integrates this literature with the broader literature on human dimensions of climate change, and some general suggestions for psychologists who wish to contribute in this area.

A simple conceptual model distinguishes climate systems (which are part of environmental systems) from human systems and delineates the connections among them (see Figure 1). As noted on the left-hand side of the figure, people affect climate through activities (e.g., burning fossil fuels, clearing forests) that directly alter environmental conditions that change the climate. These activities, which have been called proximate human causes of climate change, are a result of a full range of cultural, economic, political, and social conditions and processes, depicted as "human systems" in the figure, and of psychological considerations noted in the middle of the figure, which include human understanding of climate change, affective responses to climate change, and psychological motivations. Psychological considerations are often and appropriately treated as part of human systems. We separate them here to highlight them for a psychological audience. As depicted on the right-hand side of the figure, climate systems affect people through events that directly alter essential aspects of the environment that support humans and other living things, for example, by changing the frequency of storms and droughts, the availability of water, the viability of food crops, and the incidence of disease. Human consequences are also both psychological (e.g., distress) and social (e.g., intergroup relations) and are influenced by intra-individual

Figure 1
Human and Psychological Dimensions of Climate Change



Note. Adapted from Figure 4-1 (p. 106) in *Global Environmental Change: Understanding the Human Dimensions* (by National Research Council, 1992, Washington, DC: National Academy of Sciences. Copyright 1992 by National Academy of Sciences.) and Figure 1 (p. 273) in "Psychological Dimensions of Global Environmental Change" (by P. C. Stern, 1992, *Annual Review of Psychology*, 43, 269–302. Copyright 1992 by Annual Reviews, Inc.).

cognitive, affective, and motivational processes as well as human systems at a larger scale. Responses to anticipated and experienced climate change are mitigation and adaptation, as depicted in the bottom left and right corners of the figure. Efforts to mitigate or limit climate change are aimed at directly or indirectly altering the proximate causes of climate change. Adapting to climate change includes addressing the psychological and social impacts of both the threat and the unfolding consequences of climate change. Cognitive, affective, and motivational processes affect mitigation and adaptation via the influence of psychological processes on human contributions, systems, and consequences. The direct and indirect impacts of these psychological processes on many of the elements shown in the figure illustrate that human dimensions of climate change are inherently psychological and social and that psychology can offer knowledge and concepts that can help explain the human understanding, causes, and consequences of climate change as well as inform responses to it and help make them more effective.

What Does Psychology Have to Offer?

Over the past three decades, a number of research agendas have been developed for the human dimensions of global change, including climate change (e.g., Chen et al., 1983; Kates, Ausubel, & Berberian, 1985; National Research

Council, 1992, 1999). Many efforts, including that of the American Psychological Association's task force on climate change, have focused on the possible contributions of psychology (e.g., American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change, 2009; Center for Research on Environmental Decisions, 2009; Clayton & Brook, 2005; Clayton & Myers, 2009; Cvetkovich & Werner, 1994; Fischhoff & Furby, 1983; Gifford, 2008; Kazdin, 2009; Sjöberg, 1989; Spence, Pidgeon, & Uzzell, 2009; Stern, 1992; Uzzell & Rätzl, 2009; Vlek & Steg, 2007). Environmental psychology provides the most obvious input. Gifford (2007) described several themes in environmental psychology that have emerged over the last 50 years that are relevant to climate change: (a) an interest in informing and aiding public policy; (b) attention to technology both as a contributor to environmental problems and as a means to improve sustainability; (c) a tendency to value and benefit from multidisciplinary collaborations and theories from other fields; and (d) expansion of interest to include multiple levels of analysis from small-scale studies of individuals and small groups to larger scale issues of sustainability. Yet, as past reviews have indicated, many other subfields, such as cognitive, human factors, social, community, clinical, and counseling psychology, to name a few, have also provided valuable insights. Drawing on research from environmental psychology and other subfields, we elaborate on the model illustrated in Figure 1 by describing ways that psychological research has contributed to the understanding and addressing of (a) human contributions to climate change, (b) psychological and interpersonal consequences of climate change, (c) mitigation and adaptation responses to climate change, and (d) human cognitive, affective, and motivational responses to climate change. Then we consider some overarching characteristics of psychological research and practice that are common to these four specific topical contributions.

First, psychology can help describe and explain the human causes of climate change. Climate change is a quintessential commons problem: It involves collective action driven by individuals' short-term benefits that degrades a long-term common good (National Research Council, 2002; for reviews of the psychological literature, see Gifford, 2008, and Kopelman, Weber, & Messick, 2002). Human behavioral contributions to climate change occur through the use of goods and services that directly and indirectly result in fossil fuel consumption and the other biophysical changes that alter the climate. These activities, sometimes referred to as environmental consumption (Stern, 1997), are linked to consumer spending (economic consumption), although the two are not the same. As Swim, Clayton, and Howard (2011, this issue) and Stern (2011, this issue) show, psychologists can help us conceptualize and better understand the predictors of environmental and economic consumption by providing psychological analyses of types of consumption behaviors and directing attention to behaviors that contribute the most to climate-driving emissions.

Implicit and explicit individual consumption decisions provide a critical link between contextual influences on decisions and the proximate behavioral causes of climate change (Swim et al., 2011). Individual-level predictors of consumption decisions include personal capabilities (e.g., income, skills), motivations (e.g., connection to nature, perceptions of needs vs. luxuries, basic psychological needs), and core values and beliefs. By attending to a variety of individual predictors, researchers can help explain instances in which individual and household behavior does not follow simple models of economic benefit maximization, such as when individuals and households fail to make energy-saving investments that would yield individual benefits at no cost or very attractive rates of financial return (Creyts, Granade, & Ostrowski, 2010; Stern, 1986). In addition, individual decisions are influenced by and operate through the immediate and distal physical and social contexts in which they are embedded (Bin & Dowlatabadi, 2005; Black, Stern, & Elworth, 1985; Gifford, 2006). Contextual-level predictors include aspects of the physical infrastructure (e.g., the structure of human settlements, which influence the demand for motorized travel), available technology (e.g., machines that enable more rapid harvesting of resources such as trees and fish), geophysical events (e.g., drought, disasters, and storms), interpersonal contexts (e.g., social and cultural norms and comparisons), and cultural, economic, and political conditions (e.g., consumerism, a culture's orientation toward time and nature, energy prices, government policies). By attending to the interface between individual decisions and contextual predictors, psychologists can potentially help explain behavior in situations where individual behaviors appear constrained by their cultural contexts and also when households actively attempt to overcome these contexts, such as when they join counterconsumer movements (Bekin, Carrigan, & Szmigin, 2005; Craig-Lees & Hill, 2002).

Second, psychology can help describe and explain the human consequences of climate change. These consequences obviously include biological impacts and hazards to physical health and to human settlements (Intergovernmental Panel on Climate Change, 2007b; World Health Organization, 2010). As Doherty and Clayton (2011, this issue) note, they may also include direct and indirect psychological and interpersonal impacts. Although all of these potential impacts cannot be described with certainty and full clarity, the cumulative and interacting psychosocial effects of climate change may well be profound. Heat, extreme weather events, and increased competition for scarce environmental resources, compounded by preexisting inequalities and disproportionate impacts among groups and nations, affect interpersonal and intergroup behavior and can result in increasing stress and anxiety. Even in the absence of direct impacts, anticipation and concern about the threat of climate change may erode quality of life and threaten mental health. Individual and contextual features can influence the extent to which individuals and communities experience different impacts. Those who have the fewest social and economic resources are likely to be the most vulnerable to physical and psy-

chological impacts. It may also be useful to attend to possible positive consequences, such as people taking collective responsibility for solving a shared problem, that may aid individual coping and community responses.

Third, psychology can help describe, explain, and also inform our responses to climate change. The consequences of climate change both affect and are affected by the ways that individuals and communities adapt. Adaptation extends beyond making physical and structural adjustments to environmental changes. As Reser and Swim (2011, this issue) note, adaptation also includes a range of coping actions that individuals and communities may take, as well as psychological processes (e.g., threat and response appraisals, emotion management, and cognitive reframing responses) that both precede and follow behavioral responses. Adapting to, and coping with, climate change is dynamic; it involves many intrapsychic processes that influence reactions to (and preparations for) adverse impacts of climate change, including chronic environmental conditions and extreme events. Some relevant psychological processes include sense-making; causal and responsibility attributions for adverse climate change impacts; appraisals of impacts, resources, and possible coping responses; affective responses; and motivational processes related to needs for security, stability, coherence, and control. These processes are influenced by media representations of climate change and by formal and informal social discourse that involves social construction, representation, amplification, and attenuation of climate change risk and its impacts. These processes reflect and motivate both intrapsychic responses (e.g., emotion management, cognitive adaptation, problem solving) and individual and community responses. Individual and cultural variation influence all aspects of the process, providing context, worldviews, values, concerns, resilience, and vulnerability (Bloodhart & Swim, 2010; Heath & Gifford, 2006; Weber, 2010).

Psychologists are well positioned to design, implement, and assess interventions to ameliorate psychosocial impacts of climate change (see Doherty & Clayton, 2011). Climate change will be accompanied by and itself epitomizes both natural and technological disasters of unprecedented consequence, and climate change has been framed as a truly *global disaster* and profound challenge for humanity (e.g. Spratt & Sutton, 2008). It is important to acknowledge that some of the possible disasters associated with global climate change are not under conventional national jurisdiction and that responses to them may not be covered by conventional agencies, policies, or procedures. However, much of the existing and extensive body of psychological, social, and health science research and practice on mitigation, preparedness, response, and recovery in the context of natural and technological disasters can still be applied and utilized (Elrod, Hamblen, & Norris, 2006; Haskett, Scott, Nears, & Grimmer, 2008; Reyes & Jacobs, 2006). The disaster research literature, with its transdisciplinary orientation, has developed methodologies, measures, and many models and tools particularly apposite to the domain of psychology and climate change (e.g., Stokols et al., 2009). Psychological research in other areas, such as

intergroup relations and processes, and perceived equity and procedural justice, may be useful when addressing conflicts that may emerge over environmental justice issues or among social groups as an indirect result of climate change and when developing and framing policy responses to climate change (Clayton & Brook, 2005; Spence et al., 2009; Swim & Clayton, 2010).

Psychology can also make important contributions by informing efforts to mitigate or limit climate change, although, as with other responses to climate change, responses are influenced by both individual and contextual factors. Much policy attention has been given to structural barriers to behavioral change, but Gifford (2011, this issue) argues that removing these barriers is not likely to be sufficient because of other resistances to change. Some of these may relate to a lack of understanding of climate change, whereas others relate to habitual behavioral patterns, bounded rationality, affective processes, personal and social motivations, and interpersonal processes (Gifford, 2011; Shogren, Parkhurst, & Banerjee, 2010; Weber & Stern, 2011, this issue). For instance, a few of the many psychological and social barriers include hyperbolic discounting, which gives current outcomes more weight than temporally distant outcomes even when the latter are of greater value; reactance against policies perceived to reduce individual control; and perceived social norms that encourage energy use.

Yet, as Stern (2011) notes, psychologists have helped to design interventions to encourage actions that limit human contributions to climate change at individual, organizational, cultural, and policy levels and have broadened our understanding of why people do or do not respond to different types of interventions. Psychologists also provide and apply behavioral models that describe human and household behavioral contributions and have helped design effective interventions and evaluations to further develop and improve them. Some of these interventions provide people with better information so they know which actions have beneficial outcomes for themselves and for climate mitigation and adaptation. Psychologists design and test systems that make certain environmental choices more noticeable (e.g., energy-use feedback) or attractive (e.g., financial incentives that lower initial costs of energy-efficient equipment or move the financial benefits of the equipment temporally closer) or that make environmentally beneficial actions more convenient, combining economic and noneconomic inducements to action in highly effective ways (Vandenbergh, Stern, Gardner, Dietz, & Gilligan, 2010). Psychologists also suggest strategies for engaging values that encourage contributions to the public good beyond those in an individual's self-interest. They help design informative messages and engage informal networks (e.g., in communities, on the Internet) that promote and activate social norms for participating in collective efforts to limit greenhouse gas emissions. They are beginning to examine behavioral factors in organizations that enable or inhibit reductions in organizations' contributions to climate change. Finally, they can help design and adapt formal and informal institutions at local to global levels

that will provide assurance to individual contributors that others will also contribute, thereby promoting coordinated and equitable responses. Not only do psychologists help improve public understanding of climate change and help inform personal and societal choices about proposed technological solutions, they also address (a) how public understanding of the nature and impacts of climate change differs in important ways from scientific accounts of climate change (Weber & Stern, 2011) and (b) how such individual and societal understandings also serve important psychological and cultural needs, with important implications for adaptation and behavior change (e.g., Reser, in press).

Fourth, psychology can make further important contributions to the understanding of how people think and feel about climate change, which in turn influences their motivations and behavioral responses to perceived and objective causes and consequences of climate change. As Gifford (2011) notes, individuals perceive climate change differently depending on their awareness of the problem, their knowledge and certainty of the facts, and their trust in experts, among other barriers. Furthermore, as Reser and Swim (2011) and Doherty and Clayton (2011, this issue) note, the threat and unfolding impacts of climate change may be experienced directly or indirectly. Direct encounters can range from the experience and distress of chronic stressors, such as drought and landscape change, to acute and cataclysmic weather events such as hurricanes, heat waves, and floods. Indirect experiences result from continuous exposure to multimedia coverage and representations, educational sources, and interpersonal interactions and exchange. Social constructions and representations of climate change can both reflect and influence sense-making and whether or not events are attributed to climate change. Weber and Stern (2011) show that gaining a scientifically appropriate understanding of climate change is difficult because of (a) the difficulties inherent in understanding the physical phenomena involved and the state of relevant scientific knowledge; (b) psychological tendencies to rely on personal experience and simple mental models (both of which are often misleading; see also Gifford, 2011); and (c) a well-organized and ideologically motivated campaign to promote models of climate change that are at substantial variance with scientific evidence and the broad scientific consensus.

Aside from psychological contributions related to elements of the model illustrated in Figure 1, there are a number of characteristics of psychology as a discipline that make it useful, if not crucial, for adequately addressing global climate change and its impacts. The most obvious contributions of psychology are at the individual level, where, as noted above, it can provide both a theoretical and an empirical understanding of human causes of climate change, public risk perceptions and understandings of climate change, experienced impacts of climate change, and human responses to climate change. This individual level of analysis also illustrates links between psychologically and environmentally significant behaviors and between adaptation and mitigation. For instance, individual efforts at

mitigation may also increase psychological adaptation to climate change.

Psychologists also examine individuals within natural and constructed physical and social contexts. Interpersonal, social-structural, and technological contexts affect behaviors that have important impacts on environmental systems (Clayton & Brook, 2005; Gardner & Stern, 2002; Wapner & Demick, 2002). Attention to transactions and relationships between individuals and their natural and human-designed environments has long been a defining feature of environmental psychology (Gifford, 2007). Investigations at the intersection of psychology and the natural sciences, health sciences, humanities, and other social sciences can be particularly useful for addressing global climate change (Kazdin, 2009).

Psychologists have also uncovered individual, interpersonal, and social forces capable of explaining and changing human behavior in ways that others may fail to consider. Although people are, for the most part, able to articulate their opinions, beliefs, and preferences accurately, they are notoriously poor at recognizing the causes of their behavior (Li, Johnson, & Zaval, 2010; Nisbett & Wilson, 1977). This finding has been well demonstrated, for example, with regard to the consumption of energy (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Behavioral investigations that employ experimental methodologies can identify psychological determinants of trade-offs and choices made by people (Hardisty, Johnson, & Weber, 2010; Weber et al., 2007) that collectively influence human contributions to climate change, including energy-consuming behaviors. These psychological determinants can be utilized in communication campaigns or in the design of decision environments to encourage people to reduce their energy consumption and to prevent such campaigns from being ineffective or, worse, inadvertently discouraging behavior change (e.g., Center for Research on Environmental Decisions, 2009). Psychological methodologies and measures can also aid in ongoing monitoring of behavioral changes, psychological impacts, and psychological processes that might otherwise be overlooked and that influence individuals' and communities' willingness and capacity to engage with adaptive change and the nature and forms of adaptations they select.

Why Should Psychology Help Address Climate Change?

Psychologists should help, first of all, because we can. On the basis of past research efforts and the knowledge base in the discipline, we believe that further efforts to improve understanding of the psychological processes related to climate change and effective incorporation and utilization of psychological knowledge in collaborative research and policy initiatives can help humanity effectively mitigate and adapt to climate change.

Second, the magnitude and potential irreversibility of global climate change and its likely psychological impacts and effects on quality of life and the environment prompt a consideration of ethical imperatives for psychologists' in-

volvement. Climate change has the potential to have significant negative effects on global mental health, and these effects will likely be unevenly distributed (Costello et al., 2009; Fritze, Blashki, Burke, & Wiseman, 2008; Page & Howard, 2009). In the near term, climate change probably will have a disproportionately direct impact on those less economically privileged or with lower social status (Agyeman, Bullard, & Evans, 2003; McMichael, Friel, Nyong, & Corvalan, 2008), and as with other environmental health issues (Bullard & Johnson, 2000), social justice implications will demand consideration (e.g., Brown et al., 2006). Poverty, reduced individual preparedness, and lack of access to community-level resources for disaster relief are central to vulnerability to environmental risks (Brouwer, Akter, Bander, & Haque, 2007). Natural disasters expose the inadequacies of mental health systems at the moment those systems are most needed (Sontag, 2010). Provision of mental health services in many low- and middle-income countries is already inadequate (Jacob et al., 2007; Page & Howard, 2010), and improvement in these services is challenged by economic crises and environmental disasters.

The American Psychological Association's (APA's) Ethics Code (APA, 2010), mission statement (APA, 2008), and vision statement (APA, 2009) have direct implications in these local and global climate change contexts. They all indicate that psychologists are committed to creating, communicating, and applying psychological knowledge in order to benefit individuals and society and facilitate the resolution of global challenges. Because global climate change presents both direct and indirect threats to individual and community mental health, climate change can be considered an appropriate arena of ethical obligation for psychologists (Doherty & Clayton, 2011). As with other social issues on which psychologists have taken a stand (e.g., poverty, discrimination), climate change is an extremely consequential concern because it can harm psychological functioning, interpersonal and community relations, and human and nonhuman life and because changes in thinking, motivation, and behavior are required for successful climate change mitigation and adaptation. APA's ethical principles provide a basis for addressing social justice issues, such as disparities inherent in climate change impacts and threats to the rights and welfare of persons who or communities which may be most vulnerable to climate change impacts (APA, 2007, 2010). Increased efforts to highlight, study, and address the psychological impacts of climate change do not pose obvious counter risks (Hansen, von Krauss, & Tickner, 2008). Indeed, awareness of psychological impacts may promote engagement in the issue and subsequent behavioral change.

APA ethical principles and standards also stress that psychologists must exercise reasonable judgment and recognize the boundaries of their competence (APA, 2010). This recognition is essential for dealing with novel and complex interdisciplinary issues such as global climate change. The ethical standards also state that, in emerging areas in which recognized standards for training do not yet exist, psychologists should take reasonable steps to ensure

the competence of their work and to protect those they work with and others from harm (APA, 2010). This also means that work needs to be done to broaden our competencies in the domain of climate change and to continually develop new competencies as our understanding and the impacts of climate change unfold.

How Can Psychologists Increase Their Contribution to the Science of Climate Change?

Psychologists can be dramatically more effective if they relate and connect psychological work to constructs and perspectives developed in the broader climate research community and collaborate with scientists from other fields. Although psychologists have been investigating climate change and related subjects for decades and the discipline has a unique perspective and body of knowledge to contribute, the value of psychological contributions is not yet widely accepted, nor are psychological insights and findings widely applied. The following principles can help maximize the value and use of psychological concepts, research, and perspectives for understanding the causes and impacts of climate change and for informing effective responses to climate change:

1. Become Conversant With Language and Research Used in Other Social, Engineering, and Natural Science Fields That Address Climate Change.

Anthropogenic climate change is an interdisciplinary issue with an emerging interdisciplinary vocabulary and language. Scientists from many disciplines readily understand human interactions with climate change in terms of human contributions or drivers, impacts or consequences, and responses. However, some terms have particular meanings or connotations in certain disciplines or discourses. Being aware of the language and concepts used by others and using them when appropriate can aid communication. Differences between fields in the usage of certain terms and constructs may also reveal fundamental differences in perspective. When use of the language of one field might result in confusion or a loss of meaning or clarity for a cross-disciplinary audience, it is important to be explicit about differences in usage. *Adaptation*, for example, has varying usages across disciplines that reflect differing favored levels of analysis and different conceptualizations of human responses. Clarifying such differences is one way psychologists can help improve overall understanding of climate change, communication between disciplines, and our own approaches to climate change.

Research from other fields can be important for interpreting the meaning or relevance of psychological variables, because their effects sometimes depend on factors and parameters that are more thoroughly understood in other fields. The reverse is also true. For example, the effectiveness of financial incentives for household energy efficiency depends on how people understand the available information and on the level of behavioral effort needed to

take advantage of the incentive (Stern, 1986). Conversely, the effectiveness of information and persuasion depends on the economic incentives surrounding the behavior. A thorough understanding of the potential of psychological contributions to research on and responses to climate change should be informed by knowledge from other social sciences, such as anthropology, geography, sociology, political science, communications, and economics, as well as knowledge from engineering, business, and other fields. For example, individuals' understandings of climate change are affected by the psychological processes that influence seeking out and making sense of information as well as the activities of social movements and the judgments and decisions of journalists, editors, and corporate media organizations. Thus, individual understandings of climate change are best understood by combining insights from psychology, sociology, communications, and other social science fields (Weber & Stern, 2011). This injunction to be interdisciplinary applies, of course, to both psychologists and nonpsychologists.

2. Attend to Psychological Contributions That Address Issues Recognized as Important to Climate Science.

Psychologists must prioritize issues and behaviors recognized as important in terms of climate change causes, consequences, or responses. For example, in developing and describing psychological contributions to efforts to mitigate climate change, greater emphasis should be placed on changes that have large potential effects on emissions (e.g., using more fuel-efficient means of transportation) than on changes that have smaller potential effects in terms of their technical potential (e.g., recycling household waste) and behavioral plasticity (e.g., traveling by carpool) (see Stern, 2011). The general public is not always aware of such differences in effectiveness (Attari, DeKay, Davidson, & Bruine de Bruin, 2010). If findings about lower impact behaviors are deemed important, that importance should be described in terms of the implications for climate change overall, perhaps by making the case that a principle established in studies of low-impact behaviors is generalizable to higher impact behaviors. Similarly, when studying psychological consequences of climate change, psychologists should be prepared to indicate the broader importance and relevance of these consequences. For instance, the importance of affective or "risk-as-feelings" responses (Loewenstein, Weber, Hsee, & Welch, 2001) may need to be explained to nonpsychologists. Such an explanation could potentially be made in terms of how affective responses influence risk perceptions and subsequent willingness to change behaviors or support policies; how debilitating mental health outcomes influence preparation for, or responses to, the climate change impacts; or how the magnitude of these outcomes compares with the magnitude of other social phenomena (Ferguson & Branscombe, 2010; Fritze et al., 2008; Weber & Stern, 2011).

In psychological research, findings typically are presented in terms of statistical significance, effect size, proportion of people whose behavior changed (behavioral

plasticity), or amount of behavioral change measured as frequency or duration. However, what matters in the context of global climate change is the impact of causes or effects in environmental terms. For example, a good indicator of the impact of psychological variables in understanding human contributions to climate change is the amount of greenhouse gas emissions those variables can explain. The impact (I) of a behavioral change on climate change depends on the combined effects of the number of individuals (n) who might change their behavior, multiplied by the technical potential (t) of the behavior to alter emissions and the plasticity (p) of the behavior (the $I = tpn$ equation, see Stern, 2011). This is not to diminish the psychological significance and multiple benefits of taking personally meaningful actions in the context of climate change, and indeed such psychological significance mediates and enhances environmental significance. To demonstrate the importance of psychological variables for understanding the human consequences of climate change, it is helpful to show how these variables affect the anticipation or experience of specific aspects of climate change and how these reactions affect major or widespread human consequences that are generally considered important.

3. Explain Psychological Contributions That Are Missing From Others' Analyses and That May Be Misunderstood by Others, but Be Aware of the Limitations of This Research.

Psychologists can provide climate researchers from other disciplines with psychological constructs that are relevant to understanding problems that other disciplines already recognize, and they can correct misunderstandings and misuse of psychological constructs when these are encountered. For instance, psychologists can describe how the psychological processes of risk perception and stress management may alter people's willingness to make anticipatory adaptations to climate risks (Weber, 2006). As another example, disciplines vary in their tendency to focus on different levels of analysis. Psychologists can provide particular insight into the usefulness and importance of individual-level and experience-informed analyses and can make connections between this level and more macro-level analyses (Winkel, Saegert, & Evans, 2009).

However, we must be cognizant of the possibility that psychological phenomena are context dependent. Psychological principles often are established in narrowly defined contexts: laboratory experiments, small-scale field experiments, and surveys of particular populations. To apply these principles to climate change, one must consider their external validity: That is, one must consider whether the principles are applicable in other cultures or economies, in places with very different physical infrastructures or government regulations, or in vastly changed technological contexts that might appear a generation in the future. For example, the effectiveness of an intervention to change commuting behavior (and therefore energy use) among college students has been demonstrated (Heath & Gifford, 2002). However, without further research, the effectiveness of the intervention beyond the population and time period

studied may be questionable. Psychologists must be careful not to claim that findings from any specific group have general applicability without evidence or strong theory to support such claims. Another example is the “foot-in-the-door effect”—the process by which inducing a small behavioral change can set in motion psychological changes that lead, over time, to larger behavioral changes. Efforts to change environmentally relevant behaviors with small environmental impacts (e.g., recycling) could possibly lead to change in more environmentally consequential behaviors (e.g., travel mode choice). Yet the available evidence raises questions about whether this effect operates with behaviors that affect climate (Thøgersen & Crompton, 2009).

In speaking outside the discipline, we must be explicit about the extent to which psychological phenomena have been shown to operate in climate-relevant contexts, and if they have not been shown to do so, we must be cautious about extrapolation from the contexts in which the phenomena were established. Psychologists’ expertise about preparing for and responding to natural disasters is likely applicable to climate change disasters. Yet some inferences may be required if one considers climate change disasters to be both natural and technological (see Doherty & Clayton, 2011). When considering psychological consequences of climate change, extrapolation is usually necessary because, except for the consequences of warnings about climate change, the most significant consequences lie in the future. Thus, in their extrapolations, psychologists should be explicit about their evidence base and its likely applicability to projected future events.

4. Be Mindful of Social Disparities and Ethical and Justice Issues That Interface With Climate Change Appraisals, Responses, and Impacts.

Much of the psychological research related to climate change has been conducted in the United States and Europe. Other populations may have different understandings of climate change and of the choices they face, which can in turn influence the social and psychological impacts of climate change. Understandings of, and responses to, climate change will be influenced by worldviews, cultures, and social identities (Bloodhart & Swim, 2010; Clayton & Myers, 2009; Heath & Gifford, 2006; Swim & Becker, 2010; Weber, 2010). Much climate science research in other disciplines has taken place in regions of the world such as parts of Africa, Asia, the Andes, Australia, and Alaska, where climate change impacts are far more evident and salient. Local populations in these areas have cultural vantage points, economies, and lifestyles far removed from those found in the urban-based, highly industrialized, settings of much of North America and Europe. The influence of the mass media and contemporary information technologies also varies considerably across regions of the world. Other relevant differences within all countries reflect variation in demographic group membership (such as age, gender, and education), social identities, and the combinations of these factors. For example, gender differences in experiences with climate change and in climate change

responses can vary by race, ethnicity, age, disabilities, religion, and so forth.

For both climate change adaptation and mitigation, cultural contexts and differences are likely to be important elements of the human dimensions of global climate change. Acknowledging different cultural insights, perspectives, and experiences with disasters and adaptation can advance our understanding of the human causes of climate change, its impacts, and the means of responding to it. Cultural considerations will also be critical in the provision of suitable interventions and resources for communities that are experiencing dramatic upheavals as a result of global climate change. Different cultural meanings and social justice concerns can limit the applicability of existing research and may require attention when speaking with different populations. Finally, in attending to social and cultural differences, psychologists can further research by suggesting new ways of thinking about basic psychological processes and by advancing interventions through the formation of sensitive cross-cultural and collaborative initiatives.

Conclusion

Global climate change provides an opportunity for greater integration of approaches within psychology as well as transdisciplinary cooperation with the other social sciences and the physical sciences. Such integration and collaboration typically most often occur around a common goal or problem. Global climate change presents a shared problem and daunting challenges, but these alone do not ensure cooperation among disciplines. This article and this special issue are intended to help psychologists become more knowledgeable about how their disciplinary knowledge and expertise can inform collaborative discussions, research, and policy initiatives related to climate change adaptation and mitigation. More intensive engagement with nonpsychologists will likely highlight the urgency, challenges, and importance of global climate change as a problem for psychological research; encourage us to teach our students about the psychological aspects of climate change and human–environment transactions; and most important, help us find ways to make our contributions more useful. Psychology has already made notable contributions in addressing climate change, but it can do much more, particularly in collaboration with others from diverse fields of interest and other countries.

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