

Psychology and Climate change: Beliefs, Impacts, and Human contributions

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Abstract

A surge of psychological research on or related to global climate change has occurred since 2006. This chapter reviews research on beliefs about climate change and educational efforts to address these beliefs, impacts of climate change and adaptation to and in preparation for these impacts, and human contributions to climate change and ways to encourage mitigation behaviors. More specifically the chapter describes: 1) characteristics of and changes over time in beliefs about global climate change, who holds these beliefs, and psychological sources of these beliefs; 2) psychological, interpersonal, and intergroup impacts of global climate change, the role of appraisals in the impacts, and vulnerability, resilience and social justice issues related to adapting to the impacts are considered; and 3) behaviors that contribute to and mitigate climate change, psychological processes that predict these behaviors, and methods to encourage mitigation behaviors based upon research on social influence processes and systems theory.

Keywords: Climate Change beliefs, climate change impacts, adaptation, human contribution to climate change, mitigation of climate change

Psychology and Climate change: Beliefs, Impacts, and Human contributions

There is a rich history of psychological research on global climate change, reaching back to the early 1980's (Chen, Boulding, & Schneider, 1983; Fishoff & Furby, 1983). Yet there has been a recent surge in interest in the topic by psychologists. This interest is reflected in activities in several psychological associations such as the American Psychological Association (Benson, 2008; Swim, et al., 2009), Australian Psychological Association (2010), the Psychologists for Social Responsibility (2011), and the Society for Psychological Study of Social Issues (Swim & Clayton, 2010), which have made efforts to inform and summarize relevant psychological research and assert psychologists' role in addressing global climate change. Consistent with these efforts, several psychologists have recently illustrated the contributions of and need for psychologists to increase their involvement in studying environmental sustainability and specifically examine the psychological dimensions of climate change (Gifford, 2008; Kazdin, 2009; O'Hara, 2010; Uzzell, 2010). An examination of publication trends of articles tracked by PsychInfo, the American Psychological Association database of nearly 2500 journals, illustrates the increased attention. A search for scholarly articles that included "Climate Change" or "Global Warming" in its Keywords and Texts and that reported research, summaries of research or theory development reveals a surge in publications that mention climate change starting in about 2008 (see Figure 1). Of course, there is more psychological research on this topic than revealed from this search alone. Yet, the figure illustrates the growing attention given to climate change topics and this attention is reaching the psychological community.

<Insert figure 1 about here>

A wide range of research is relevant to climate change, including many chapters in this handbook. Global climate change is having and will continue to have many natural impacts that

affect and are affected by humans. Many of these types of impacts, such as environmental degradation and disasters, have been of concern for psychologists for several decades. Solutions to a wide range of environmental problems, ranging from individual and household behavioral changes, to community engagement, to organizational and governmental policy development and support, are relevant to responses to global climate change. Further, theoretical perspectives, such as the common's dilemma (Gifford, 2008; Committee on the Human Dimensions of Global Change, National Research Council, 2002; Van Vugt, 2009), used to understand human and psychological dimensions of environmental and social problems are relevant for understanding issues of global climate change.

There are aspects of global climate change, however, that make it worthy of specific attention by psychologists. The complex interlocking causes and impacts of global climate change, time course of climate change impacts, and multiple solutions with unknown side effects contribute to uncertainty, ambiguity, feelings of threat, and inaction. Climate change impacts are sometimes contradictory, ranging, for instance, from both too much water in some areas to too little in other areas, which can potentially cause confusion about what climate change is and what is evidence of the impacts. Climate change impacts are extensive. The impacts are not limited to those in one's immediate neighborhood or even one's own country but are occurring and will occur across the globe. Many individuals might not personally experience the direct impacts given the temporal and geographic patterns of climate change and given many people's disconnection with nature. Further, some, particularly in industrialized countries, will be able to use their wealth to buffer themselves from climate change impacts. Yet, increasing globalization, which makes people much more interconnected and interdependent, means that many will indirectly experience the impacts even if they are not directly affected in their own

communities. The scope of the impacts can be difficult to grasp, cope with, and know how to respond to. Responding to climate change may require cultural shifts that challenge the status-quo and therefore may meet with resistance. Thus, the scope of climate change, including the types of impacts expected, the temporal and geographic patterns of change, and the connection between individual actions and impacts on nature and other people, is critical to discerning individuals' understanding of and responses to climate change.

It is impossible for us to review all relevant psychological research on climate change in this chapter, particularly because it overlaps with many other research domains. Instead, we highlight research that has specifically made connections to global climate change. We consider three primary research areas: 1) beliefs about global climate change; 2) impacts of global climate change; and 3) human contributions to global climate change. Within each of these topics we also examine responses to global climate change through educational efforts, adaptation, and mitigation, respectively. It is worth noting that much of the research we review has been done in the United States and, secondarily, in Europe. We do this because it reflects the research base. The research base may reflect the extent to which researchers are attempting to understand U.S. residents' beliefs about climate change and the disproportionate need to change human behaviors in industrialized countries.

<h1>Beliefs about Global Climate Change

Over the past two decades, sociologists, public pollers, psychologists and others have conducted dozens of surveys and studies examining non-experts' (i.e., the public's) beliefs about, knowledge of, and concern over global climate change (for reviews, see Brewer, 2005; Nisbet & Myers, 2007), and to a lesser extent exploring how those different beliefs relate to one another (e.g., Kellstedt, Zahran, & Vedlitz, 2008; Malka, Krosnick, & Langer, 2009; O'Connor, Bord, &

Fisher, 1999). Taken together, these studies reveal both consistency and change over time with respect to the public's understanding of and engagement with global climate change (cf., Dunlap & McCright, 2008). Moreover, as discussed below, this research reveals a significant role for psychological science in explicating beliefs about global climate change. Here, we provide a general and brief review of the types of beliefs that have been assessed, partly in an attempt to reveal the broad range of issues that have been identified as critical components of the public's understanding of global climate change. We next discuss some prominent moderators and correlates of those beliefs (e.g., demographics, individual differences, group identification) before briefly exploring the question of where beliefs about global climate change come from. Recent education and communication efforts aimed at increasing "climate literacy" are also discussed.

<h2>What do People Believe about Global Climate Change?

Researchers have examined many domains of global climate change beliefs including: whether or not the phenomenon is occurring; definitions of "global warming" and "climate change"; causes and mechanisms (e.g., human caused vs. naturally occurring); scientific consensus over the issue; consequences, concerns and risk perceptions; "solutions" beliefs (including perceived self- and group-efficacy); and beliefs about perceived responsibility to confront global climate change. Not surprisingly, the resulting body of research reveals that people's beliefs about climate change are complex and situationally dependent (to a degree) and that members of the public disagree with one another regarding nearly every facet of the issue. In addition, extant research points to the significant, yet oftentimes unintended, effects of question wording on people's beliefs about global climate change (cf., Yeager, Larson, Krosnick, & Tompson, in press).

<h3>**What is global climate change?**

Initial research on people's beliefs about global climate change (e.g., Kempton, 1991; Bostrom, Morgan, Fischhoff, & Read, 1994) began by asking respondents what the terms "greenhouse effect" and "global warming" meant to them. Kempton and his colleagues (1995) found that people's conceptualizations of global climate change were tied to four preexisting knowledge structures (mental or cultural models) held by most respondents: ozone depletion; air pollution; plant photosynthesis and deforestation; and personally experienced weather (temperature) variation. These mental models shaped respondents' beliefs about nearly every aspect of global climate change (Bostrom et al., 1994), from its causes (e.g., deforestation) to its potential consequences (e.g., linking the ozone hole with increased solar radiation) to seemingly plausible responses to the problem (e.g., reducing use of CFCs, Chloral Floural Carbons that deplete the ozone). While some of these mental models appear to have decreased in prevalence and importance over the past twenty years (cf., Bord, Fisher & O'Connor, 1998; Bulkeley, 2000), recent polling data suggests that many individuals continue to confound the "ozone hole" with global climate change (Leiserowitz & Smith, 2010). At the same time, there appears to be more agreement among the public that global climate change refers to long-term changes and trends in the climate system, although significant differences in this belief exist as a function of group membership (see below).

<h3>**"Global warming" vs. "Climate change."**

Throughout the 1990s, the term "global warming" came to be the label most often used in talking about global climate change. In the early 2000s, right-leaning political consultants in the U.S. (most prominently Frank Luntz, see Villar & Krosnick, in press; Weber & Stern, 2011) urged leaders, including then-president George W. Bush, to shift from using the term "global

warming” to using the term “climate change” due to a belief that the latter term was less scary and therefore less motivating to members of the general public. Research conducted in the U.K. in 2003-2004 (Whitmarsh, 2009) suggested that, indeed, at least among Britons, the two terms did differ from one another with respect to how people conceptualized the issue (e.g., many more individuals referred to temperature increases and melting glaciers when asked to define global warming as opposed to climate change; see also Leiserowitz, 2006). However, Villar and Krosnick (2010) found only small differences between the two terms as a function of political party identification, and in the opposite direction than the one predicted by Luntz: climate change was rated as slightly more serious among Republicans, while Democrats found global warming to be slightly more serious. Villar and Krosnick concluded that use of the two terms may have had some effect on public perceptions of the issue, but that such effects are likely small and inconsistent across different groups.

<h3>Is climate change happening?

Perhaps the most basic facet of people’s beliefs about global climate change is whether or not the phenomenon exists or will occur in the foreseeable future (essentially every public poll on the issue asks some form of this question). Longitudinal data collected by Gallup over the past 13 years suggests relative stability in “existence” beliefs when looking across all individuals and groups. However, as Dunlap and McCright (2008) among others (e.g., Leiserowitz, Maibach, & Roser-Renouf, 2010) have demonstrated, such apparent population-level consistency masks significant and opposing trends occurring among Democrats and Republicans within the U.S.: in 1998, 46% of Democrats and 47% of Republicans believed the effects of global warming had already begun; by 2008, 76% of Democrats but only 41% of Republicans believed that to be the case (McCright & Dunlap, 2008). More recent polling (Leiserowitz et al., 2010)

suggests that belief in the existence of climate change has decreased among all groups in the past two years, although this may be a temporary dip due to various events that occurred in 2008-2009 (e.g., “Climategate”; COP15; extremely cold winters in the Northern hemisphere). On the other hand, polling in the U.K. and other non-U.S. nations reveals consistently strong beliefs in the existence of climate change (e.g., Guardian/ICM, 2011).

<h3>Causes and mechanisms of Global Climate Change

Much research on global climate change beliefs has focused on individuals’ attributions of causation (i.e., humans vs. nature) and understanding of the physical mechanisms responsible for the phenomenon (e.g., emissions of Greenhouse gases). Although initial research examined people’s mental or cultural models (see above; Kempton et al., 1995; Bostrom et al., 1994), more recent research has focused primarily on beliefs about whether global climate change is caused by humans’ actions or else due to naturally occurring changes in the climate system.

Unfortunately, due to the use of differently worded items across various polls and studies, it is difficult to get a clear sense of people’s beliefs on this particular facet. For example, Gallup (Newport, 2010) reports that from 2003 to 2010 the percentage of Americans who believed global climate change was a result of “human activities” dropped from 61% to 50%, while those believing it to be naturally occurring rose from 33% to 46%. However, data from Pew (2010) suggests that as of 2010, only 34% of Americans believed GCC was caused by human behavior and roughly 20% believed it was due to “natural patterns.”¹ Others have also examined perceptions of personal responsibility for climate change (Read et al., 1994; Whitmarsh, 2009). Those that report such responsibility may be especially likely to feel morally responsible for addressing climate change (Markowitz, 2011).

Looking somewhat more closely at people's factual knowledge about the causes of global climate change, recent findings indicate that while many Americans now know something about certain causal mechanisms responsible for global climate change (e.g., emissions of CO₂ from cars, power plants and other sources; deforestation), misconceptions abound regarding other perceived causes of global climate change, for instance, many people continue to believe that CFCs from aerosols are responsible (Leiserowitz & Smith, 2010). Interestingly, these mistaken beliefs about various causes of global climate change are at least as strong if not stronger among individuals highly convinced that global climate change is happening and is a problem (Leiserowitz & Smith, 2010). Taken together, these findings suggest that many Americans' beliefs about the etiology of global climate change remain significantly out of step with the scientific consensus on the issue, although this may be improving.

<h3>**Scientific consensus**

Considerable polling has also been done exploring beliefs about whether or not there is scientific consensus over climate change. As with the public's beliefs about the causes of climate change, there are significant discrepancies between the actual amount of agreement among scientists (i.e., there is almost complete scientific consensus on the basic fact of whether climate change is happening; see Oreskes, 2004) and the public's beliefs about the amount of consensus (which are all over the map). Moreover, the public's beliefs about scientific consensus over global climate change appear to be moving toward greater perceived scientific disagreement (e.g., Pew, 2010), despite a lack of any objective change in the state of scientific discourse over global climate change in the past few years in that direction.

<h3>**Meta-cognitions**

Meta-cognitions, reflections on primary perceptions or evaluations or attempts to control cognitions, represent a potentially important set of climate change beliefs (Scannell & Grouzet, 2010). At least three meta-cognitions are relevant to beliefs about climate change: certainty about climate change and its impacts, confidence in one's self-assessed knowledge about climate change, and importance of climate change. Meta-cognitions can be as important or more important predictors of behaviors than lower-order beliefs. For instance, importance and certainty of beliefs predict attempts to persuade others of those beliefs (Visser, Krosnick, & Simmons, 2003) and confidence in one's knowledge is related to more risk taking behaviors and less information seeking (Scannell & Grouzet, 2010). Importance assigned to climate change is related to donating more to environmental and climate change activism (Visser, et al., 2003). Further, confidence in one's knowledge of climate change is associated with being less concerned about climate change (Kellstedt, Zahran, & Vedlitz, 2008).

<h4>**Certainty.** Risk perceptions and concerns about climate change consequences can be considered assessments of the certainty about the impacts of climate change (Scannell & Grouzet, 2010). Considerable research address perceptions of the impacts of climate change and associated risks that global climate change poses to individuals, their communities, humanity and other species (cf., Bostrom et al., 1994; Bulkeley, 2000; Read, Bostrom, Granger Morgan, Fischhoff, & Smuts, 1994; Whitmarsh, 2009). Americans tend to perceive the impacts of global climate change as accruing almost exclusively to other individuals and communities, especially those living in distant nations and far in the future (Bord et al., 1998; Nisbet & Myers, 2007; Stamm, Clark, & Eblacas, 2000), although a subset of the population does believe that global climate change will have significant negative effects on themselves in the near future (Leiserowitz et al., 2010). For example, early research found that many individuals believed that

climate change posed serious direct health risks to people, primarily through increased incidence of skin cancer and respiratory problems (Bostrom et al., 1994; Kempton et al., 1995; Stamm et al., 2000); however, more recent research has suggested that direct and nameable health consequences of climate change have become less salient to Americans (cf., Lorenzoni, Leiserowitz, Franca Doria, Poortinga, & Pidgeon, 2006). In addition, many individuals hold widely shared beliefs about the physical consequences of climate change on the natural world, for example, warmer temperatures, melting icebergs, dying polar bears, sea level rise, changes in precipitation patterns and “weird weather” (cf., Bostrom et al., 1994; Leiserowitz, 2006; Read et al., 1994; Stamm et al., 2000).

Taken together, these findings suggest that most individuals in the U.S. believe (in line with experts) that the worst consequences of climate change will be borne not by themselves but rather by distant others (spatially and temporally), and it is likely the case that this basic lay understanding of climate change has had an important dampening effect on perceived risk, concern and urgency for action (Bord et al., 1998; Weber, 2006). Indeed, as these beliefs about the perceived “otherness” of the victims of global climate change have become more widely held, concern, worry and risk perceptions regarding global climate change appear to have weakened among Americans (e.g., Leiserowitz et al., 2010). It is important to note, however, that risk perceptions and concern over global climate change are highly differentiated among the U.S. public, as Leiserowitz et al. (2010) have shown with their “Six Americas” research program (see also Dunlap & McCright, 2008 for differences in concern as a function of political party identification).

<h4>***Confidence in Knowledge.*** Research by Sundblad, Biel, and Garling, 2008 indicates that confidence in one’s knowledge about climate change varies across individuals and topics.

These researchers found that Swedish respondents were generally certain of their knowledge about climate change, with experts being the most certain about their knowledge followed by journalists, then politicians, and then lay people. These Swedes tended to be more confident in their knowledge about the causes of climate change than about the state (e.g., global temperature patterns) or future consequences of climate change. Moreover, knowledge of, or confidence in, one's knowledge about climate change is likely to be low among the least knowledgeable. Consistent with research on the role of preconceived beliefs about one's ability on poor self-assessments of performance (Dunning, 2005), Sundblad et al. (2008) found that the correlation between Swedish respondents' confidence in their knowledge about climate change and actual knowledge was lowest among those who knew the least about climate change.

<h4>Importance. Finally, research on importance placed upon addressing climate change partially explains discrepancies between perceiving that climate change is real and support and lack of support for efforts to address climate change. Although many in the U.S. believe that climate change exists, few volunteer it as the most important problem facing (Yeager, Larson, Krosnick, & Tompson 2010). Yet, when the question is framed in such way to focus on problems for the world and in the future, environmental problems and climate change emerge are identified as much more important (Yeager, et al., 2010).

<h2>Who believes what and why?

Research conducted within the past ten years has begun to examine the closely related questions of *who* believes what about global climate change as well as *why* people believe what they do regarding the issue. Here we first very briefly mention some of the more prominent moderators and correlates of global climate change beliefs before discussing some of the many psychological processes that likely play a role in shaping those beliefs.

<h3>Demographic and psychosocial predictors.

Beliefs about global climate change are significantly correlated with a number of demographic and psychosocial variables. For example, McCright (2010) found that women tend to possess more accurate knowledge of climate change than men and are more concerned about the issue, but that they also are more likely to underestimate their own knowledge of the issue while men are likely to overestimate their knowledge. O'Connor et al. (1999) found a slight positive relation between age and support for various climate mitigation policies, but other research suggests either a negative or non-significant relation between age and various domains of global climate change belief, including concern and knowledge (cf., Leiserowitz et al., 2010; McCright, 2010). Educational attainment generally appears to be positively but weakly related to increases in existence beliefs, concern and preferences to confront global climate change (e.g., McCright, 2010). Not surprisingly, individuals who hold strong pro-environmental attitudes and those who hold biocentric values are generally more concerned about global climate change, report knowing more about the topic and are more likely to believe global climate change is occurring as a result of human actions (cf., Kellstedt et al., 2008; Bord et al., 2000).

As mentioned previously, beliefs about global climate change are also strongly moderated by political party identification and socio-economic ideology more generally (cf., Dunlap & McCright, 2008; Leiserowitz et al., 2010; Malka et al., 2000; Kellstedt et al., 2008). American conservatives and Republicans are much less likely than liberals and Democrats (and moderates/Independents) to believe global climate change is happening, is due to human actions, and that it poses significant threats to themselves and others. As a result, conservatives/Republicans generally report lower levels of concern and willingness to respond proactively to the issue. Hoffman (in press) and others (e.g., Nisbet, 2009) have argued that climate change has

in many ways become a highly politicized issue over the past ten years; this is reflected not only in the public polling data on the issue but also in the vastly different and contrasting frames or “logics” that climate change advocates and skeptics utilize in talking to their bases (and largely past one another) about climate change.

At a broader scale, beliefs about global climate change clearly differ between nations. For example, polling conducted by Gallup in over 125 countries in 2007-2008 revealed wide gaps between nations in basic awareness of the issue, with the populations of some nations (e.g., India) showing very low levels of familiarity with the terms “global warming” or “climate change” (Pelham, 2009). Moreover, even among individuals who have heard about global climate change, there are huge cross-national differences in public perceptions of the threat global climate change poses to individuals and humans more generally (Pugliese & Ray, 2009), although it is not clear whether education about or experience with global climate change impacts moderate this effect.

<h3>Where do GCC beliefs come from?

Beliefs about global climate change are shaped both by our direct experiences with climate-relevant phenomena (e.g., daily weather, extreme climatic events) as well as, and perhaps more powerfully, by our indirect experiences with the issue (e.g., via social interaction and media coverage). As Weber (2006) and others have argued, our direct experiences of climate change is severely limited, in part by definition (i.e., global climate change is a statistical phenomenon consisting of many different events spread out temporally and spatially) and in part due to various features of the issue, for example, its slow pace of change, centuries-long time horizons, and non-linear feedback loops (see Sterman & Booth Sweeny, 2002). Yet, regardless of whether or not it is objectively appropriate to use such experiences as the basis for forming

beliefs about global climate change, Kempton and others have shown that individuals do come to understand global climate change in large part through personal experiences of local weather. Indeed, some recent research indicates that experiences of local weather (and especially extreme events) can have a significant effect on climate change beliefs (Egan & Mullin, n.d.), although Jenkins-Smith et al. (in preparation) suggest that this relationship may be bi-directional (i.e., beliefs about climate change shape perceptions of local weather). In general, it seems likely that direct experiences with the climate-relevant phenomena strongly shape beliefs regarding the existence of climate change, what its impacts will be (if any) and how important the issue is.

Beliefs about global climate change are also strongly shaped by indirect experiences with the phenomenon, particularly interactions with close others (e.g., family and friends) and exposure to media coverage of global climate change (Boykoff & Boykoff, 2004; Iyengar & Hahn, 2009). Over the past 15 years, communications researchers, psychologists and others have documented the ways in which global climate change is framed and talked about in both interpersonal settings (cf., Norgaard, 2006; Bulkeley 2000) and in the media (e.g., Boykoff & Boykoff, 2004; Nisbet, 2009). This and other research suggests that global climate change is a socially constructed issue in many ways (Hulme, 2009), and the effects of this are seen in part in the polarization of the issue at the group level (e.g., Republicans vs. Democrats) as well as in the ways in which various groups and opinion leaders utilize rhetoric (and scientific findings in some cases) to either accentuate or discredit various aspects of the issue (Hoffman, in press). Some experimental work also suggests that media representations of certain aspects of the issue (e.g., uncertainty) can significantly impact individuals' beliefs about global climate change (e.g., Corbett & Durfee, 2004).

Work on motivated information seeking and reasoning suggests that individuals likely seek out information about global climate change that allows them to confirm preexisting beliefs about the issue (cf., Kunda, 1990; Lord, Ross & Lepper, 1979) and about how the world operates more generally (e.g., Kahan, Braman, Gastil, Slovic, & Mertz, 2007). At the same time, these motivated processes allow us to defend ourselves, to some degree, against the threats posed by information about global climate change. For example, Feinberg and Willer (2010) found that individuals show reactance to strongly negative portrayals of global climate change in part due to the challenge that such messages pose to deeply held beliefs about the world being a just, orderly and stable place (see also Meijnders, Midden, & Wilke, 2001). In a similar vein, Feygina, Jost and Goldsmith (2010) showed that the tendency to support the status-quo via justification of existing socio-economic systems (i.e., system justifying) is negatively related to concern about global climate change and willingness to respond (behaviorally) to the issue. Similarly, Kahan et al. (2007) have argued that traditional representations of global climate change as a scary, complex problem that requires immediate change to the U.S. economic system motivate those with hierarchical and individualistic values to reject claims about the existence and seriousness of global climate change (and conversely, to make the problem seem more important to those with egalitarian and community-oriented values). At the same time, representations of global climate change as causing significant harm to innocent others (including those not yet born) likely activate moral values that are deeply held by liberals in the U.S. (cf., Haidt & Graham, 2007; Markowitz, 2011). Moreover, the “scariness” of global climate change and the threat it poses to our own mortality may activate existential needs, as outlined by Terror Management Theory (Dickinson, 2009; Greenberg, et al., 1992) that lead us to cling to our group identities and values. Taken together, these and other findings suggest that at least some of the political

polarization in beliefs about global climate change may result from basic, underlying psychological differences between liberals and conservatives (Jost, Glaser, Kruglanski, & Sulloway, 2003), including differences in values, system justification needs and beliefs about how the world should operate.

Political identification, basic values, and worldviews aside, people's beliefs about global climate change are also influenced by a wide variety of situational and attitudinal factors. For example, Malka et al. (2009) found that trust in scientists significantly moderated the relationship between knowledge about global climate change and concern over the issue, and that knowledge and concern were only positively related among individuals who trust scientists for information about global climate change (and many do, see Leiserowitz et al., 2010). Moreover, the recent "Climategate" scandal appears to have decreased trust in scientists (Leiserowitz et al., 2010), although perhaps only or primarily among individuals already skeptical of global climate change. In a separate vein, Risen and Critcher (in press) found that individuals placed in warm settings (e.g., heated room) report higher levels of belief in "global warming" (effects on "climate change" were not tested), suggesting that beliefs about global climate change are at least somewhat situationally dependent and mutable (see also Joireman, Truelove, & Duell, 2010).

Clearly there are many other psychological constructs and processes that likely shape people's beliefs about global climate change (e.g., temporal construal, optimistic biases, biased information recall, need for closure, numeracy, naïve physics), and much research remains to be done in exploring these and other factors. At a psychological level, global climate change (and particularly how it is framed in the media) activates both affectively driven, heuristic-based processing as well as more cognitively effortful reasoned engagement with the issue. Explicating

how, when, and why these systems are differentially activated in processing information about global climate change may go a long way in explaining differences between individuals and groups with respect to beliefs about global climate change; moreover, examining these issues should provide important insights for communicators, politicians and others interested in shaping public opinion regarding global climate change.

<h2>Educational efforts

Since James Hansen’s awareness-raising 1988 congressional testimony, many environmental leaders, science communicators and others have attempted to raise not only public awareness but also understanding of global climate change, largely in an attempt to shape people’s beliefs about the existence, causes and importance of the issue. The field of environmental education, particularly in the Kindergarten through 12th grade curricula, has addressed many topic areas including sustainable development and biodiversity (Clayton & Myers, 2009). Consistent with these educational efforts, over the past few years, climate science has become much more mainstream in many K-12 curricula around the country and there are further efforts underway to increase exposure to scientific knowledge and training that will allow students and adults at all levels to better interpret global climate change data for themselves. In addition, many zoos, aquariums and museums have dedicated programs aimed at increasing “climate literacy,” in part by attempting to link climate science with tangible effects on things people care deeply about (e.g., welfare of other humans and animals). Within the U.S., many of these efforts are supported by the National Science Foundation, the National Oceanic and Atmospheric Administration and the U.S. Global Change Research Program; together, these organizations have produced educational materials, including the document “Climate literacy: The essential principles of climate sciences” (USGCRP, 2009), meant to improve the general

public's understanding of basic climate science principles and constructs. Many other researchers are also working on developing novel techniques for improving climate literacy (cf., McCaffrey & Buhr, 2008; Niepold, Herring & McConville, 2008; see Moser, 2010 for a review of global climate change communication research and strategies).

Of course, given our understanding of the ways in which individuals engage with global climate change at a psychological level, it is clear that such direct information provision efforts are likely to result in only marginal success at best with respect to increasing knowledge, and ultimately concern in the general public, about global climate change (cf., Kellstedt et al., 2009; Bulkeley, 2000; Moser, 2010). In an effort to promote effective communication with the public about global climate change, various organizations and research groups have published manuals, articles and books (Moser & Dilling, 2007; Maibach, Roser-Renouf & Leiserowitz, 2008; Shome & Marx, 2009) aimed at applying our understanding of the challenges that global climate change poses to our cognitive and experiential based systems (see above) to the development of education and communication strategies that increase objective knowledge about global climate change (cf., Shome & Marx, 2009). These efforts reflect the insights that psychological research holds for explicating people's understanding of the issue, as detailed above. For example, because the dynamics of stock and flow systems are highly confusing for most individuals (Booth Sweeny & Sterman, 2002), utilizing analogies from real life (e.g., bathtubs, bank accounts) to talk about climate dynamics may be effective in some cases. In a related vein, the ability of films to portray vivid images has been found to influence knowledge and concern about climate change (if not necessarily behavior that would address it; see Nolan, 2010), pointing to another possible route for educating non-scientists about the issue.

More broadly, Pidgeon and Fischhoff (2011) suggest that because of the nature of both global climate change and human psychology, climate change communicators must fundamentally rethink their approach to communicating with the public regarding the risks posed by climate change. Rather than utilize traditional, unidirectional messaging in which the public is treated as an empty slate just waiting to be told what to believe, communicators must move towards a more inclusive, engaging bidirectional approach that provides opportunities for scientists to receive meaningful feedback from members of the public; moving in this direction would not only increase public engagement, but also provide for critical recalibration of the messages communicators and scientists want to get across to non-experts. These and other efforts to improve communication strategies attempt to minimize the sorts of motivated rejection of climate science information which so often results from providing skeptical individuals information about global climate change (cf., Kellstedt et al., 2009; Malka et al., 2009). Although relatively little assessment has been conducted of these initial efforts (Moser, 2010; Pidgeon & Fischhoff, 2011), it seems likely that such psychologically informed approaches have much to offer environmental communicators interested in engaging effectively with members of the general public on this topic.

<h1>Impacts

Much attention has been given to the current and impending physical effects of global climate change, in addition to increasing attention for the human dimensions of these impacts. Impacts on the Earth itself include heat and drought in some areas of the world, to melting icecaps, eroding beach lines, and increased rainfall in others. These geophysical changes in turn impact animal populations and their habitat and migration, as well as possible increases in the maltreatment of animals and animal welfare (e.g., increased factory farming for food production;

Dawkins & Bonney, 2008). For humans, these climate change driving ecological changes can have considerable health implications. Physical impacts include decreased access to essential resources such as food (Brown & Funk, 2008), clean air (Kinney, 2008), clean water, and energy resources, movement and migration (Reuveny & Moore, 2009), economic and occupational changes (Pereira, 2009; Galvin, 2009), increased disease and illness (Donahoe, 2010), personal loss (Randall, 2009), decreased fertility and/or life expectancy (Lin, 2010; Tang, Petrie, & Rao, 2009).

The human impacts of global climate change extend into domains often studied by psychologists (Doherty & Clayton, 2011; Swim & Clayton, 2011). These include impaired emotional well being, stress, and anxiety. They also include extended effects into personal relationships and intergroup relations due to, for instance, increased crime and violence (e.g., due to heat-related crime, Rotton & Cohn, 2003; conflict over resources, Donahoe, 2010; or domestic violence, Enarson, 1999). Individuals and communities who then attempt to cope with and prepare for geophysical, social, and psychological impacts create subsequent effects. Below we first consider some of the psychological impacts of climate change. We then consider adaptation to climate change and associated social justice issues.

Psychological impacts

While climate change impacts can result in short-term, isolated, or discrete stressors (e.g., hurricanes or floods), long-term climate changes may be more wide-spread over geographic space and time (e.g., spreading of disease) and can result in chronic stress. The former has been examined in a host of literature both within and outside psychology addressing the human impacts of natural and large-scale disasters and adaptive coping techniques (see Lindell, this volume). These include the development of phobias, social anxiety disorder, Post traumatic

Stress Disorder, and depression (Hussain, Weisaeth & Heir, 2010). The latter, however, are less studied in direct relation to climate change as the impacts of long-term climate changes have only recently been discussed within the psychological literature. Yet, chronic effects are likely to include anxiety, worry, grief and mourning, guilt, despair, and apathy, to name a few (Doherty & Clayton, 2011).

A variety of intergroup consequences are also likely to develop. Competition over increasingly scarce resources will likely increase intergroup tensions and conflict (Zhang, Brecke, Lee, He, & Zhang, 2007), such as the conflicts and suffering that have and will likely continue to ensue over access to water (i.e., “water wars”, e.g., see Shiva, 2002; 2006). Additionally, conflicts and increasing climate threats may lead to changes in identity or social categories, such as environmentalists, climate change deniers or contributors, which may, in turn, lead to the formation of new stereotypes, prejudice, and discrimination. Impacts such as forced migration from rural areas may create indirect effects such as changes in cultural values or boundaries, which in turn may impact health, poverty, substance abuse, and community and social cohesion (Beard, Tomaska, Earnest, Summerhayes, & Morgan, 2009).

Psychological impacts of climate change may be highly related to appraisals of the severity and risk posed by climate change (Doherty & Clayton, 2011; Reser & Swim, 2011). For many people living in much of the Global North and working in industrialized spaces, climate change can be seen as an abstract issue which does not immediately impact their livelihoods or wellbeing, and their only connection to climate change is through the media or discussions with others (see risk perceptions above). Appraisals of climate change may also serve as a coping strategy to diminish the negative effects of climate change stressors. The extent to which climate change is viewed as an overwhelming and unchangeable force, as opposed to one with human

solutions or not even as an issue at all, will likely alter the degree of psychological impact. Thus, those who might otherwise feel psychologically burdened, overwhelmed, or have belief systems threatened by climate change may instead chose to reject the belief in its existence (e.g., Feinberg & Willer, 2011).

<h2>Adaptation

Although the term ‘adaptation’ has largely been used in climate change discussions to refer to technological and physical changes made in response to climate disasters, it is applicable to a psychological examination of climate change impacts as a way of understanding how people respond to and cope with climate change impacts. Reser and Swim (2011) have described psychological adaptation as anticipated and reactive responses to climate change in human thinking and behavior, and as a coping response to physical and social environmental changes.

Some forms of adaptation focus on coping with immediate short term consequences of climate change that emerge from natural disasters. Basic behavioral adaptation to climate change can include assistance with essential human needs, such as food, clothing, and shelter. This may also extend to financial assistance, creation of new jobs, and migration. Short-term impacts such as natural disasters tend to make suffering more salient or easy to identify with, which according to the empathy-altruism hypothesis, increases helping behavior (Batson et al., 1981). In addition, psychological effects such as tokenism (Gifford, 2011; see also the low-cost situation hypothesis, e.g., Diekmann & Preisendörfer, 1992; Kempton et al., 1985) and social helping norms (Cialdini et al., 1981) may increase helping when one comes across an easily identifiable charity or witnesses others helping.

These types of assisted adaptations may not be related to long-term climate change impacts. Such individual and social assistance is not usually as readily available to help with

adaptation to chronic impacts of climate change, perhaps because it requires more dedicated monetary relief and behavior change rather than one-time donations of time and money. Long-term impacts are also less likely to be covered by the media, and when they are, chronic exposure may create compassion fatigue (Figley, 1995). Additionally, psychological processes such as the free-rider tendency (e.g., Condie et al., 1976) and the bystander effect/diffusion of responsibility may hinder helping with adaptation to climate change impacts because individuals may assume that there are many other individuals who can take care of the problem (Frantz & Mayer, 2009; Latane et al., 1981).

Those who have already experienced chronic impacts of climate change may use a number of methods to psychologically adapt or adjust to their current situation. These may include cognitive responses (e.g., appraisals or reframing), affective responses (e.g., worry, hope, guilt, or shame), or social responses (e.g., volunteering, social support, or social amplification or attenuation; Doherty & Clayton, 2011; Reser & Swim, 2011). A new scale specifically intended to measure coping with global environmental problems have recently emerged, which assess problem solving, expressive coping, denial of guilt, relativization, wishful thinking, self-protection, pleasure, and resignation, which overall support the concepts of problem-focused coping vs. deproblemization-focused coping (Homburg, Stolberg, & Wagner, 2007).

Another important type of psychological adaptation is proactive coping, in which individuals prepare for a stressful event before it occurs, in order to thwart or minimize its effect (Aspinwall & Taylor, 1997). When related to climate change, this may include preparing for anticipated threats and stressors, or preparing for future disasters after the experience of a previous disaster. Once again, there is a relatively large body of literature addressing proactive coping in relation to short-term stressors, such as disaster preparation. Some of these

preparations include community building and education about mental health impacts, emotion management training, cognitive behavioral coping skills, and stress inoculation training, as well as changing threat perceptions and appraisals of the event (Morrissey & Reser, 2007). Sims and Baumann (1972) illustrated that increased locus of control led to better preparedness for natural disasters such as tornados. The proactive coping literature itself focuses largely on immediate and personally relevant health issues such as diabetes (Thoolen, de Ridder, Bensing, Gorter, & Rutten, 2008) and physical activity (Stadler, Oettingen, & Gollwitzer, 2009). However, no research has, to our knowledge, assessed the effect of proactive coping on dealing with the chronic, uncertain, and varying impacts of climate change. While proactive coping could very well be an effective means of handling chronic stress, as determined from the health literature, numerous factors make climate change impacts less amenable to pro-active coping. These factors include uncertainty of whether impacts are directly related to climate change, lack of personal control over many climate change impacts, and for many people currently, lack of direct current experiences with climate change impacts.

Mitigation behaviors may also be used as a form of psychological adaptation. Doing ‘green’ behaviors may help reduce guilt or other negative affective responses to climate change (e.g., worry, hopelessness). Participating in mitigation behaviors may also create a sense of self-worth or positive identity related to one’s environmental actions (Brook, in press) or being a humanitarian. This developed “role-identity” may in turn lead to increased subsequent pro-environmental or humanitarian behaviors (Piliavin & Callero, 1991). Finally, a resistance to mitigation behaviors may follow from a psychologically adaptive need to deny climate change or reject affective feelings of guilt or worry (Gifford, 2011; Swim & Bloodhart, in preparation).

<h2>**Vulnerability and Resilience**

An important and lately more recognized factor in the climate change discussion is that of vulnerability, or the ability of individuals or groups to cope with the impacts of climate change. Keim (2008) has described vulnerability to natural disasters as having two parts: the degree of exposure to dangers or disasters (susceptibility) and the capacity to cope with or recover from their consequences (resilience). Others equate vulnerability with susceptibility, by conceptualizing it as the inability to cope based on varying factors such as location, economics, level of industrialization, and social disadvantages, while resilience is conceptually the opposite: the personal, social, economic, and infrastructural resources which help one to cope with climate change impacts (e.g., see Reser & Swim, 2011).

Due to the geophysical impacts of climate change, people in the Global South are more susceptible to drastic changes in their environment, such as floods, droughts, malaria, reduced water resources, destroyed crops, and land erosion. Unfortunately, due to colonization, global trade markets, and industrialization in the North, many of these areas are also left with little resources to cope (e.g., see Roberts & Parks, 2007). Of the many resources to cope with climate impacts, the greatest is access to financial capital, which in turn gives access to essential resources such as food, water, and shelter, but can also facilitate the ability to change or influence national policies related to climate change adaptation (e.g., see Brouwer, Akter, Brander, & Haque, 2007). Research has shown that cultural self-expression values decrease and survival values increase due to lack of wealth in high climate change-impact areas of the world (Van de Vliert, 2007), and that life expectancy in these areas is moderated by income (Tang, et al., 2009).

<h3>Social Justice Implications.

Given issues of vulnerability and resilience, climate change has readily become a social justice issue. Groups high in socio-economic status have both the ability to continue to contribute to climate change through the production of carbon emissions, but also have the ability to protect themselves from its consequences and more easily adapt to climate changes and the associated impacts. Those who lack social power and are members of marginalized groups (e.g., women, racial minorities, the poor) are also less likely to participate in the economic market and have access to income-earning jobs (Masika & Joekes, 1997).

Terry (2009) illustrates how gender roles and expectations can play a large role in gendered experiences of climate change through examining how rural women in Africa and Asia are often more dependent on natural resources and do most of the agricultural work, while poor women are most likely to bear the brunt of health problems due to less access to education and healthcare. Gender imbalances exist in mortality rates due to disproportionate socio-economic status, as women's access to capital is often restricted or limited compared to men's and can be more severely reduced based on other social identities such as race or age. Women can also be impacted based on expectations about gendered behavior and the value of women's lives. For example, women will be more negatively impacted in cultures where women receive less food than men during food shortages, and are expected to do adaptation work (e.g., take care of the household, care for elderly, participate in community building), while men return to wage-earning work (Nelson, Meadows, Cannon, Morton, & Martin, 2002). Traditional gender role beliefs may also have negative impacts on men, as food shortages and lack of agricultural opportunities may cause stress or mental illness in males who are typically expected to provide for the household, or who are expected to behave heroically during natural disasters and thus make life-risking decisions (Brody, Demetriades, & Esplen, 2008). In other words, people may

be pushed to the extreme margins based on gender and intersecting identities and experience profound discrimination or other consequences.

Policies meant to address adaptation and mitigation to climate change also need to take considerations of intersectionality into account. Women's and men's social position is constructed in relation to their other forms of identity (e.g., race, class, marital status, sexual orientation), and their agency and ability for adaptation and mitigation may largely depend on cultural norms and beliefs about these different groups (both in terms of their voice in the debate and their vulnerability on the ground; e.g., see AWID, 2004). For example, people have different needs and connections to the environment based on gender, location, religion, and education. Some women are solely dependent on clean water supply and food production in their immediate area, while the wealth or education of other women allows them to bypass some climate change impacts by getting food and water from sources further away from home. Thus, the risk of climate change may be higher for someone more connected with nature (either physically or psychologically). But risk can also be temporal and based on whether there are more immediate stressors in life. In such cases, poor women might be financially restrained from adaptation strategies whereas wealthy women might have fewer restrictions and educated women might have better access to people and places where they can make their voices and opinions on climate change adaptation strategies heard.

Similarly, the decisions made about how to enhance adaptation and mitigation of climate change need to incorporate local knowledge and worldviews. Not only do many national policies attempt to define the "best" solutions for people and cultures without asking for the viewpoint of those groups, but they may also actually harm or disproportionately penalize members of those groups (Denton, 2002). For example, agricultural technologies meant for

adaptation to higher heat and drought in many areas of Africa are often more accessible to male farmers, although the majority of agricultural workers in many areas are women. Alternatively, when asked what would help them to adapt best, women in the Ganges River basin, for example, request safer living spaces and information and knowledge about agricultural practices, rather than new technologies (Brody et al., 2008). Even though many groups have begun to recognize the importance of having a “gender” policy (or a policy meant to address gender differences), without intersectional perspectives these will be based on normative (i.e., White, middle class, heterosexual, etc.) experiences rather than understanding and addressing all women’s experiences.

Additionally, strategies based on an assumption about a maximum tolerable increase in temperatures are based on Northern, wealthy, and industrialized perspectives about what is an acceptable amount of change. For example, while the “global” community (namely, the United Nations) has agreed that a two degree Celsius change in global temperature is acceptable, this level of temperature increase will further harm communities which are already experiencing harmful climate impacts (Shaw, 2009). As Seager (2009) argues, “for whom is two degrees acceptable?” Climate change is creating negative impacts *now* for many people in the global South and will only get worse as the climate continues to change. Decisions regarding climate change adaptation and mitigation need to take into consideration the viewpoints and concerns of those who do not have the ability to ward off the consequences with technology and wealth and who do not have such an invested interest in continuing to use natural resources which contribute to climate change impacts in order to sustain what is ever more becoming a privileged existence.

<h1>Human Behavioral Contributions

Human activity is a main contributor to global climate change. It is necessary to include human activity, along with other natural transformations (volcanoes and solar activity), in order to explain late twentieth century warming (Meehl et al., 2004). Increases in greenhouse gases are a result of increased reliance on fossil fuels, land use that impedes the ability of the earth to absorb greenhouse gases, and exponential population growth (more precisely, the growth of the number of households; Carr, Suter, & Barbieri, 2006; Druckman & Jackson, 2009; Petroni, 2010); Stern, Young, & D. Druckman, 1992; Swim, Clayton, & Howard, 2011). We focus here on activities that involve the use of fossil fuels and specifically the production of CO₂ because this is a primary focus of many why study increases in greenhouse gases (Intergovernmental Panel on Climate Change [IPCC], 2007; Solomon, Plattner, Knutti, & Friedlingstein, 2009; Stern et al., 1992). Below we discuss behavioral analyses of human contributions to climate change, predictors of these behaviors, and methods of changing these behaviors.

<h2>Analyzing human mitigation behaviors

Practically, it is useful to understand which behaviors result in greenhouse gas emissions, but this is not always a simple deduction, in part because human activities both directly and indirectly create to greenhouse gases. Direct contributions occur during the time when the activity is occurring, such as when driving a car. Indirect contributions occur behind the scenes, in preparation of an activity or after an activity. For instance, emissions at the beginning of the life cycle of a product (upstream emissions) include the emissions created during extraction of materials and the manufacturing, assembly, and delivery of products. Emissions at the end of the life cycle (downstream emissions) include emissions created during the process of collecting, recycling, and incinerating waste (Environmental Protection Agency, 2006). Emissions from one behavior can also be linked to other behaviors. For instance, using

the internet involves the energy that runs the device (e.g., a computer, phone, etc.), the energy used to connect to the internet, and the energy to run the internet, all of which contribute greenhouse gas emissions.

The distinction between direct and indirect contributions is important psychologically. One might argue that it is more fruitful to attend to direct than indirect contributions, in part because households can monitor and control their direct contributions. For similar reasons, it might be easier to assess the success of behavioral efforts to reduce direct emissions. Plus, indirect contributions often include sources outside of a country, such as the production of material goods. Bin and Dowlatabadi (2005) note that about 40% of UK households' indirect contributions come from sources outside of the United Kingdom. Yet, indirect sources need to be addressed because, for example, in the U.S. and U.K., they account for more emissions than direct emissions (Bin & Dowlatabadi, 2005; Druckman & Jackson, 2009). Collectively, household behaviors can influence indirect contributions by creating consumer demand for environmentally sensitive products (Collins, Steg, & Koning, 2007). Further, attention to the full lifecycle of a product connects consumer behavior to other ethical considerations such as fair labor practices and the treatment of animals.

Categorizing sources of emissions into types of human activities brings one closer to understanding the specific behavioral sources of climate change. In the United States, about a third of CO₂ emissions come from transportation, with gasoline for personal vehicles accounting for about half of the emissions from transportation (Environmental Protection Agency, 2010). Other sources of CO₂ emissions are industrial (about 27%), residential (21%), and commercial end use (19%). Attention has also been given to food production as a source of emissions though its focus is often on Methane and N²O (Environmental Protection Agency, 2010). For example,

meat consumption, and thus factory farms animals (particularly cows) contribute to methane (Jorgenson, 2006). A functional classification of household consumption patterns reveals that recreation and leisure (25%) and food and catering (22%) contribute the most to greenhouse gases in UK households, suggesting a need to develop alternative ways to engage in leisure activities (Druckman & Jackson, 2009). It is also possible to examine regional variation in contribution to greenhouse gases. In the United Kingdom, those living in suburbs contribute substantially more emissions than those living in cities (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009). This could be a function of wealth and the tendency to purchase more products and services, but it also could be a function of the efficiency of city living, including the ability to forgo or minimize private transportation. Understanding these types of variations can point to reasons why individuals do these activities and potential ways to change behaviors.

A useful alternative analysis of behavioral contributions is an assessment of the extent to which different behaviors could help *reduce* emissions. Dietz and colleagues (2009) estimated that, among 17 impactful behaviors, purchasing fuel-efficient vehicles is the most effective direct method of reducing emissions in the United States. Other impactful behaviors include carpooling and trip-chaining (e.g., combining two car trips to the store into one), weatherizing one's home, driving more efficiently, upgrading appliances and heating and cooling systems, and setting back thermostats. Based on typical compliance rates, they calculate that a 7.4% reduction in U.S. national emissions could occur with smart policies and social encouragement to change these 17 behaviors. To put this percent into perspective, in November, 2010, President Obama proposed a goal of reducing U.S. emissions by 17% over the course of 10 years.

A limitation of these assessments is our ability to measure behaviors. Sometimes behavior frequency is inferred based upon amount of money spent within a country which, while

correlated with frequency of consumption, may, for instance, misrepresent the extent to which expensive behaviors create emissions (Swim et al., 2011). Other times behavioral frequency estimates are based upon self-reports which can be flawed (Schwarz, 2001). Emerging technologies such as smart meters that can transmit household energy use to others (Wallenborn, 2011) and the use of global positioning devices (i.e., GPS) to assess speed and distance traveled in cars (Bolderdijk, Knockaert, E. M. Steg, & Verhoef, 2011) may overcome these limitations.

<h2>Predicting human mitigation behaviors

Understanding psycho-social predictors of behaviors that contribute to or reduce greenhouse gases is a starting point for understanding how to reduce human contributions to climate change. Darnton (2008) describes nine types of predictors of pro-environmental behavior: 1) information, 2) values, beliefs, and attitudes, 3) norms and identity; 4) agency, efficacy and control; 5) habit and routine, 6) emotions, 7) self regulation, 8) external factors, and 9) societal factors. Some models draw on several of these variables, such as the Value-Belief-Norm model (Stern, 2000), references the second (value, beliefs, and attitudes) and the third (norms and identity) type of predictor. Yet the distinctions in variables from the different models are useful for an analysis here of the psychological processes involved in mitigation behaviors. We discuss eight of these nine predictors (saving self-regulation for a latter section) and describe decision-making processes that influence behavioral choices.

<h3>Information.

The public's lack of information about personal climate change mitigating behaviors is revealed by its underestimation of the extent to which certain behaviors produce relatively a lot of CO₂ and the overestimation of the extent to which other behaviors produce relatively little CO₂ (Attari, DeKay, Davidson, & Bruine de Bruin, 2010)). Knowledge about the extent to

which different behaviors produce CO₂ is useful for individuals who are motivated to reduce emissions as well as policy makers who want to know which behaviors to target. However, individuals' behavioral choices are not typically based upon energy savings (Poortinga, Steg, Vlek, & Wiersma, 2003) and, while information may be necessary for some behaviors, it alone is not likely to be sufficient to predict behaviors (see Schulz, this volume).

Values, beliefs, and attitudes.

Much attention has been given to environmental values, beliefs, and/or attitudes in the general literature on environmental behaviors. Thus, it is not too surprising that these predictors would, in general, predict personal mitigation behaviors and support for policies that would address climate change. For instance, self-transcendent values in the form of biospheric values and concerns are associated with willingness to engage in behaviors and support policies that would directly and indirectly reduce emissions whereas self-enhancement values in the form of egoistic values and concerns are negatively related to these behaviors (Steg, DeGroot, Dreijerink, Abrahamse, & Siero, 2011; Steg & Dreijerink, & Abrahamse, 2005; Swim & Becker, 2011). Like self-transcendent values, intrinsic aspirations focus individuals beyond themselves and are associated with engaging in ecologically responsible behavior that would reduce emissions, (Crompton, 2008; de Groot & L. Steg, 2010a). These distinctions are important when considering the egoistic approaches, such as financial incentives, to encouraging pro-environmental behaviors (cf., Schulz, this volume). That is, emphasizing financial returns could backfire because they reinforce extrinsic motivations (Crompton, 2008). Yet, financial considerations do influence decisions particularly in business settings and these considerations can promote decreases in emissions. Values can play a role in business decisions while still attending to fiscal concerns when business leaders perceive, for instance, that sustainable

practices are opportunities for business growth, energy savings result in cost savings, and early action on climate change outweigh the eventual costs (Revell, Stokes, & Chen, 2010).

<h3>Norms and identity.

Much attention has been given to the predictive power social norms over economic incentives and appeals to environmental concerns, even when people are not aware of the power of such norms (Schultz, Jessica M Nolan, Cialdini, N. J. Goldstein, & Griskevicius, 2007). Group identity can also be important if it directs people toward the common good rather than gratification of immediate self-interest (Van Vugt, 2009). Consistent with this finding, a global perspective enhances support for cooperation with others who are globally distant, suggesting that a broad identification with humans would help address the global problem of climate change (Buchan et al., 2009). Yet, if identification is restricted to feeling connected with humans, animals may be treated as out-group members and this differentiation may prevent some forms of mitigation (Crompton & Kasser, 2009; Plous, 2003). These considerations are related to the importance of environmental identity and whether one's "Scope of Justice," or the breadth to which one is willing to apply roles of justice, is applied to people and animals harmed by climate change (Clayton & Opatow, 2003; Opatow, 1996).

<h3>Agency, efficacy, & control.

Agency, efficacy, and control refer to perceived and actual ability to engage in a behavior of interest and the effectiveness of behaviors to make a difference (Darnton, 2008). The importance of these perceptions provide an opportunity for public education and informational campaigns, such as information regarding the effectiveness of individual actions at reducing emissions, particularly when combined across different types of behaviors (Dietz et al., 2010). Individuals

may also feel more efficacious when they engage in collective action, knowing that the effects of their behaviors are combined with others' behaviors (Van Vugt, 2009).

<h3>**Habits and routines.**

Habits are behaviors that are done frequently and automatically and are often cued by something in the environment (e.g., Verplanken, 1997). Climate change mitigating behaviors include both onetime behaviors, such as purchasing efficient appliances, as well as lifestyle changes (e.g. walking, biking, car pooling, or taking public transportation rather than driving one's personal car to work), which may involve changing habits and routines. Lifestyle behaviors have to be repeatedly constrained or enacted making them more difficult to change. Plus, individuals tend to prefer technological improvements over lifestyle changes, suggesting that it may be difficult to get individuals to adopt lifestyle changes (Poortinga, et al., 2003) and therefore make them less effective at reducing emissions. Yet efforts that address lifestyles and habits are part of a larger package of obtaining behavioral changes.

<h3>**Emotions.**

Emotions can be powerful predictors of behavior and are likely to be aroused when people think about climate change. Appraisal theory of emotion suggests that those who perceive climate change to be a risk are likely to experience fear or worry and those who perceive they or their country are responsible for climate change will likely experience individual or collective guilt, respectively (Swim & Bloodhart, 2011). These emotions can then influence behaviors such as when collective guilt predicts support for climate change policies (Ferguson & Branscombe, 2009). Other emotions (e.g., hope, empathy, pride, moral outrage, and boredom) are also likely to be important for predicting willingness to engage in climate change mitigating behaviors (Swim & Bloodhart, 2011). For instance, volunteer behavior that benefits

the environment helps people feel pride in their efforts to address climate change (Nevin, 2010). Such positive consequences can encourage individuals to change and sustain their own behaviors (Neuringer, 2010).

<h3>**External factors.**

External factors are predictors beyond the individual that influence behaviors (Stern, 2000). It can be practically beneficial to explicitly identify external factors that are barriers, as is done within Community Based Social Marketing (McKenzie-Mohr & Smith, 1999), and help individuals overcome the barriers. External factors, including time, money, and responsibility to others, can hamper individuals and businesses in following through on practices that could reduce emissions (e.g., Free, 2010; Revell et al., 2010). External factors, however, can also prompt climate change mitigation. For instance, government regulations and shareholder actions, which can be considered external to those in management, can encourage or even mandate energy reduction in businesses (Reid & Toffel, 2009).

<h3>**Societal factors.**

Societal factors provide a backdrop for individual behavior and reflect macro-level external predictors of behaviors (Swim et al., 2011). Of importance to human consumption, societal factors can include the impact of culture on perceptions of what is considered a necessity versus a luxury, the relative importance of consumerism (a cultural foundation for materialistic tendencies), cultural level values such as aspirations of mastery over harmony and hierarchy over egalitarianism and perceptions and valuing of time which can influence willingness to plan for and address future problems now and perception of time as a resource.

<h3> **Decision making.**

Decision making about climate change mitigating behaviors faces many uncertainties: about when various impacts will occur; whether there will be tipping points in impacts; the extent to which individual behavioral changes will aid adaptation or mitigation; whether others will also change behaviors making one's own behavior more meaningful; and, whether undesirable or unintended effects of responses to climate change, such as threats to security, will occur, to name a few. Research on decision making under uncertainty has been applied to understanding responses to environmental risks and some have illustrated how it can be applied to understanding responses to climate change (e.g., Rachlinski, 2000; Weber & Stern, 2011). As one example, a preference for the certainty of the status quo over an unknown future can impede action (Rachlinski, 2000). One explanation for the status quo bias is loss aversion, where individuals are reluctant to sacrifice current benefits even for other benefits (Rachlinski, 2000). Greater concern about losses than gains suggests that individuals will be more concerned about potential losses from mitigation, such as jobs in the coal industry, than potential benefits that might arise from these mitigation efforts, such as jobs in the field of renewable energy. This example is related to asymmetric discounting where individuals discount future rewards in exchange for current consumption, even when the current consumption is worth less than the future rewards (Milch, Weber, Appelt, Handgraff, & Krantz, 2009).

Another approach to understanding decision making is to understand how groups and not just individuals make decisions (Kempton & Neiman, 1987). Understanding group decisions can be important for understanding household decision making. Some of the early work on household energy use and audits attended to these types of decision making processes (Kempton & Neiman, 1987) and interest in this topic has returned in part as a result of new technologies available to monitor household energy use and renewed interest by energy companies in assisting

household energy conservation (e.g., Armel, Flora, Houde, Sudarshan, & Todd, 2010a; Herter, 2010; Karlin, 2010;).

It may also be important to consider *how* decision making in households is done. Gender roles, for instance, may determine who has influence over different types of behaviors (Gronhoj & Olander, 2007). This also suggests that an important predictor of household decision making will be the composition of individuals living together because most households are not composed of traditional family units of heterosexual parents with children living at home. A range of other decision making situations are also relevant to study. These include climate change-relevant decisions made by boards of directors (Galbreath, 2010; Prado-Lorenzo & Garcia-Sanchez, 2010) governmental bodies form policies make decisions that influence opportunities for residents (Stern, 2011).

<h3>Limitations

The models used to derive the predictors noted above have not always been tested with environmentally significant behaviors, relying instead on health behaviors or community participation (e.g., voting), and when they do test environmentally significant behaviors, the behaviors are not always those with the most impact on climate change. Further, it is likely important to differentiate between different types of behaviors such energy investments, lifestyle changes, and activism.

A second limitation is that these models do more to describe or explain behaviors than to assist in actual behavioral change (Darnton, 2008). Models that describe predictors of behaviors can be useful for behavioral change (see, for instance, Maio et al., 2007), but tend to be linear, depicting factors that precede behaviors. Instead, models of change tend to include reciprocal relations, developmental changes, and mechanisms for deep psychological or system-wide

changes, which attend to more fundamental processes of change that can be necessary for more comprehensive and long term change.

Promoting human mitigation behaviors

Much research in psychology has focused on communication and diffusion instruments, such as information and persuasive appeals, and secondarily on financial incentives, as means of encouraging behavioral change (Stern, 2011; see Schultz, this volume for an extensive review). This includes practical advice on how to take advantage of psychological insights into decision making and responses to persuasive messages to increase the effectiveness of climate change communications and interventions (e.g., Center for Research on Environmental Decisions, 2009). Social marketing is perhaps the most well known application of psychological methods and findings to encourage sustainable behaviors, many of which would address climate change (McKenzie-Mohr & Smith, 1999). This method identifies behavioral barriers specific to communities via social science methods such as surveys and focus groups, applies social influence processes to help with behavioral change such as using public commitments, social norms, and behavioral prompts, and using principles from program evaluation to pilot and improve the program.

A related approach takes into account factors that influence behavioral decisions when designing interventions to change behavior. This is the basis of “paternalistic libertarianism” (Thaler & Sunstein, 2009), where contexts are designed to increase the probability that individuals will chose to do a behavior and counter decision making processes, such as hyperbolic discounting, that would hinder individuals from doing the behavior. For instance, www.Stikk.com is a web site that applies principles of behavioral economics to help individuals change behaviors. This web site provides a mechanism that encourages personal behavioral

commitments for a future goal (which could include routine pro-environmental behaviors) and sets up losses in the form of monetary payments to others should users not meet this commitment. Other examples include designing roadways that encourage slower driving and financial incentives to encourage companies to regulate their emissions. There are concerns, however, about applying paternalistic libertarian approaches to climate change mitigation. One objection is policies may be set up without the input of those affected by them, which will occur when policies affect future generations (Schlag, 2010). When this occurs, there may be reactance or unanticipated harms.

A third approach to behavioral change focuses on behavioral change processes. Darnton (2008) identified five different behavioral change approaches which we review below. These approaches are: 1) changes in habits, 2) changes across time within individuals; 3) changes across time within and across social networks, 4) change as learning, and 5) changes in systems.

Changes in habits.

Changing habits fits into a larger area of research on changing lifestyles, including changing unhealthy eating, smoking, and driving behaviors, as well as energy conservation (Maio, et al., 2007). Efforts to change habits focus on individuals' efforts to change behaviors or focus on surroundings that cue and enable behaviors. Critical self-analysis can help "unfreeze" behavior by identifying automatic behaviors and cues that activate the behavior (Darnton, 2008). It is also possible to change environments to cue new behaviors, such as through financial incentives and structural changes (see Schultz, this volume). Once change has started, a challenge is to avoid reverting back to an old behavior or developing new habits ("refreezing behaviors"). This latter process can be aided by anticipating situations that would lead to old behavioral habits and

establishing plans to address these situations should they emerge (e.g., Bloodhart, Swim, & Zawadzki, 2011; Gollwitzer, 2006).

<h3>**Changes across time within individuals.**

Process models of change explicitly include a temporal dimension to change. Self regulation models are one example of one of a process models that take into account feedback mechanisms. For instance, self-regulation involves responding to discrepancies between one's current state relative to a standard, attending to the consequences of these responses and readjusting behavior should it be needed to meet one's standard (Carver & Scheier, 2011). . Self-regulation also provides a connection to emotions, because affective states (e.g., self-reflective emotions or approach and avoidance emotions) can result when one's current state is compared to a desired state. Stage models describe the development of change over time. According to one theory, individual behavioral change occurs in stages: pre-contemplation, contemplation, preparation, action, maintenance, and termination (Grimley, Prochaska, Velicer, Blais, & DiClemente, 1994). Although criticized for various reasons, including the practical difficulty in differentiating and identifying which stage individuals are in, the model is useful in noting that individuals may be at different stages of change and, as such, may require different types of interventions. Applying a decision making process to reducing emissions, it is potentially useful to distinguish pre vs. post energy upgrades decisions (Wilson, 2010; 2011). When doing so, however, it is important to realize that the reasons people give after making a decision may reflect justifications, rationalizations, or realizations and not the original motivations that led to their behaviors.

<h3>**Changes across time within and across social networks.**

Change processes can also occur within and across social networks. The implications of social networks for health have been well researched (Smith & Christakis, 2008), including access to social support, social influence processes, social engagement, and access to resources (Berkman & Glass, 2000). These same factors are likely important for climate change mitigating behaviors and may explain the success of neighborhood interventions used to encourage pro-environmental behaviors and social movements (Staats, Harland, & Wilke, 2004). Understanding how information, attitudes, and behaviors flow through networks and how social networks adapt to changes can be important for understanding how to influence large groups of individuals. These processes which involve interpersonal channels of communication may be particularly important in a culture that is saturated with marketing campaigns all vying for individuals' attention.

The Innovation-Diffusion model (Rogers, 2003) is perhaps the most well-known description of the spread of new behavioral practices through social networks, although it does not provide a full description of the different types and qualities of social networks. The innovation-diffusion model describes rates of change through a community starting with innovators and moving to the last people to adopt an innovation, and highlights the importance of key individuals to facilitate these changes. This model has frequently been used to describe or assist the acceptance of new technologies within communities. As such, this model is likely useful for understanding the diffusion of green technologies and behaviors within communities. The model is also useful for attending to key individuals who can promote change within organizations. For instance, many universities employ students to help spread pro-environmental messages through campuses and attention to processes involved in innovation diffusion can assist the success of these programs (Zawadzki, Swim, Bloodhart, & Lenz-Watson, 2011).

Champions can also be influential in business contexts such as when particular individuals influence sustainability investments (Lewis & Carmen, 2010). Innovation-diffusion can potentially be strengthened when combined with social marketing approaches (Dearing, Maibach, Buller, 2006).

It is important, however, to acknowledge ethical criticism of innovation-diffusion models (Lambert, 2007; Stephenson, 2003; Yappa, 1977). One criticism is that the model assumes equality within communities. When there are inequalities, wealthy individuals are likely the first to adopt and benefit from an innovation. When their success improves their ability to produce more products at a lower cost, they can gain a competitive advantage that increases the gap between the wealthy and the poor. A second criticism is applicable when the value of innovations is determined by people outside a system and not those within a system. Reactance to these efforts or lack of sensitivity to cultural concerns about the innovation can impede the success and spread of innovations.

Change as learning.

Learning models focus on the processes by which individuals learn new ideas and behaviors. Learning models can involve learning what behaviors are most likely to reduce emissions as well as learning skills to accomplish behavioral goals or overcome habits. The information-motivation-behavioral skill model is an example of a learning model that has successfully been used to encourage the adoption of health behaviors (Fisher, Fisher, Bryan, & Misovich, 2002). It has also been used to examine recycling (Seacat & Northrup, 2010), has the potential for addressing climate change mitigating behaviors, and can be practically helpful for interventions.

Other learning models seek to understand deeper, transformational learning, which supports complex problem solving and engages learners in the process of change (Darnton,

2008). The double-loop learning model is an example of such transformational learning processes. In this model, learning is composed of one loop where individuals engage in efforts to change a particular behavior, and a second loop where individuals reflect upon feedback from their first loop learning efforts. This reflection results in changes in mental models or beliefs systems that can influence behavioral assumptions, goals, and strategies (Argyris & Schön, 1978). Hall, Taplin, & Goldstein (2009) illustrated this process through an Australian community's efforts to address climate change policy.

<h3>Changes in systems

Double-loop learning is related to a larger set of behavioral change models that are grounded in systems thinking which attends to how parts feedback processes and interrelations between parts of systems predict change within a system (Hutchins, 1996). When applied to behavioral change, interventions to assist in changing systems focus on process rather than on how to achieve a particular outcome (Chapman, 2004). As a result change is more participatory and less directed by those outside of a system. Systems theory is a component of Earth Circles (2011) which involve small groups of individuals that think deeply about climate change and devise their own personal responses to climate change. They reflect on the web of life and how understanding climate change requires thinking about connections across people and the planet. From these reflections participants first address their own feelings of pain about environmental problems and, after doing so, proceed to actions developed from the group context. An example of a community-based systems approach is “transition towns,” in which individuals work together to create changes in their community and connect to other communities doing the same (Transitionnetwork.org, 2011). A principle of these efforts is that whole systems are the source of problems and not just isolated individual behaviors (such as recycling or driving smaller cars).

As a result, changes have to address the complexity of system problems and not target individuals alone, in order to bring about behavioral change at both the individual and system levels. Ecological approaches by community psychologists are consistent with systems approaches to behavioral change (Kagan, 2011).

Changes in systems are particularly important in order to fully address climate change and its impacts. That is, it may be insufficient and unrealistic to expect individuals to alter a specific set of behaviors without also attending to larger changes in the social and physical system where that behavior resides (Moisander, 2007). Further, more radical alterations in the way that everyday lifestyles, work and leisure are needed in order to achieve the degree of change necessary to reduce emissions within high emitting communities, improve living standards within other communities, and maintain and restore biodiversity and animal habitats. Change will require time and willingness to let go of particular mindsets about how the world should operate and openness to new possibilities that emerge through consideration of different views which can and cannot be represented (e.g., future generations and animals).

Psychologically, this requires, for instance, devising methods that encourage individuals and groups to step outside of typical patterns of thought, perhaps via mindfulness training (e.g., Brown & Kasser, 2005) and attending to ways that teams and organizations make decisions (e.g., Mohammed, Ferzandi, & Hamilton, 2010). In addition, it likely requires educational efforts, noted earlier, to increase the perceptions that climate change as is an important enough problem worthy of the extended effort to devise adaptation and mitigation efforts.

<h1>Conclusion and Future Directions

Climate change can be understood as a symptom of a larger issue, namely, the imbalance in the relations between humans and the natural world. It goes beyond our normal senses

because it requires interpretation of current and projected patterns of events. As such, it requires trust in scientists because members of the public do not have the training to understand the data describing these patterns of events. Given the projected and anticipated impacts on people and the biosphere, it is imperative that people engage in adaptation to prepare for and cope with the impacts and mitigation to forestall even worse impacts. Additionally, considerations about differential vulnerability and resilience to global climate change needs to be taken into account when adaptation and mitigation strategies are proposed, and those who are impacted need to be given a chance to voice their differential concerns and needs.

Many need to be involved in this process and psychologists play an essential role. The present review illustrated numerous ways that psychologists can participate. More research needs to be done to be able to address the divide between those who believe and do not believe in climate change and to activate those who are not engaged. While the divide may appear large, it is possible that the gap can be addressed by listening to the issues and beliefs expressed by all sides of the debate to learn to better communicate (Hoffman, in press). Work needs to be done to be able to effectively change human behavior, not only in terms of household lifestyles and consumer choices, but also with respect to corporate decision- and policy-making. Individuals can only go so far in changing their behaviors. Yet, individual behaviors and consumer demands can influence larger organizations (Collins, Steg, & Koning, 2007). More research is needed to better understand the ways that systems can change to provide the context for behavior change and social movements in order to activate large-scale changes. Psychological tools for changing behavior will be critical for achieving these changes. However, these tools need to be integrated into changes in social systems.

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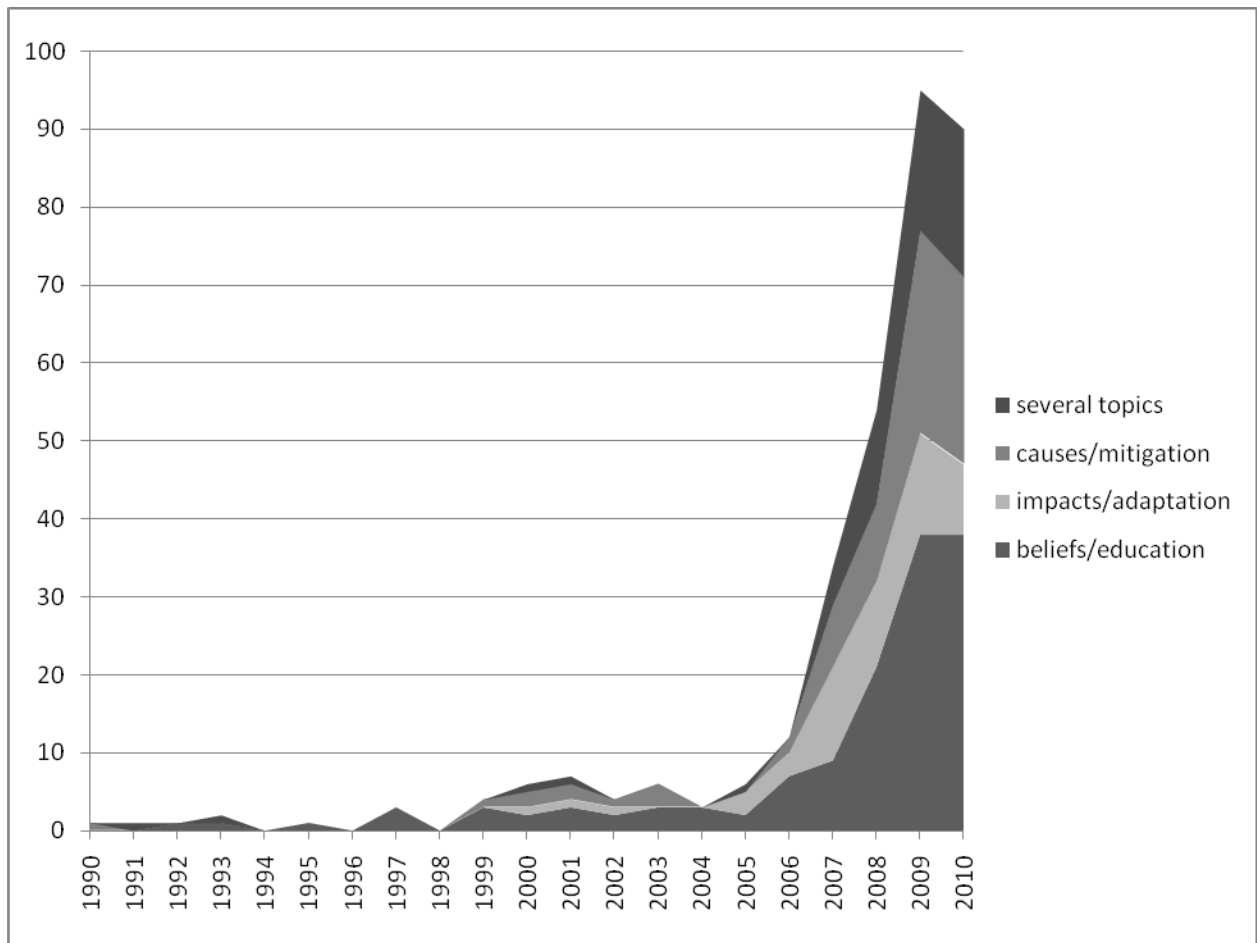


Figure 1: Search of scholarly articles from 1990 to 2010 using words “climate change” or “global warming” in PsychInfo.

Endnotes

¹ These differences likely have to do with the item wording used by Gallup and Pew; Pew asks participants, “Is there solid evidence the earth is warming: Yes, because of human activities; Yes, because of natural patterns; Yes, but don’t know why; No; Don’t know” while Gallup asks, “From what you have heard or read, do you believe increases in the earth’s temperature over the last century are due more to: the effects of pollution from human activities or natural changes in the environment that are not due to human activities?”