The Pennsylvania State University

The Graduate School

College of the Liberal Arts

FOSTERING DISCUSSION: THE ROLE OF KNOWLEDGE AND PERCEIVED AGREEMENT IN ENCOURAGING DISCUSSIONS ABOUT CLIMATE CHANGE

A Thesis in

Psychology

by

Austin Nathaniel Geiger

Submitted in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science

August 2015

The thesis of Austin Nathaniel Geiger was reviewed and approved* by the following

Janet K. Swim

Professor of Psychology

Thesis Adviser

Melvin M. Mark

Professor of Psychology

Head of the Department of Psychology

Martha E. Wadsworth

Associate Professor of Psychology

*Signatures are on file in the Graduate School.

Abstract

Climate change is a socially relevant topic that few Americans discuss regularly. In this thesis, I review previous literature on three potential barriers to discussion of the topic: lack of concern, pluralistic ignorance, and lack of knowledge. Following this literature review, in two studies I examine the effectiveness of two manipulations designed to increase discussion in a laboratory setting: one to alleviate pluralistic ignorance, and one to increase climate science knowledge. In Study 1, I find that increasing climate science knowledge, but not alleviating pluralistic ignorance, increases willingness to discuss climate change. In Study 2, I again find that alleviating pluralistic ignorance does not increase willingness to discuss climate change, but unlike Study 1, increasing climate science knowledge is only effective at stimulating discussion when pluralistic ignorance is also alleviated. Mediation analyses reveal that the effect of knowledge on stimulating discussion among those who believe others are concerned may be driven by increased self-efficacy and reduced fear of isolation. In post-hoc analyses, I explore these results in more detail.

Table of Contents

List of Figures

List of Tables

Acknowledgements

Thanks to the Penn State Sustainability Psychology lab for their assistance running the study sessions and help entering Study 1 data into the computer. Thanks to Janet Swim for chairing my committee and providing advice and feedback on project design and experimental methods. Thanks to Mel Mark and Martha Wadsworth for participating in my committee and providing suggestions on experimental design and measure inclusion. This research was partially supported by NSF Grant DUE 1239775.

Chapter 1. INTRODUCTION

Climate change is likely to be one of the defining social issues of the 21st century. The average global temperature has risen by 0.6˚ C in the last century and if no action is taken, global temperatures may rise by 6-8˚ C by the end of the current century (IPCC, 2013, 2014). This increase in average global temperature is projected to lead to a number of severe negative outcomes, including oceanic flooding of major cities, crop failures, water shortages, and increased spread of disease.

To reduce climate change and the likelihood of the most severe negative effects occurring, sustainable development plans call for the United States to reduce its carbon emissions by 80% by the year 2050 (e.g. Presidential Climate Action Project, 2011). The first major steps to doing so have been proposed by the current presidential administration, which has committed to reducing carbon emissions by 17% (relative to 2005 levels) by the year 2020 (Change.gov, 2014) and 28% by the year 2025 (White House, 2015). However, attempts to reach these goals have highlighted disagreements with proposed policies to mitigate climate change. For example, a major push for impactful climate legislation in 2010 ran into a fervent minority of politicians who were able to use the filibuster to block the passage of this landmark bill (Walsh, 2010). More recently, the Senate majority leader, who opposes these emission reductions, has vocally encouraged state governments to ignore recently enacted climate policies (McDonnell, 2015).

Faced with these competing demands, local, state, and national governments may be influenced by a strong grassroots social movement supporting action on climate change. However, few Americans report meaningful engagement with efforts to address climate change (Leiserowitz, Maibach, Roser-Renouf, & Feinberg, & Rosenthal, 2015). In the current thesis, I

will focus on one manifestation of public engagement with which Americans report low involvement: interpersonal discussion of climate change. Surveys over the past few years have found low and declining rates of climate change discussion, with one-quarter of Americans currently reporting regular discussions climate change with friends and family (Leiserowitz et al., 2015).

The focus of the present research is on identifying factors which facilitate scientifically grounded discussion of climate change. Below, I will first describe the importance of interpersonal discussion about climate change. Next, I will review previous research with regard to several potential barriers to discussion of climate change. Finally, I describe the results of two laboratory experiments designed to test the effects of manipulations designed to overcome barriers to discussion.

Chapter 2: POTENTIAL OUTCOMES OF SCIENTIFICALLY GROUNDED DISCUSSION

Many researchers and climate advocates have called for interventions to promote greater public engagement with climate change (e.g., Maibach, Roser-Renouf, & Leiserowitz, 2008). Public discussion of climate change is an important form of engagement. Scientifically grounded discussion of climate change has the potential to affect numerous outcomes directly related to climate change, including increased perceived risk, political priority of the topic, public knowledge, and the likelihood of developing effective solutions. Although these outcomes are not directly assessed in the present research, I describe them below to contextualize climate change discussions.

Increased Perceived Risk

Risk perceptions are influenced by interpersonal discussion. The Social Amplification of Risk framework (Kasperson et al., 1988) revolutionized the field of risk perception by proposing that individuals understand risk largely in terms of the messages they receive from others and the media, rather than the objective qualities of the risk. Characteristics of certain risks lead some risk messages to be socially amplified (i.e., the seriousness of the risk is exaggerated), while other risks may be socially attenuated (i.e., the seriousness of the risk is downplayed). High levels of interpersonal discussion and media coverage of a risk tends to amplify the risk, while little media and interpersonal silence regarding a risk tends to attenuate the risk (Kasperson & Kasperson, 1996). Group polarization processes that occur during discussions may also lead to risk amplification or attenuation depending upon the original views expressed by group members (Isenberg, 1986).

The widespread interpersonal and media silence around the topic of climate change may serve to socially attenuate the risk (Renn, 2011; Pidgeon & Fischhoff, 2011). A majority of Americans already express belief in and concern about climate change (Leiserowitz et al., 2014) when directly asked about the topic. However, few of these people are hearing about climate change from those close to them - only 15% of the US population reports that someone close to them mentioned climate change in a conversation. This lack of conversation may reduce the salience of the topic and contribute to making the issue seem less risky than the scientific experts suggest that it is (IPCC, 2014). Thus, if those who are concerned about climate change but not currently engaged with the topic were to discuss it more, many of them might begin to perceive the risk as greater than before, which might then lead to other positive consequences such as greater engagement with the topic.

Increased Political Priority

"Ma'am, I'd like to do all those things. But if I'm reelected, you must make me." – Franklin D. Roosevelt, 1936

U.S. history reveals that there has been little prioritization of major legislation to mitigate or adapt to climate change at the federal level. Beginning with Lyndon B. Johnson in 1965, various presidents and high-level politicians have acknowledged the potential consequences of the widespread burning of fossil fuels (Oreskes, 2007). In 1992, George H. W. Bush signed a treaty calling for immediate action to mitigate climate change, which was later unanimously ratified by the U.S. Senate. However, beyond symbolic measures such as these, federal lawmakers have been more hesitant to pass specific legislation that might exert a substantial effect at reducing harmful carbon pollution. For example, when the Clinton administration signed the Kyoto protocol in 1997, the U.S. Senate unanimously passed a non-binding resolution expressing disapproval of taking action based on this agreement (Byrd-Hagel Resolution, 1997).

During the second half of the first decade of the 2000s, however, the topic of climate change began to garner increased public attention (Gallup, 2010), partially due to increased media and movie releases such as "An Inconvenient Truth," (Nolan, 2010) and several catastrophic natural disasters occurring around the world. Perhaps in response to this increased public attention, for the first time the national political establishment almost converged on a major bill to reduce carbon emissions – the cap-and-trade bill that was nearly signed into law in 2010 (Walsh, 2010). After the bill passed the House, however, there were insufficient votes to overcome a filibuster in the Senate.

Failure to achieve enough support for action can be attributed in part to lack of pressure from the public. Much of the public continued to be hurt by the economic crisis, drawing attention away from this landmark legislation (Scruggs & Benegal, 2012). Public surveys

completed in January 2010, after the cap-and-trade bill had passed the House and was being debated in the Senate, revealed few Americans had learned about the merits of the cap-and-trade bill - 75% of Americans had either not heard of cap-and-trade or had nothing to say about it (Nisbet, Markowitz, & Kotcher, 2012). After the failure of this legislation to pass, many environmental leaders who had pushed for this bill acknowledged that they had lost this battle in part because they had not paid enough attention to maintaining and mobilizing grassroots efforts in key House districts and Senate states (Nisbet, 2015), taking the pressure off politicians to pass this legislation and allowing anti-cap-and-trade elements of the constituency to influence important swing votes. Following the defeat of this bill, climate change took a backseat as an issue relevant to national politics: the presidential election in 2012 was the first in over 20 years in which the candidates did not discuss climate change in at least one presidential debate (Zeller & Zelman, 2012).

Interpersonal discussion may increase prioritization of climate change in part through increasing grassroots mobilization on the topic. Interpersonal discussions can create changes in the spread of awareness across social networks (Funk, Gilad, Watkins, & Jansen, 2009) and is associated with greater political participation relative to the issues (McLeod, Scheufele & Moy, 1999), potentially because discussions increase individuals commitment to the topic, a strong predictor of action (Abrahamse & Steg, 2013). In addition, widespread public discussion of climate change might change social norms, helping to create a political environment supportive of activists and politicians supporting climate change action and decreasing the fervency of opposition among politicians firmly opposed to climate change action.

Increased Public Knowledge

Improved public knowledge and understanding of the topic may be another benefit of discussing climate change. Currently, many Americans are uncertain or uninformed about basic or crucial components of understanding climate change and the climate system (e.g. Reynolds, Bostrom, Read, & Morgan, 2010). This may be partly due to the complexity of climate change, a phenomenon that may be "intrinsically difficult to understand" (Weber & Stern, 2011). Similarly to other complex scientific topics, climate science may require repeated exposure and discussion to clarify confusing points and result in a more complete understanding. If the discussion is grounded in the actual science (what Barabas, 2004 refers to as deliberation), then increased discussion could serve to increase public understanding of the issue. Discussions could also prompt interest in the topic which could result in people seeking out information to better understand the topic (Owens, 2000). However, if interpersonal discussion about climate change is based on misinformation, then the discussion may result in further confusion and misunderstanding.

Increased Development of Acceptable Solutions

Discussion of climate change is also likely to result in an increased likelihood of discovering publically acceptable solutions to the issue (Owens, 2000; van Kasteren, 2014). Scientifically grounded discussions of climate change can examine costs and benefits to currently proposed solutions and work on modifying them as needed to fit the local social, economic, and natural conditions. In addition, discussing currently proposed solutions can result in improvement of existing ideas or discovery and dissemination of new ideas, as well as helping to build social capital that could be used to improve the likelihood of community-level solutions succeeding (van Kasteren, 2014; Putnam, 2000, p 95).

Chapter 3: PSYCHOSOCIAL BARRIERS TO DISCUSSION OF CLIMATE CHANGE

Several individual and social factors may converge to prevent discussion on climate change. Three explanations that have been proposed to explain lack of discussion on climate change are as follows: a) Americans are not concerned about climate change, b) pluralistic ignorance leads to avoidance of discussion, and c) Americans are not informed enough about the topic to feel comfortable talking about it. Below, I describe why lack of concern may play less of a role than what may be commonly thought, and examine the purported effects of pluralistic ignorance and lack of knowledge about the topic in reducing discussion.

Lack of Concern

Some Americans may not discuss climate change because it is not an important topic to them. Indeed, national data shows that people who are less concerned about climate change are less likely to discuss the issue on a regular basis (Leiserowitz et al., 2013). However, this explanation cannot fully account for the widespread lack of discourse; poll and survey data consistently reveal that only a minority of Americans are unconcerned about climate change (e.g. Leiserowitz et al., 2013; Pew Polls, 2013). Further, even science educators who are engaged in teaching the public about climate change report not talking about climate change as much as they desire (Swim & Fraser, 2014) and being distressed about their lack of ability to do so (Fraser, Pantesco, Plemons, Gupta, & Rank, 2013). Thus, in order to understand why many concerned Americans do not typically discuss climate change, I examine other potential barriers to discussion.

Pluralistic Ignorance

The Spiral of Silence theory (Noelle-Neumann, 1993) proposes that on topics that are perceived to be politically controversial, people monitor what others think about these topics and

remain silent on controversial topics when they believe that their opinion is not shared by others. In turn, silence leads to the perception that their opinion is uncommon, which leads to even more silence among those who share this opinion. This theory has been applied to a variety of potentially controversial topics (for meta-analyses see Glynn, Hayes, & Shanahan, 1997; Scheufele & Moy, 2000).

Noelle-Neumann (1993) suggests that these perceptions of others' opinions are often highly accurate despite the limited information upon which they are based, leading to expression of the majority opinion and inhibition of minority opinion. On the other hand, *pluralistic ignorance* occurs when people who hold an opinion underestimate how common it is for others to share their opinion because of lack of knowledge about others' privately held opinions (Miller & McFarland, 1987). Taken together, pluralistic ignorance and spiral of silence processes can lead to the majority opinion holders remaining silent.

Research points to the likelihood of a spiral of silence on discussions about climate change. Leviston, Walker, and Morwinski (2013) found pluralistic ignorance about climate change among the Australian public: a majority of Australians were concerned about climate change but most believed that they were in the minority. Geiger and Swim (in prep.) found that that many students believed that a majority of other students doubted the existence of climate change and that students who were concerned about climate change were less willing to discuss climate change when they believed that other students did not share their opinion.

Geiger and Swim (in prep.) identified psychological processes that promoted self-silencing on the potentially controversial topic of climate change. In one study, we examined whether expectations of being perceived negatively by others would mediate the relationship between meta-beliefs and willingness to discuss climate change. We found that expectations of

others perceiving one as incompetent, but not expectations about being unlikeable, mediated the relationship between meta-beliefs about climate change and willingness to discuss climate change. A follow-up study revealed that when people expected that an audience held different beliefs than they did, they not only expected that others would perceive them as less competent for discussing climate change but that this expectation led them to feel less hopeful about their ability to discuss the issue. These two expectations subsequently led less willingness to engage in a discussion about climate change.

Lack of Knowledge

Another barrier to scientifically grounded climate change discussion may be a widespread lack of knowledge about the issue. Indeed, much of the public shows misunderstanding on core components of climate science and the causes and impacts of climate change are often misunderstood (Reynolds et al., 2010; Weber & Stern, 2011; Swim, Fraser, & Geiger, in press). Furthermore, less than half of Americans correctly understand that there is a scientific consensus that human-caused climate change is occurring (Leiserowitz et al., 2014).

The *knowledge deficit model* suggests that lack of engagement in a publically desirable behavior is caused by the public not knowing enough information about the topic, so improving knowledge should lead to behavior change (Schultz, 2002, p. 69). In the past, many behavioral change campaigns took this hypothesis for granted and attempted to educate their audience about an issue without empirically testing whether this would be effective at changing behavior. More recently, the often untested assumptions of knowledge deficit model have been criticized (e.g, Lawlor, Kerridge, Ankeny, & Billson, 2007), and some studies have shown that knowledge-only campaigns are not always effective at changing behavior in many domains, including recycling behavior (e.g., Schultz, 1999).

However, this criticism of the knowledge deficit model should not be taken to suggest that public knowledge of socially relevant topics is not important. A review of the effects of knowledge on pro-environmental behavior (Schultz, 2002) concludes that while knowledge alone is unlikely to inspire an unmotivated audience to change behavior, lack of knowledge can serve as a barrier to pro-environmental engagement. The review, at least with regard to recycling behavior, concludes that some of the controversy may be driven by the fact that disseminating information is likely to increase behavior when people do not know much about the topic, but not when people are already highly familiar with the topic. Other scholars argue that public knowledge is important but scholars should avoid the the top-down focus of the knowledge-deficit approach and work within the framework of a new, deliberative model which takes account of how people think about and interact with the world in their everyday lives (Owens, 2000; van Kesteren, 2014).

Previous literature on how knowledge about climate change might affect engagement with the topic provides mixed support for the importance of knowledge in promoting engagement. Correlational research shows that lack of knowledge about climate change is associated with less concern about the issue (Swim and Geiger, in prep) and failure to understand the causes of climate change is associated with decreased support for climate change action (Bord, O'Connor, & Fisher, 2000; O'Connor et al., 1999). Furthermore, those who are unaware that there is a scientific consensus behind climate change are less likely to support climate-friendly public policy (McCright, Dunlap, & Xiao, 2013). Further, my previous research (Geiger & Swim, in prep.) showed that people were less willing to discuss climate change when they believed that others would perceive them as incompetent in a discussion; perhaps if people felt

more knowledgeable about climate change they might believe that others would also perceive them as more competent and be more willing to discuss the topic.

On the other hand, one study showed that higher general scientific literacy (i.e. general scientific ability not specifically related to climate change) was only associated with climate change concern and support for action among those who self-identified as Democrats; among those who self-identified as Republican, higher levels of general scientific knowledge were associated with *less* concern about climate change and support for action to address the issue (Hamilton, 2011). Similar findings were shown in another study (Hart & Nisbet, 2012), in which Democrat participants reported higher concern about climate change after receiving information about it, but Republicans appeared to react negatively to certain framings of climate change information and reported decreased concern in response to these specific framings.

In sum, it appears that lack of knowledge can act as a barrier to climate change engagement, but whether learning more about climate change leads to greater engagement is context and person dependent. Among those who are already doubtful about the existence of climate change or have social identities consistent with climate change "skepticism," increased knowledge about climate change may cause psychological threat and yield a "boomerang effect" (Hart & Nisbet, 2012), paradoxically leading to lower engagement with the topic. On the other hand, previous research generally supports the idea that knowledge will potentially increase engagement among those who are already concerned about climate change and do not have social identities conflicting with action, the people who we will target in this research. As I will explain in more detail below, knowing more about climate change is likely to boost self-efficacy about discussing climate change among this population.

Chapter 4: PSYCHOLOGICAL MECHANISMS OF DISCUSSION

To identify psychological processes that might play a role in facilitating or hindering discussion, I considered research on psychological mechanisms that promote willingness to talk about climate change (Geiger & Swim, in prep.; Swim et al., in press, Swim et al., under review), applications of the Spiral of Silence model (Noelle-Neumann, 1993; Neuwirth & Frederick, 2004), and applications to coping models to health behaviors (Ruiter, Verplanken, Kok, & Werrij, 2003; Floyd, Prentice-Dunn & Rogers, 2000) and climate change engagement (Swim & Fraser, 2014; Swim et al., in press; Swim et al., under review; Cismaru, Cismaru, Ono, & Nelson, 2011; Lam, 2014). Three constructs emerged as consistent psychological mechanisms likely to also play a role in willingness to discuss climate change: a) fear of isolation, b) self-efficacy, and c) response efficacy. These mechanisms will be examined in Study 2.

Fear of Isolation

The Spiral of Silence theory proposes that that people may be hesitant to discuss potentially loaded topics with strangers and acquaintances when they believe others do not share their opinion because they fear being isolated from the group if they speak up (Noelle-Neumann, 1993). However, little empirical research has linked fear of isolation and popularity of opinions. To my knowledge, only two studies have directly tested whether fear of isolation acts as a mediator in the process of self-silencing due to assumptions or knowledge about other's opinions. Neither of these two studies found evidence to support the role of fear of isolation (Petrič & Pinter, 2002; Shoemaker, Breen, & Stamper 2000). Both Petrič & Pinter's (2002) and Shoemaker et al.'s (2000) measures of fear of isolation, however, used trait-like measures similar to those used to assess general social anxiety, with questions such as "I avoid social gatherings" and "I worry about what people think of me even when I know it won't make any difference."

These measures may not have explained self-silencing because they reflect general tendencies to silence rather than topic- and situation-specific concerns about speaking. A single study (Kim, 2012) indicates that those high in trait fear of isolation may be especially likely to self-silence in the face of an audience who is perceived to disagree. Kim issues a call for research examining causal mechanisms (i.e., statistical mediation) to better illustrate whether fear of isolation is the primary mediator in the relationship between perceived opinion congruence and willingness to express one's opinion.

As noted above, my previous work (Geiger & Swim, in prep.) measured expectations of being perceived negatively by others. The fact that expectations of being perceived as incompetent mediated the relationship between perceived opinion climate and willingness to discuss climate change may indicate a fear of isolation in response to discussing climate change in these circumstances. However, this fear of isolation was not directly measured in the previous work. In the present work, I will measure fear of isolation directly using a topic- and situation-specific measure of this construct.

Self-Efficacy

Self-efficacy refers to the belief that one will be capable of successfully performing a desired behavior (Bandura, 1982). In general, self-efficacy has been shown to be a strong predictor of behavior (Bandura, 1982). For example, students with higher self-efficacy are more likely to be more motivated in the classroom and to actually perform better in the classroom (Zimmerman, 2000). Self-efficacy also boosts motivation and behavioral outcomes in the domain of pro-environmental engagement, including discussion of climate change (Swim & Fraser, 2014; Swim, Fraser, & Geiger, in press; Swim, Fraser, & Geiger, under review). My previous research (Geiger & Swim, in prep.) found that hope about one's ability to discuss

climate change – a construct closely related to self-efficacy (Snyder, 2002) - mediated the relationship between meta-beliefs and willingness to discuss climate change among those concerned about climate change, such that when concerned participants were led to believe others shared their beliefs about climate change, they reported more hope about their ability to discuss the issue and subsequently greater willingness to discuss the topic.

Some research disputes the link between self-efficacy and pro-environmental behavior (Homburg & Stolberg, 2006; Chen, 2015). These studies conceptualize self-efficacy as the ability to personally deal with climate change or the threats posed by climate change, solo (with items such as "I know how to take precautions against climate change in everyday life"). Thus, these measures do not address self-efficacy toward engaging in specific behaviors toward mitigation of climate change. Greater specificity of self-efficacy beliefs could improve its ability to predict behavior. As noted above, self-efficacy with regard to discussing climate change may be particularly relevant; I will attempt to extend these findings in the current research.

Response Efficacy

Response efficacy (sometimes alternatively referred to as efficacy or outcome expectancies) generally refers to the belief that through one's behavior, a desired outcome will result (Bandura, 1982). In the present research, we define response efficacy as the belief that through average people discussing climate change, positive outcomes will occur as a result. Recently published research shows that collective efficacy (a dimension of response efficacy that applies to people's beliefs about whether they can achieve success by working together with others; Lam, 2006) predicts pro-environmental engagement (Chen, 2015). Further, our previous correlational studies show that response efficacy mediates the relation between knowledge and talking about climate change (Swim et al., in press; Swim et al., under review). In the present

research, I tailor measures of efficacy to the specific laboratory context with a specific audience, rather than with a more general audience, as has been done in our previous research.

Chapter 5: PRESENT RESEARCH

In the present research I focus on overcoming barriers to discussion among those who are already concerned about climate change instead of focusing on counteracting climate change denial. Unconcerned Americans, including those who deny the existence of climate change or humans' role in contributing to the problem, have been a common target for social scientific research on the human dimensions of climate change (e.g. Lewandowsky, Ecker, Seifer, Schwaz, & Cook, 2012; McCright & Dunlap, 2011). However, as noted above, this group represents a sizeable but still small section of Americans. Those who are already concerned about climate change but not regularly discussing the topic make up a larger group than those who are not concerned. Given the two barriers to communication noted above, I conduct two laboratory experiments to examine the effectiveness of countering pluralistic ignorance and climate science education on willingness to discuss climate change and, in Study 2, the psychological mechanisms by which these manipulations function.

Countering Pluralistic Ignorance

It may be possible to overcome pluralistic ignorance through presenting information on others' beliefs. In my previous work, students concerned about climate change who were led to believe that others in a classroom shared their opinion were more willing to engage in a climate change discussion than those who were led to believe others in the room disagreed with them (Geiger & Swim, in prep.). In the present research, I attempt to conceptually replicate this effect in a formal laboratory setting and test whether the effect of countering pluralistic ignorance is modified by climate change education.

Climate Change Education

Given the potential benefits of increased public understanding of this topic, climate scientists, educators, and social scientists have attempted to develop simple effective messaging strategies to successfully communicate this topic in a way that encourages greater public engagement (Fraser et al., 2013). The educational method that I will use in the present research was devised to encourage public engagement with and deliberation about climate change and focuses on three strategies: a) connect with the audience via shared values, b) use simplifying metaphors, and c) stay optimistic and incorporate a focus on solutions) (Frameworks, 2013; Bales, 2009; Swim et al., under review). Quasi-experimental survey research using a national sample (Swim et al., under review) suggests that this method may be effective at increasing public engagement and interpersonal discussion of climate change; however, this has not yet been tested in a fully experimental context, independent of the researchers who recommended these strategies.

Pluralistic Ignorance and Knowledge Together

An important question is how the knowledge intervention might increase discussion in conditions where others are perceived to share one's opinion versus in conditions were others are perceived to disagree. Among those who have already expressed some degree of concern about climate change, two possibilities are that a) knowledge increases willingness to engage in discussion only among audiences already perceived to agree with one's own view, or alternatively, b) knowledge helps individuals overcome the tendency to self-silence in situations where when others are perceived to disagree with one's opinion; Geiger & Swim, in prep.).

The first possibility suggests that neither an audience perceived to be receptive nor knowledge are sufficient for promoting willingness to talk because, alone, the other barrier is still

present. The converse of this is described in Schultz's (2002) review of the knowledge deficit model (described above), in which he concludes that knowledge alone is not enough to motivate action, but lack of knowledge can act to a barrier to action even among those otherwise motivated to act. In the present research, this suggests that knowledge would be most effective at increasing willingness to discuss climate change under conditions in which others are perceived to share one's opinion.

The second suggestion considers the possibility that knowledge about climate science can be especially effective in promoting discussion in perceived unsupportive social contexts where those who do not know much about the topic may be unwilling to engage in discussion. Research with scientific educators indicate that those who learned more about the science of climate change and the effective communication strategies noted above, were more hopeful about their ability to discuss climate change (Swim & Fraser, 2013), even when they were unsure whether the audience would share their opinions on the topic. In the present research, I will examine whether a student sample led to believe that others do not share their opinion on the topic are more willing to discuss the topic after learning about it.

Beyond testing the roles of pluralistic ignorance, climate change education, and these two competing hypotheses about the relationship between the two independent variables, another goal of the present research is to further elucidate the psychological processes leading to discussion and self-silencing. Thus, in the second study, I also test psychological processes based on the three psychological mechanisms described in Chapter 4.

Chapter 6: STUDY 1

The purpose of Study 1 is to a) examine the effect of the knowledge intervention on willingness to discuss climate change and b) to examine whether the knowledge intervention interacts with a pluralistic ignorance intervention on willingness to discuss climate change.

Methods

Participants

Participants were recruited from the Penn State undergraduate psychology pool based on their response to a pre-screening scale assessing climate change concern. Specifically, only those who indicated that they were Alarmed, Concerned, or Cautious about climate change were recruited. 132 participants were recruited, which gives a power of .81 to detect a medium-sized main effect and a power of .81 to detect a medium-sized 2x2 interaction (Faul, Erdfelder, Lang, & Buchner, 2007), as well as a power > .80 to detect an indirect effect if both paths are medium-sized (Kenny & Judd, 2014).

Design

The study consisted of a 2(climate change opinion consensus: others concerned vs. others unconcerned) x 2(science education: climate change vs. control topic) between participants experimental design.

Procedure

Participants came to the lab in small groups of two to five people and were told that they were participating in a study on discussion of current topics. They were informed that they were participating in two ostensibly separate tasks as part of a pilot study to prepare for a larger study the following semester: 1) rating the quality of educational videos about scientific topics and 2) participating a group discussion about some of the topics, allegedly to determine how average

students talk about these topics. For the video task, the participants each sat at a different computer and were led to believe that each person was watching videos about a different topic. To add to the cover story, the participants completed surveys before and after watching their assigned videos. Next, participants were told that they would only have time to discuss two topics and were asked to rate the topics so that the experimenter could choose the top two preferred topics based upon the group ratings. They completed a survey containing the measures discussed below and were then informed that there would not be a conversation and debriefed.

Manipulations

Science education. Those in the climate science education condition watched three short videos about the science behind climate change and possible methods of reducing carbon emissions, for a total of 10 minutes. These videos were obtained from the New England Aquarium and incorporated materials based on the techniques used by Frameworks (Bales, 2009). Those in the control condition watched three short videos about nanotechnology for a total of 10 minutes.

Opinion consensus manipulation. Participants were randomly assigned to learn that others were either concerned or unconcerned about climate change. After watching the videos but before beginning the surveys regarding the alleged discussion, the experimenter told participants the following: "Our pre-test at the beginning of the semester shows that most subject pool participants are fairly interested in these topics. Nanotechnology, for example, is a hot topic this semester. But we have found that most of you guys are *highly concerned* (*not particularly concerned*) with climate change. Could you please fill out these surveys so that we can get a better sense of everyone's preferred topics to discuss?"

Measures

For full question wording of all measures, see Appendix A.

Climate change concern. A single-item measure from Swim & Geiger (in prep.) was asked in the pre-screener to determine who was eligible to participate in the study. Participants self-categorized as Alarmed, Concerned, Cautious, Disengaged, Doubtful, or Dismissive. Category descriptions were provided with each category.

Willingness to discuss climate change. Participants were asked five seven-point items assessing the degree to which they felt willing to participate in a discussion about climate change with the other participants. Study 2 had more measures for participants to complete, so I wanted a shorter measure for Study 2. I selected four of the five items to form a scale, eliminating the item "How willing are you lead a discussion on climate change?" based upon a single-factor factor analysis. The remaining items had strong internal reliability (α=.92). All results reported below are similar whether the four-item scale or five-item scale is used.

Manipulation checks. In order to test whether knowledge improved after viewing the climate science video, after watching their videos respondents indicated their subjective knowledge about climate change, on a single-item five-point measure with answer choices ranging from "nothing" to "an extreme amount." In order to test whether the opinion consensus information influenced their perceptions of others' opinions about climate change, respondents completed a single-item five-point measure with answer choices ranging from "not at all" to "an extreme amount." To assess their perception of others' interest discussing climate change, respondents completed a single-item seven-point measure assessing the degree to which a participant believed that other participants agreed with their opinion about climate change,

ranging from "strongly disagree" to "strongly agree." This final item was originally intended as a filler question, but as described below, became useful in post-hoc analyses.

Cover Measures. Questions identical in wording to those described above except that the topic was changed to reflect a) neuroscience, b) cancer research, c) genetic modification, and d) nanotechnology. All participants received all the questions about climate change as well as identical questions about all four of these topics.

Results

Descriptive statistics and correlations for variables are presented in Table 1. Manipulation checks and willingness to discuss climate change were analyzed with a 2(climate change opinion consensus: others' concerned vs. others unconcerned) x 2(science education: climate change vs. control topic) between participants ANOVAs.

Table 1. Correlations and descriptive statistics for measures used in Study 1.

	1	2	3	4	Mean	SD
1. Others want to discuss topic[1]	-				0.05	0.68
2. Knowledge of topic[1]	.17*	-			0.05	0.83
3. Others would agree with your opinion[2]	.06	.21*	-		0.70	1.00
4. Willingness to discuss climate change[3]	.35**	.56**	.21*	-	0.99	1.12

* p < 0.05, ** p < .0.01

[1]On a -2 (Not at all) to 2 (An Extreme Amount) scale.

[2]On a -3 (Strongly Disagree) to 3 (Strongly Agree) scale.

[3]On a -3 to 3 scale, with higher scores indicating more willingness to discuss climate change.

Manipulation Checks

Consistent with manipulations, those who learned about climate science reported being better informed about climate change (M = 0.31) than those in the control condition (M = -0.25), $F(1, 130) = 16.37$, $p < .001$, $\eta_p^2 = .11$. Also consistent with manipulations, those who were told that others were concerned about climate change were more likely to believe that others in the

room were interested in discussing climate change (M=0.34) than those told that others were unconcerned about climate change (M=-0.25), $F(1, 127) = 29.39$, $p < .001$, $\eta_p^2 = .19$. However, in contrast to the manipulation, they were no more likely than those told others were unconcerned to believe that others shared their opinion, $F(1, 130) = 3.42$, $p = .55$, $\eta_p^2 = .003$, Ms = 0.66, 0.75.

Planned Analyses

Those in the climate science education condition were significantly more willing to talk about climate change (M=1.18) than those in the control condition (M=0.77), $F(1, 130) = 4.62$, $p = .034$, $\eta_p^2 = .03$. In contrast to my hypothesis and previous research, those in the "others concerned" condition were no more willing to discuss climate change than those in the "others unconcerned" condition, $F(1, 130) = 0.03$, $p = .87$, $\eta_p^2 = .000$. The interaction between these two manipulations did not significantly affect willingness to discuss climate change, $F(1, 128) = 1.65$, $p = .20$, $\eta_p^2 = .013$. See Figure 1 for cell means.

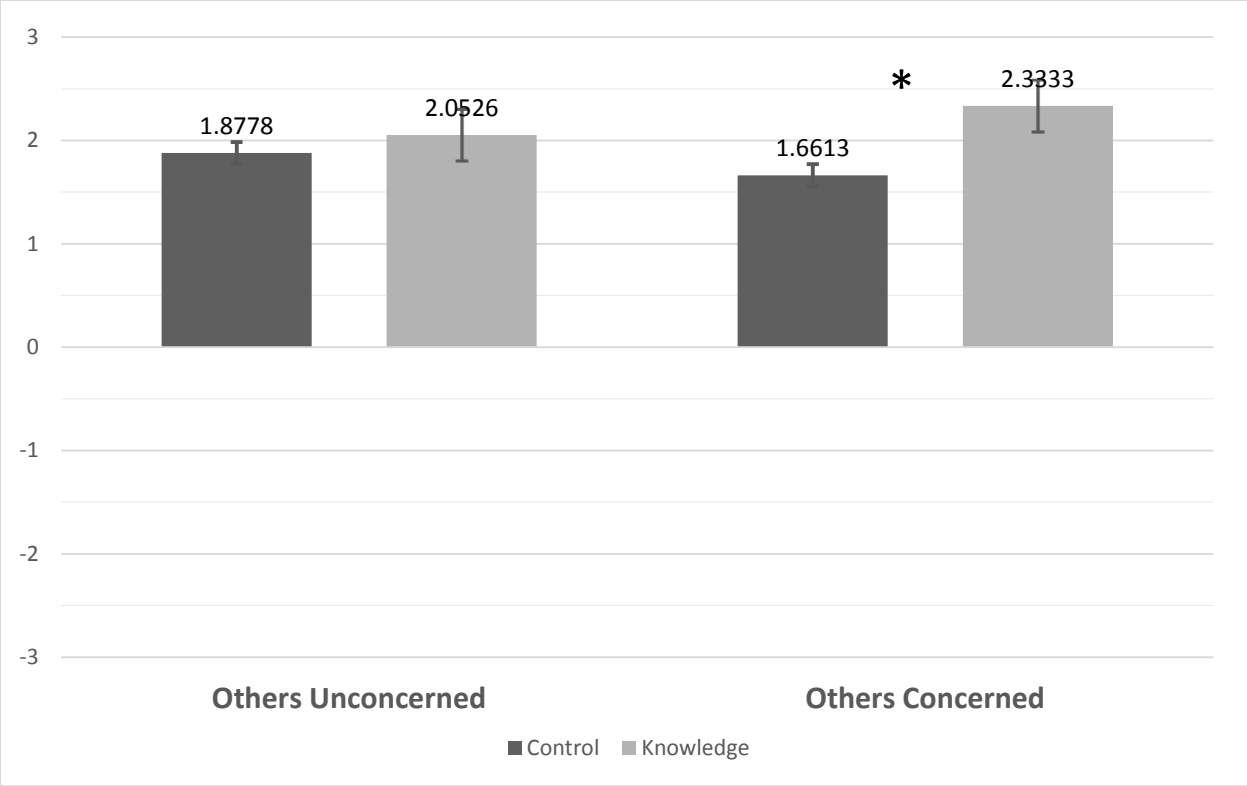


Figure 1. Effects of knowledge and opinion consensus conditions on willingness to discuss climate change in Study 1.

Next, I tested whether the effect of the knowledge manipulation could be explained by a perceived increase in knowledge about climate change. Using PROCESS (Hayes, 2012) with 10000 bootstraps, I found that perceived knowledge about climate change fully mediated the relationship between the knowledge manipulation and willingness to discuss climate change, b = .42, SE = .12, 95% CI (.22, .68), with the direct path statistically reduced to zero, b = - .01, SE = .17, 95% CI (-.35, .34).

Post-Hoc Analyses

Post-hoc analyses were conducted to explore the failure to replicate previous research on the effect of perceived agreement on willingness to discuss climate change. Since the manipulation check findings suggested that the manipulation had an effect on the belief that others wanted to discuss the topic, but not the belief that others would agree with one's own

opinion, I test the former in mediation analyses. Using PROCESS with 5000 bootstraps, I revealed that there was a positive indirect effect of the manipulation of other's beliefs on willingness to discuss climate change that was mediated by the belief that others in the room wanted to discuss the topic, b = . 41, SE = .11, 95% CI (.22, .68). However, this indirect effect was suppressed by a *negative* direct effect of the manipulation on willingness to discuss climate change, b = .38, SE =.21, p = .07.

In post-hoc analyses, I also examined whether either the direct or indirect effects were qualified by whether participants had learned about climate change, as a potential moderator providing insight why the direct effect and indirect effects were in opposite directions. Those who learned about climate change could have had a different reaction to the message than those who did not. For example, one possibility would be that those who learned about climate science may have wanted to discuss the topic no matter what, while those who did not learn about climate science would only want to learn about it when they believed that others wanted to talk about the topic. However, on the other hand, perhaps those who learned about climate science would be relatively more willing to discuss the topic when they were told that it was not a hot topic because they could have believed that they had more novel information to contribute. Using PROCESS with 10000 bootstraps, I tested whether learning about climate science moderated either the direct effect or the relationship between the belief others wanted to discuss the topic (the mediator) and willingness to discuss climate change. Neither potential interaction was statistically significant, ps > .30.

Participants may have had different expectations about the consequences of others opinions depending upon how many other people might have been in their discussion group, as inferred by the number of participants who were in the study at the time as they were. Thus, in a

third post-hoc analysis, I examined whether the effect of perceived opinion climate on willingness to discuss climate change differed in groups of varying sizes. I used PROCESS (Hayes, 2013) with opinion consensus condition as the independent variable and group size as the moderating variable. The effect of being told that others were concerned about climate change increased willingness to discuss the topic more in smaller groups than larger groups, b = -.42, SE = .20, p =.035. Follow-up analyses revealed that the effect was in the predicted direction for small groups (i.e., people were more willing to discuss climate change when they were told others were concerned than when they were told others were not concerned) and in the opposite direction in large groups, although neither of these effects were significant, ps > .10. I found that group size did not affect the relationship between perceived opinion consensus and beliefs that others would want to discuss the topic, or between perceived opinion consensus and beliefs that others would share one's opinion, ps > .10.

Discussion

The results of Study 1 suggest that the participants are more willing to discuss climate change after learning about the topic, at least when the expected discussion occurs immediately after the learning experience. Further, this relation was mediated by improved subjective knowledge about climate change after watching the videos. These results suggest that at least in this case, the hypothesis that increased knowledge results in a measurable change in behavior is correct.

Contrary to predictions, the results of Study 1 did not show that perceptions of others' agreement had a significant effect on willingness to discuss climate change. This is in contrast to spiral of silence theory and research (Noelle-Neumann, 1993; Hayes, Shanahan, & Glynn, 2001) and with my previous work (Geiger & Swim, in prep.) where we show in two studies that these

perceptions predict willingness to discuss climate change. Based on the post-hoc analyses reported above, I suggest two potential explanations for the failure to replicate this effect. First, the particular manipulation used in this study may have had unexpected effects that suppressed the manipulation of opinion consensus beliefs. The experimental condition had an effect on perceptions of others' desires to discuss the topic, but did not affect perceptions that others' agreed with one's opinion on the topic. Further, there was a positive indirect effect mediated through beliefs about others' desire to discuss the topic (similar to what might be expected) but this was suppressed by the *negative* direct effect. This suggests that the experimental manipulation was effective to the degree that it fostered the belief that others wanted to discuss the topic, but that there was a second, unpredicted effect of the manipulation that decreased willingness to discuss climate change and suppressed the expected outcome.

A second explanation is that the effect could have been moderated by participants' own concern about climate change, an effect found in my previous research (Geiger & Swim, in prep.) I did not expect that this would be the case in this study since I only recruited participants who were Alarmed, Concerned, or Cautious about climate change. Nonetheless, it is possible that even within this restricted range of concern, this variable may moderate the relationship between perceptions of others' opinion and willingness to discuss climate change. I cannot test this speculation with the present data due to data constraints.

Chapter 7: STUDY 2

Study 1 confirmed our hypothesis that those who had recently learned about climate change would be more willing to discuss the issue. However, as noted above, Study 1 failed to replicate previous research on the influence of perceived opinion consensus on willingness to discuss climate change. In Study 2, I retest this hypothesis using a different experimental

manipulation that is more consistent with my previous research (Geiger & Swim, in prep.). I will also measure participants' personal concern about climate change to determine whether this could moderate the effects.

In addition, Study 2 assesses the psychological mechanisms by which these manipulations might affect willingness to discuss this topic. As noted in Chapter 4, I examine a) fear of isolation, b) self-efficacy, and c) response efficacy as potential mechanisms for observed differences caused by the two manipulations.

Paths of Change

In this study, I replicate and extend previous findings on the three process variables described in Chapter 4. Unlike in Study 1, in Study 2 I expect to find an interaction pattern between perceived opinion consensus and knowledge on willingness to discuss climate change. However, as noted in Chapter 5, there are competing hypotheses regarding the pattern that will be shown. Based on the interaction pattern identified, I predict that the effects of the two manipulated variables will be mediated by the three process variables, as depicted in Figure 2. Below, I describe specific hypotheses regarding these mediation effects.

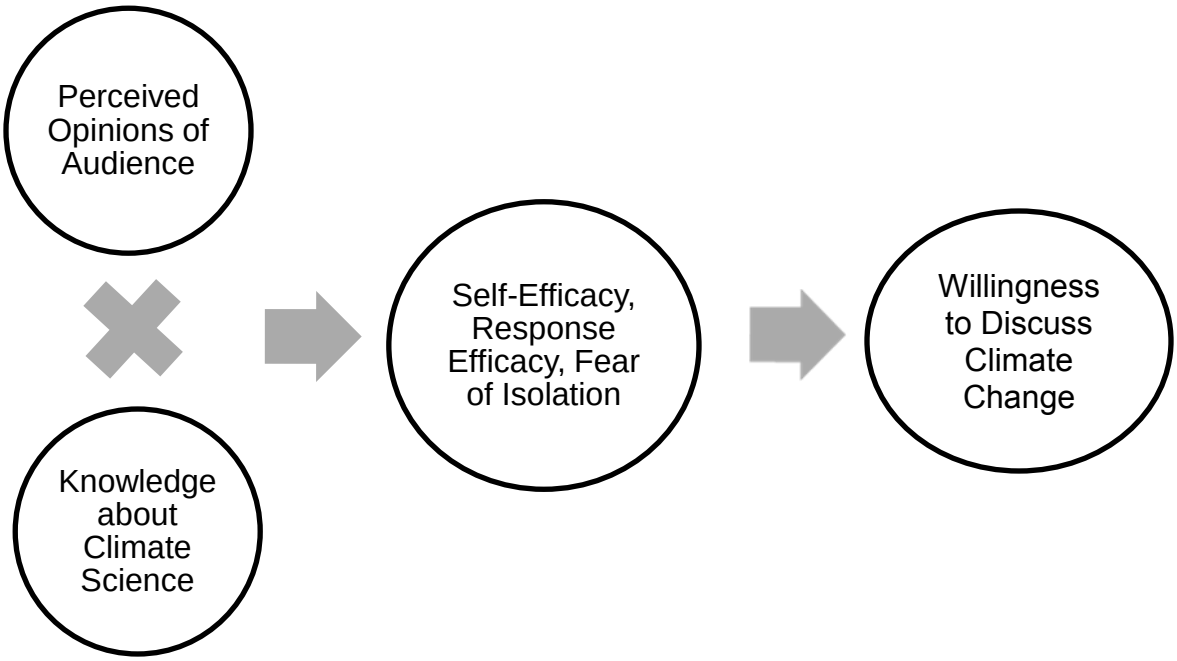


Figure 2. General process model examined in Study 2.

First, based on Noelle-Neumann's spiral of silence theory (1993), I predict that *fear of isolation* will mediate the effect of perceived opinion congruence on willingness to discuss climate change. However, as noted in Chapter 4, this mediation model has not been supported in previous tests. Perhaps the more specific *fear of isolation* measure that I developed for use in this study (see Appendix B) will show a different pattern than that previously found using less specific fear of isolation measures. Thus, in the present study, I expect that beliefs that others share one's opinion on climate change reduces fear of isolation, thereby increasing willingness to discuss the topic. I will further examine whether this indirect effect is moderated by knowledge. My previous work found that participants were hesitant to discuss climate change to the degree that they perceived others would perceive them as incompetent if they were to do so (Geiger & Swim, in prep.). Perhaps those who are better educated about climate change will be less concerned about being isolated because they have less concerns about being perceived negatively (as incompetent) in a discussion.

Second, I suggest that *self-efficacy* will mediate the relationship between knowledge about climate change and willingness to discuss the topic. I predict that those who learn about climate change will feel more confident and efficacious about their ability to participate in a discussion about the topic and thus will be more willing to engage in a discussion. As described in Chapter 4, this pattern has been demonstrated in previous non-experimental work and I expect to replicate the finding. Further, my previous work suggested that people felt like others would perceive them as more competent in a climate change discussion the more that they believed that others were concerned about the topic. Thus, the indirect effect described above may be moderated by perceived opinion agreement such that people may report higher self-efficacy when they believe others are share their concern about the topic.

Third, I predict that *response efficacy* will mediate the relationship between perceived opinion congruence and willingness to discuss climate change. Those who believe that others share their opinion on climate change may feel more efficacious about discussions about the topic having the potential to make a difference, and thus may be more willing to engage in these discussions. In addition, since previous research found that knowledge may increase response efficacy (Swim et al., under review), I suggest that knowledge may moderate this effect, such that those who learn about climate change will report higher response efficacy than those who do not.

Methods

Participants

Participants who indicated that they were Alarmed, Concerned, or Cautious about climate change in a screening given at the beginning of the semester were invited to participate in the study. 178 participants were recruited, from which 5 participants were eliminated due to having

previously participated in the same study, participating in a session where they attended alone, or requesting to have their data removed from the study, leaving 173 participants in the final dataset. This yields a power of .90 to detect a medium-sized effect and a power of .90 to detect a medium-sized interaction. (Faul et al.,2007), as well as a power > .80 to detect indirect effects if the effect sizes of both paths are medium-sized (Kenny & Judd, 2014).

Design

The study consisted of a 2(climate change opinion consensus: others' concerned vs. others unconcerned) x 2(science education: climate change vs. control topic) between-participants experimental design.

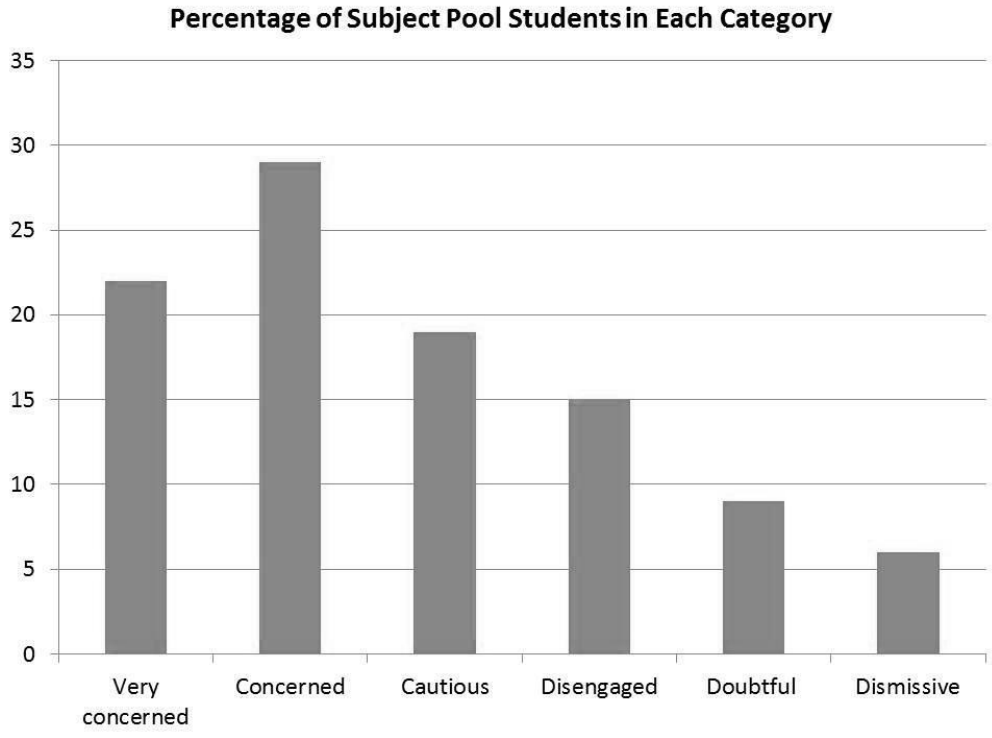
Procedure

Study 2 used a similar procedure and cover story as Study 1 with several differences. First, all surveys were computerized in Study 2. Participants came into the room and immediately sat at a computer, where they completed the consent form, all surveys, the video, and then were debriefed. Second, the maximum group size was expanded from five to seven to allow for increased participation. Third, the cover story was revised to increase the perceived separation between the ostensible two tasks. Fourth, a small camera was placed in the corner of the room to lead to the perception that they might be later recorded in the discussion. The purpose of this was to increase the credibility that there would actual be a group discussion. Finally, the opinion consensus manipulation was altered, as described below.

Manipulations

Science education. Participants watched the same video sets as those given in Study 1, with half watching the 3 videos about nanotechnology and the other half watching the 3 videos about climate change.

Opinion consensus. The manipulation was altered to be more similar to what was used by Geiger and Swim (in prep.) where information about other's beliefs influenced participants' willingness to talk about climate change. After completing the first question about each topic (in which participants indicated their personal concern about the topic), on the next page of the survey they viewed a graph about other students' opinions on the topic, which was allegedly presented to get a feel for how other students felt about the topic so that they could more accurately answer the questions and prepare for the discussion. Participants were randomly assigned to see one of two graphs about others' opinions about climate change. As shown in Figure 3, half of the participants viewed a graph showing that most other psychology pool students were concerned about climate change, while the other half of participants viewed a graph showing that most other psychology pool students were unconcerned about climate change. Previous research had revealed that this population understood the meaning of these graphs (see Geiger & Swim, in prep).



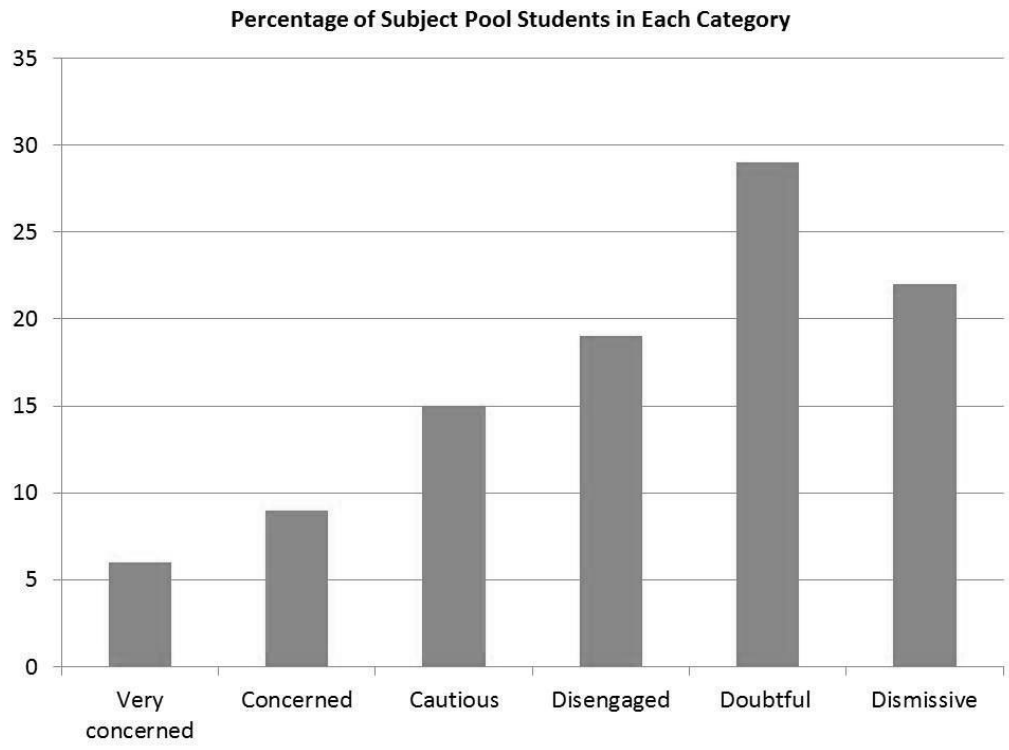


Figure 3. Illustrations used for the opinion consensus manipulation in Study 2.

Measures

Full descriptions of all measures are provided in Appendix A.

Concern about climate change. The single-item scale used in Study 1 was asked both in the pre-screener for recruitment, and in the actual study for testing as a potential moderator of the effects (Swim & Geiger, in prep).

Fear of isolation. An five-item scale designed to capture participants' fears of being socially isolated or excluded if they were to express their opinions about climate change in the upcoming conversation (e.g. I worry about being excluded in the discussion if I express my opinions about climate change) ($\alpha = .95$).

Self-efficacy. A four-item scale designed to capture participants' efficacy about being able to discuss climate change in a conversation (e.g. I know how to talk about climate change in a conversation with other students.) ($\alpha = .84$).

Response efficacy. An four- item scale designed to assess participants' beliefs about discussing climate change being a productive way to successfully accomplish climate change mitigation goals (e.g., When average people talk about climate change, it increases awareness of the importance of climate change.) ($\alpha = .83$).

Willingness to discuss climate change. The four items with the best fit from Study 1 were again used to form a scale ($\alpha = .91$).

Manipulation checks. In order to test whether the climate science videos were effective at increasing perceived knowledge relative to a control condition, after watching their videos respondents indicated their agreement with the item "I am well informed about climate change," on a 7-point "strongly disagree" to "strongly agree" scale. In order to test whether the opinion consensus information influenced their perceptions of others' opinions about climate change, respondents indicated their agreement with the item "I think that the other students in the room would agree with my opinions and beliefs on climate change" on a 7-point "strongly disagree" to "strongly agree" scale.

Cover measures. Questions identical in wording to those described above except that the topic was changed to reflect vaccination. In addition, after completing all questions above, participants received a question assessing their concern about genetic modification before receiving an "error message" intentionally included to shorten the survey length.

Results

Descriptive statistics and correlations for variables are presented in Table 2. Manipulation checks, mediators, and willingness to discuss climate change were analyzed with a 2(climate change opinion consensus: others concerned vs. others unconcerned) x 2(science education: climate change vs. control topic) between-participants ANOVAs.

Table 2. Correlations and descriptive statistics for measures used in Study 2..

	1	2	3	4	5	6	7	Mean	SD
1. Concern about climate change[1]	-							4.86	0.99
2. Knowledge about topic[2]	.40**	-						0.55	1.35
3. Others would agree with opinion[2]	.25**	.42**	-					0.68	1.02
4. Self-efficacy[2]	.37**	.72**	.35**	-				1.06	1.10
5. Response efficacy[2]	.32**	.16*	.23**	.17*	-			0.65	1.14
6. Fear of social isolation[2]	-.19*	-.27**	-.20**	-.45**	-.15	-		-1.94	0.85
7. Willingness to discuss climate change[2]	.47**	.63**	.42**	.58**	.23**	-.31**	-	0.87	1.15

* p < 0.05, ** p < .0.01

[1]From 1 (Nonbeliever) to 6 (Very Concerned)

[2]On a -3 (Strongly Disagree) to 3 (Strongly Agree) scale

Manipulation Checks

Consistent with manipulations, those who learned about climate science reported being better informed about climate change (M=0.77) than those in the control condition (M=0.33), $F(1, 171) = 4.80$, $p = .03$, $\eta_p^2 = .027$. Also consistent with manipulations, those who were told that others were concerned about climate change were more likely to believe that others in the room would agree with their opinion on climate change (M=0.87) than those were told that others were not concerned about climate change (M=0.48), $F(1,171) = 6.73$, $p = .01$, $\eta_p^2 = .04$. However, the means were above the midpoint of zero, suggesting that most participants who were told that others were unconcerned nonetheless still believed to some extent that others would share their opinions on the topic.

Planned Analyses

Replicating Study 1, those who learned about climate science were more willing to talk about it (M=1.02) than those who learned about a different topic (M=0.72), although the effect was marginally significant, $F(1, 171) = 2.98$, p=.086, $\eta_p^2 = .017$. Contrary to predictions, those who were told that others were concerned about climate change were again no more willing to discuss climate change than those who were told others were unconcerned, $F(1, 171) = 0.02$, $p = .88$, $\eta_p^2 = .000$.

The interaction between the two conditions predicted willingness to discuss climate change, $F(1,169) = 3.98$, $p = .048$[1], $\eta_p^2 = .023$, with the pattern of effects fitting the hypothesis that learning about climate science would only increase discussion when people believed others would agree with their opinion. Those who were led to believe that others shared their opinions were no more willing to discuss climate change than those who were led to believe that others did not share their opinions, both among those who had learned about climate science, $b = .32$, SE = .24, $p = .19$ and those in the control condition, $b = -.37$, SE = .24, $p = .13$. As shown in Figure 4, the interaction was a result of a greater impact of climate science education among those who were told that others were concerned about climate change $b = .64$, SE = .24, $t = 2.64$, $p = .009$ than among those who were told that others were unconcerned about climate change, $b = -.05$, SE = .24, $t = -.20$, $p = .85$.

[1] Multivariate outlier tests revealed one potential outlier. When this outlier was eliminated from the data, the interaction was marginally significant, $p = .077$.

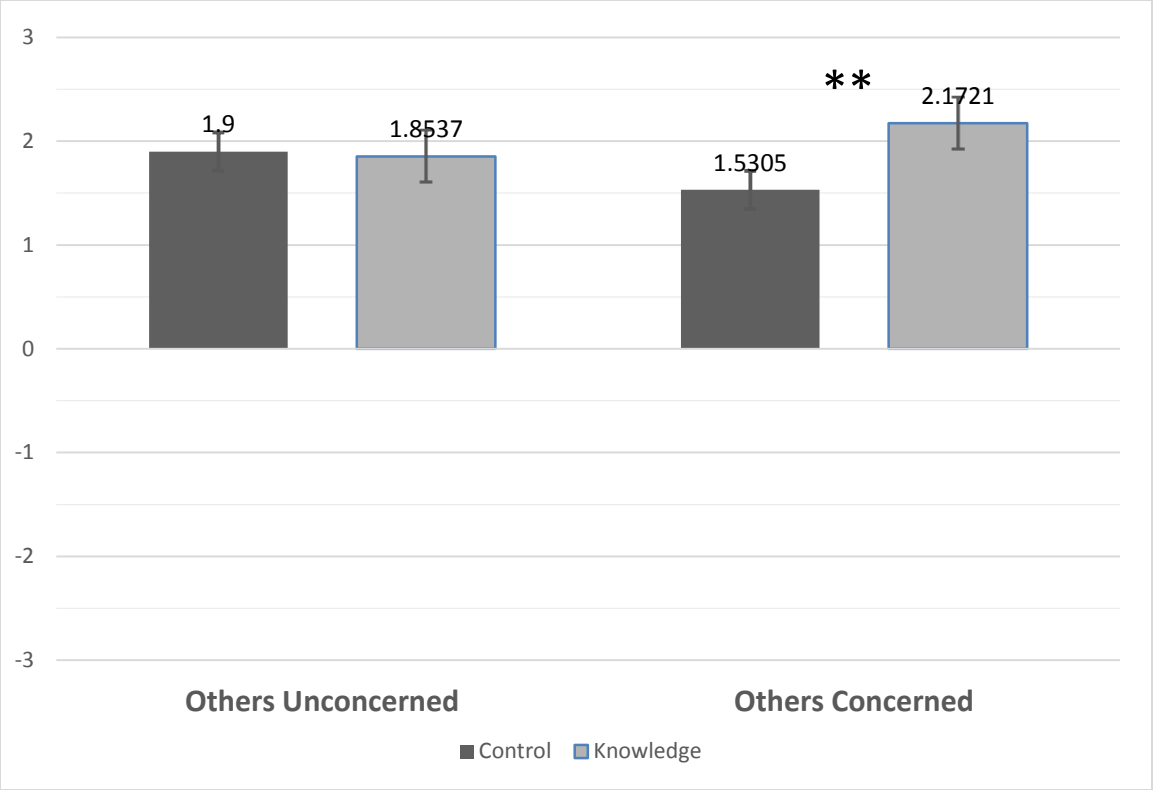


Figure 4. Effects of the knowledge and opinion consensus manipulation on willingness to discuss climate change in Study 2.

*** cells significantly different at $p < .01$.*

Next, I tested whether participants' personal concern moderated the above findings. I found that those who were more concerned about climate change were more willing to discuss the topic, b =.52, SE = .14, $p < .001$. However, this concern did not interact with perceptions of others' concern, p = .54, with learning about climate science, p = .65, or with the interaction previously described above, p =.89.

As in Study 1, I examined whether these effects might differ depending on the size of the group. In Study 2, unlike Study 1, group size did not moderate the effects of opinion consensus condition on willingness to discuss climate change, b = .06, SE = .12, p = .65. Thus, I do not consider group size in any further analyses in this study.

Mechanisms

Those who learned about climate change had higher self-efficacy than those who did not learn about climate change, $F(1, 169) = 9.62$, $p = .002$, $\eta_p^2 = .05$, Ms = 1.30, 0.81, and less fear of isolation than those who did not learn about climate change, $F(1, 169) = 4.45$, $p = .036$, $\eta_p^2 = .03$, Ms = -1.08, -0.80, but response efficacy was the same for both conditions, $F(1, 169) = 2.48$, $p = .12$. Those led to believe that others shared one's opinions had higher response efficacy (M=0.89) than those led to believe that others did not share one's opinions (M=0.41), $F(1, 169) = 7.63$, $p = .006$, $\eta_p^2 = .04$, but there was no effect of opinion condition on self-efficacy or fear of isolation. The interaction of the two conditions did not have an effect on any of these three variables, ps > .15. See Figures 5, 6, and 7 for the patterns of cell means for these variables.

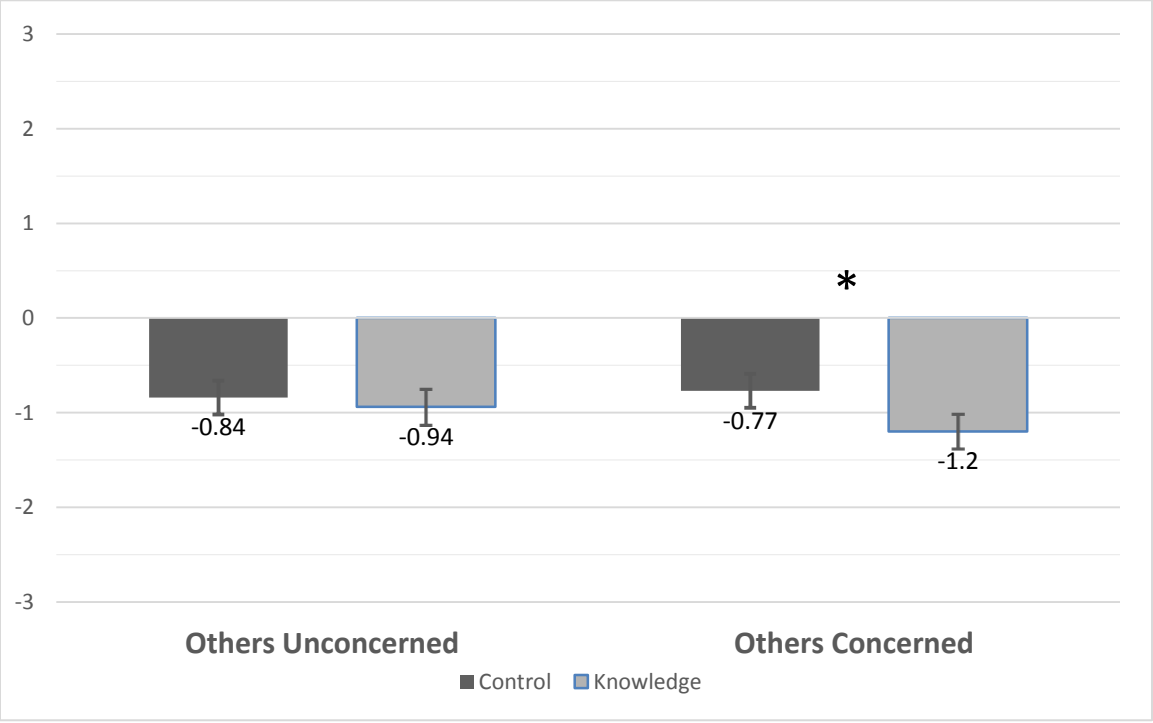


Figure 5. Effects of the knowledge and opinion consensus manipulation on fear of isolation in Study 2. The interaction between the two variables did not exert a significant effect, p = .19.

** cells significantly different at p < .05.*

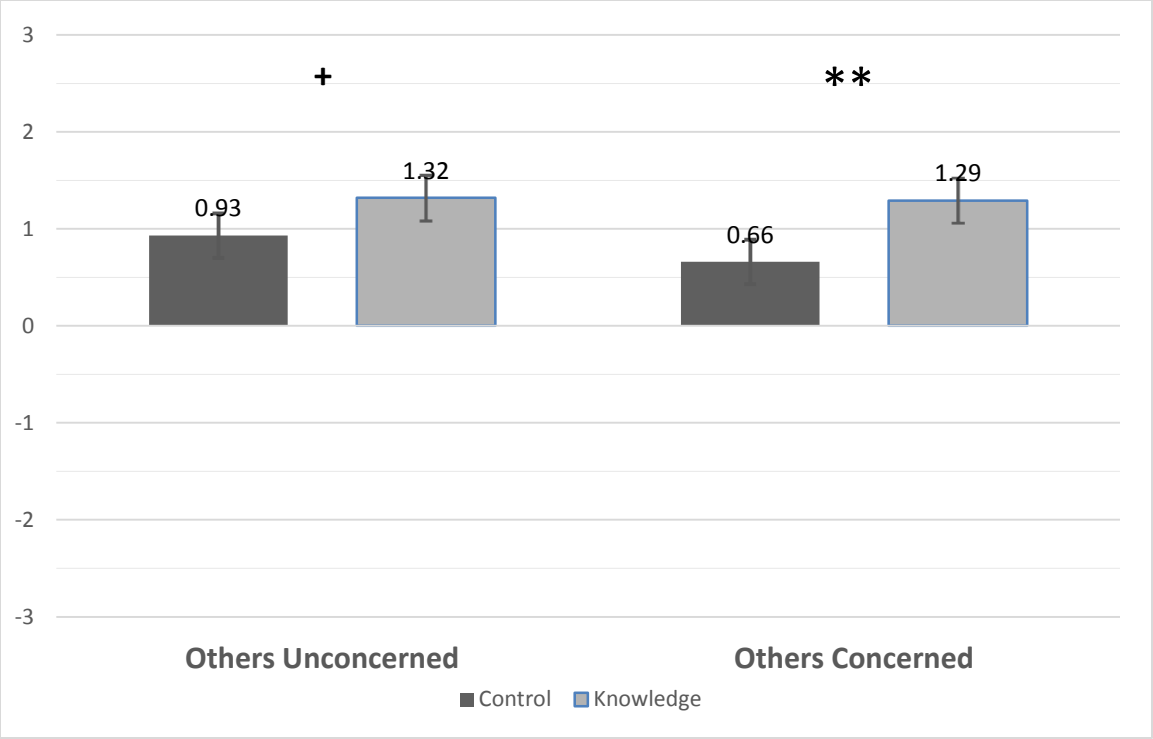


Figure 6. Effects of the knowledge and opinion consensus manipulation on self-efficacy in Study 2. The interaction between the two variables did not exert a significant effect, p = .45

*+ cells significant different at p < .10, ** cells significantly different at p < .01.*

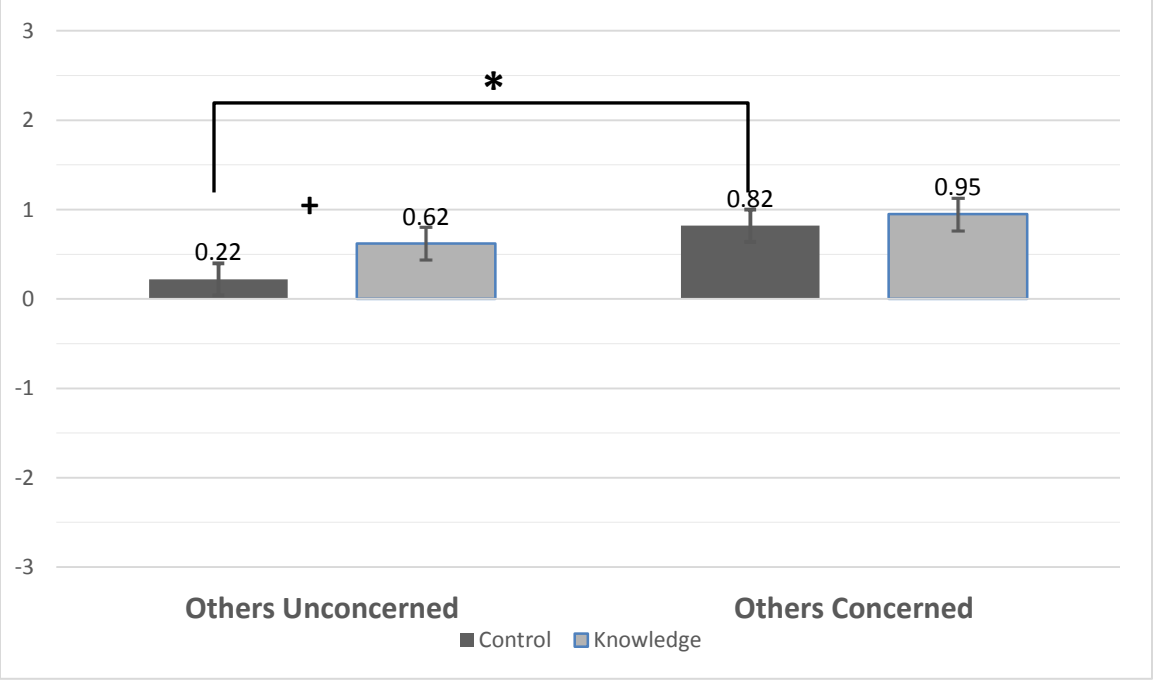


Figure 7. Effects of the knowledge and opinion consensus manipulation on response efficacy in Study 2. The interaction between the two variables did not exert a significant effect, p = .43.

*+ cells significantly different at p < .10, * cells significantly different at p < .05.*

As shown in Table 2, all three process variables (self-efficacy, response efficacy, and fear of isolation) were correlated with willingness to discuss climate change. When willingness to discuss climate change was regressed onto all three variables, however, only self-efficacy and response efficacy predicted willingness to discuss climate change, with fear of isolation no longer related ($p > .05$).

To examine the simple indirect effects of knowledge among those who were led to believe others were concerned, I used Hayes PROCESS for conditional mediation with 10000 bootstraps. Among other output, this model gives output of the estimated size and statistical significance of simple indirect effects of the independent variable on the dependent variable for each level of a moderating variable. In this case, I set science education condition as the independent variable and perceived opinion consensus as the moderating variable. The three process variables were examined individually as potential mediators in separate models to explain the effects of learning about climate science among those who learned that others were concerned about climate change. Among those believed others were concerned, fear of isolation mediated the relationship between science education condition and willingness to discuss climate change, $b = .17$, SE = .08, 95% CI (.04, .38), such that those who learned about climate change reported lower fear of isolation than those who did not, which led to greater willingness to discuss climate change. Among those who believed others were concerned, self-efficacy positively mediated the relationship between knowledge condition and willingness to discuss climate change, $b = .37$, SE =. 15, 95% CI (.10, .69), such that relative to those who did not learn about climate change, those who learned about climate change were more willing to discuss

climate change due to their higher self-efficacy. Response efficacy did not mediate this relationship, *b* =.03, SE = .06, 95% CI (-07, .17).[2]

I also conducted a parallel mediation analysis using fear of isolation, self-efficacy, and response efficacy as parallel mediators. In these analyses that the indirect effect of self-efficacy remained significant among those led to believe others were concerned about climate change, *b* = .36, SE = .14, CI (.11, .69), but fear of isolation did not, *b* = .03, SE = .06, CI (-.07, .17). This suggests that self-efficacy is a better explanation than fear of isolation for the effects.

Post-Hoc Analyses

I used Hayes PROCESS for serial mediation with 10000 bootstraps to examine different serial mediation models for further explaining the relationship between science education condition and willingness to discuss climate change among those who believed others were concerned about the topic.

Hayes PROCESS does not have a statistical model to conduct conditional serial mediation. However, one can conduct such an analysis by manually creating interaction variables (Hayes, personal communication). To conduct an analysis examining the results of serial mediation among those who believed others were concerned, I created a new variable for perceived opinion consensus centered so that the belief that others were concerned was a 0 value and belief that others were not concerned was a 1 value. I created an interaction term by multiplying this value by the variable corresponding to the knowledge manipulation. I entered both the recoded perceived opinion consensus variable and the interaction term as covariates to

[2] An alternative way to conduct these analyses would be to conduct mediation analyses on only of the half of the sample led to believe others were concerned. Using these methods, the results were similar for the indirect effects through fear of isolation (b= .17, SE =.11, 95% CI (.02,.44)), self-efficacy (b = .29, SE =.13, 95% CI (.08, 60)), and response efficacy (b= .02, SE = .05, 95% CI (-.04, .16)).

test the simple indirect effect of knowledge among those who were concerned, similar to what would be done in a standard multiple regression to look at a simple main effect.

The first model tests whether response efficacy plays a role in the link between self-efficacy and willingness to discuss the topic. An individual with relatively low self-efficacy may be more likely to also have low response efficacy, believing that the behavior will not be effective at changing important outcomes since he or she is incapable of performing the behavior (Bandura, 1977). Increasing perceived ability to discuss climate change may increase the belief that discussions of climate change would lead to positive outcomes, since if individuals believe that they are more able to contribute to these conversations they may also increasingly believe that the discussions would be productive. Thus, I test whether among those who believed others were concerned, if learning about climate change would increase self-efficacy, leading to an increase in response efficacy and finally an increase in willingness to discuss climate change. This model was supported (albeit with a small percentage of the total effect), b = .02, SE = .02, 95% CI (.0000, .0725) (see Figure 8).

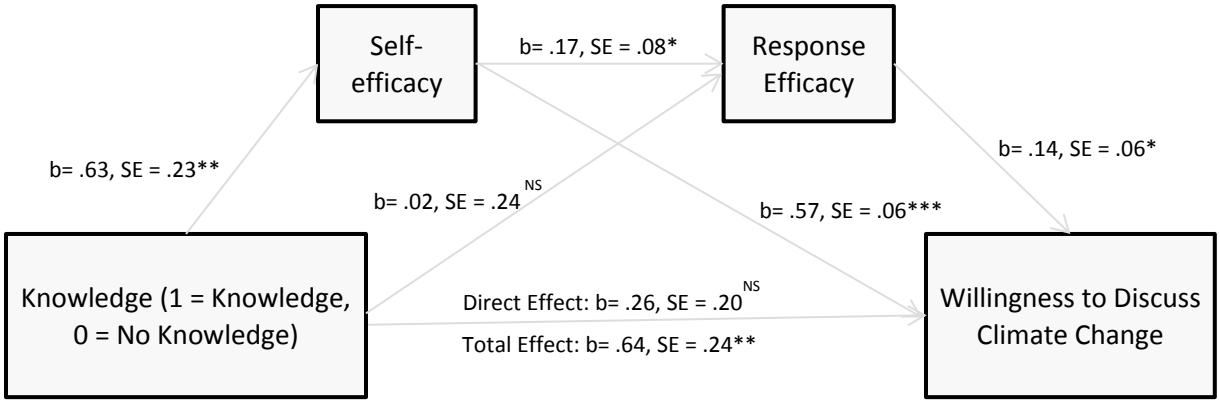


Figure 8. A post-hoc serial mediation model for those who believed others were concerned about climate change.

The second model tests whether fear of isolation plays a role in the link between self-efficacy and willingness to discuss climate change. In my previous research (Geiger & Swim, in prep) I found that those who perceived that others would see them as less competent in a conversation about climate change were less willing to discuss the topic. This suggests that increasing participants' expectations that others would perceive them as competent would increase their willingness to discuss climate change. In this model, I extend these previous findings by testing whether increasing self-efficacy reduces people's fear of being isolated if they were to share their opinion about climate change. Specifically, it is possible that people might be less worried about being isolated in a conversation about this topic when they are more confident in their ability to communicate their opinion.

I examined whether learning about climate change would increase self-efficacy, leading to a decrease in fear of isolation and correspondingly an increase in discussion. However, this model was not supported, b = .01, SE =.03, 95% CI (-.03, .09).

Discussion

My results show that learning about climate science, using techniques documented to have positive impacts on the general public, led to increased willingness to discuss climate change relative to learning about a control topic. However, this effect is only found for participants led to believe that others share their concern about climate change; those led to believe that others do not share their concern are no more willing to discuss climate change when they learn about it than when they do not. This suggests that learning about climate science has the potential to increase discussions about climate science, but that this effect will not be seen in certain environments, such as when the audiences is perceived to not agree with one's views on the topic.

Planned analyses of the proposed processes provide an explanation for importance of knowledge among when one's audiences are concerned about climate change. A parallel mediation analysis revealed that self-efficacy, but not response efficacy or fear of isolation explains the results found in this study. Knowing that others share one's concern is not sufficient to increase willingness to talk about climate change in these results; perhaps because perceiving oneself as in the minority does not exert the same self-silencing effect in this laboratory setting as it would in other settings. However, learning about climate science in a context where others were likely to share one's opinions on the topic did increase willingness to discuss the topic, by allowing participants the confidence that they could speak competently about the topic (i.e. increased self-efficacy).

Post-hoc serial mediation analyses provide insights into why self-efficacy increases willingness to talk about climate change. The results of the first serial mediation suggested that a portion of the effect of increased self-efficacy on the outcome (resulting from learning about climate change) was explained by increased response-efficacy. This suggests that to the degree that learning about climate change boosts self-efficacy and thereby increases the perception that discussions will result in positive outcomes, individuals will be more willing to discuss climate change.

Chapter 8: ADDITIONAL ANALYES

The findings in Study 1 indicated that participants who learned about climate change were more willing to discuss the topic than a control group, regardless of whether they were led to believe others were concerned or unconcerned. Yet, in Study 2, learning about climate change only increased willingness to engage in discussion (relative to a control group) among those who were told others were concerned about the topic. The discrepant results may be due to the fact

that the manipulation of perceived opinion agreement in Study 1 did not effectively alter perceptions of others' agreement, while the manipulation in Study 2 did accomplish the desired effect. However, examining the patterns of results (in Figures 2 and 4) reveals that despite differences in statistical significance, the differences between cells means appear to be similar in Studies 1 and 2. To further examine these results, I created a merged dataset containing the relevant similar variables from both studies.

In this combined dataset, I used a 2(study) x 2(learning) x 2(audience) between-subjects ANOVA to examine whether the results would differ by study. Results showed that those who had learned about climate change were significant more willing to discuss the topic (M = 1.09) than those who had not (M = 0.74), $F(1, 303) = 7.49$, $p = .007$, $\eta_p^2 = .024$. As in the two individual studies, those who had been told others were concerned were no more willing to discuss climate change (M= 4.93) than those who had been told others were unconcerned, $F(1, 303) = 0.00$, $p = .96$, $\eta_p^2 = .00$. These effects were qualified by an interaction between the two variables, $F(1, 301) = 5.39$, $p = .021$, $\eta_p^2 = .018$. The interaction followed the same pattern as Study 2 where among those led to believe others were concerned, learning about climate science increased willingness to discuss the topic, $b = .65$, SE = .18, $p < .001$, but among those led to believe others were unconcerned, learning about climate science had no effect, $b = .06$, SE = .18, $p = .74$. Similar to the Study 2 results, those who were led to believe that others shared their opinions were no more willing to discuss climate change than those who were led to believe that others did not share their opinions, both among those who had learned about climate science, $b = .29$, SE = .18, $p = .10$ and those in the control condition, $b = -.30$, SE = .18, $p = .10$.

None of these findings described here significantly differed between Study 1 compared to Study 2, *p*s > .10. This suggests that the pattern of results observed here was similar across the two studies, despite individual differences in statistical significance within studies.

Chapter 9: GENERAL DISCUSSION

The purpose of this research was to examine whether, when, and how climate science education might play a role in increasing interpersonal discussion of climate change. The results of the present research reveal the importance of perceived knowledge in discussing the topic, and more specifically, the importance of knowledge in stimulating conversation when in situations where people already believe others share their concern on the topic.

In my previous work where no participants learned about climate change in the study, I found that those who believed others were concerned about climate change were more willing to discuss climate change than those who believed others were not concerned. In the present research, this finding was not replicated. One explanation for these divergent findings is that my previous research examined willingness to discuss climate change in two public settings that participants would regularly encounter: a library setting and a classroom. In contrast, both studies in the present research were conducted in a less typical laboratory setting. Further, participants were specifically told that we wanted to see how the average student would discuss the scientific topics, which may have made them less concerned about being perceived negatively by students who disagreed with their opinion. Indeed, most participants reported very low fear of isolation based on expressing their opinion about climate change in this context.

Even in this laboratory setting, however, perceptions of others' opinions were important in that they influenced whether learning about climate change would affect participants' willingness to discuss the topic. Among participants led to believe others were not concerned

about climate change, learning about the topic did not increase their willingness to discuss the topic relative to a control group. However, among those led to believe others were concerned about climate change, those who learned about the topic were more willing to discuss the topic than those who did not learn about the topic.

The data further reveal that this difference in willingness to discuss the topic could be explained by self-efficacy. These results suggest that before beginning a knowledge campaign designed to change behavior, practitioners should conduct an analysis of existing self-efficacy regarding the behavior. To the degree that self-efficacy is low (or close to neutral, as it was in the present study), a knowledge campaign focusing on increasing self-efficacy with regard to performing the behavior may be likely to be effective at increasing behavioral intent. The present results show that an educational program designed to increase knowledge may be effective at increasing self-efficacy and thereby increasing willingness to discuss climate change, however, this pattern of effects was shown only for those who believed others were concerned. Thus, further research may be needed to determine whether this pattern replicates in other contexts.

The results of the mediation analyses were also informative with regard to the other two process variables. The model shown in Figure 5 illustrates that in addition to self-efficacy, response efficacy predicts willingness to discuss climate change. Although the knowledge intervention did not directly affect response efficacy, the results suggest that to the degree that knowledge increases self-efficacy, it may also give response efficacy a small boost, further increasing willingness to discuss climate change.

Fear of isolation was also identified as another potentially important process variable: in a basic model it mediated the effects of learning about climate science on willingness to discuss

the topic among those led to believe others were concerned. In the parallel mediation model, however, fear of isolation no longer mediated the relationship when self-efficacy was included. This could be partly due to the fact that those with higher self-efficacy also tended to be lower in fear of isolation (see Table 2). However, a serial mediation model failed to support the proposition that the increased self-efficacy from learning about climate change might increase willingness to discuss climate change because it reduced fear of being isolated as a result of the discussion. Thus, the results of the present study ultimately do not support the role of fear of isolation as a variable in the process of knowledge increasing willingness to discuss this topic. Further study may be warranted to examine the connection between fear of isolation and self-efficacy and clarify the meaning of these findings.

Limitations

Because the focus of the present research was on overcoming barriers to discussions about climate change among those who are already concerned, the results here cannot make any claims about the role of learning about climate change and other's opinions on those who disagree with the scientific consensus on this topic.

The degree to which these results would have external validity is also unclear. As noted, the nature of the tasks may have led to participants reporting very low fear of isolation if they were to share their opinion in the discussion, however, when asked to comment before the "discussion," a number of participants expressed feelings of anticipated awkwardness due to the perception that they were about to talk to a group of people whom they didn't know personally. An alternative approach is to have participants "imagine" a climate change discussion in a more typical context and fill out measures with regard to that discussion; however, this strategy also has limitations (Hayes et al., 2001). Perhaps a study could be devised where participants interact

with a group of acquaintances of whom they are unlikely to know the opinions in advance but with whom they also anticipate interacting fairly regularly in the future.

Future Directions

In the present research we assessed people's willingness to engage in a discussion about climate change, an important first step given the low rates of discussion about this socially relevant topic. Another relevant question is whether the discussions that do occur are more effective at achieving the proposed benefits listed in the introduction, namely, increased political priority, increased public knowledge, increased accuracy of risk perceptions, and increased public collaboration on solutions. Given the widespread confusion regarding much of the basic mechanisms of climate change, we suggest that if a group of misinformed people engage in a discussion about climate change, this discussion may serve to further increase misunderstanding about climate change. In contrast, perhaps those who have are more familiar with climate change science would be more likely to spread accurate information.

Future research could also focus on examining different education messages, different social contexts, and expanding the audience from the student population to the general public. First, the study could be replicated in a non-laboratory setting to determine whether perceived opinion climate exerts a different effect. Further, the effectiveness of the knowledge intervention could be tested across an audience with a range of climate change beliefs and political orientations. Another study could target upcoming educators – students from the college of education – to examine how the training would influence their willingness to talk about climate change. This is important because our current research suggests that many science educators are reluctant to discuss climate change in educational settings.

This study did not identify an effective strategy for facilitating climate change discussion in contexts where people believe that others do not share their opinion. This is practically relevant because even with a larger public social context where most are concerned about climate change, individuals may find themselves in situations where those who are unconcerned are disproportionately present. For example, a person might be concerned about climate change and interested in discussing the issue with his or her family, with a conservative religious community where climate change has not historically been a priority, or with a less scientifically educated audience living in an area where they have little exposure to accurate information about the true risks of climate change. Pluralistic ignorance may still be a factor in these situations, as people concerned about climate change may be unaware that a significant minority does agree with them. However, even if they are aware of others' opinions, beliefs that a majority of people disagree with them may still inhibit discussion. However, expressing their view may still result in positive outcomes, leading to social innovation and change (Nemeth, 1986; Cameron, Weintraub, & Schwarzenegger, 2014), while silence may lead to reduced support for climate change action among others (Czopp, 2013). Hence, I suggest that this is a ripe topic for future research.

Another future direction might be to identify common goals that people have when engaging in climate change discussions in realistic situations. This work would have practical value in that it would allow practitioners to better understand motives to engage in climate change discussions despite potential barriers to doing so. In addition, this work could be important at building upon the self-efficacy and response efficacy measures that I use here. While the measures used here serve to capture general goals that might motivate people to discuss climate change, including in the laboratory context, future research could help to

empirically identify goals and build results into wording of future questions regarding self- and response efficacy about climate change discussions.

On a theoretical level, future research could examine the extent to which the findings in this research apply to other socially relevant topics. For example, the high levels of income inequality in the U.S. are highly concerning to many Americans (Riffkin, 2014), and the logic behind addressing the problem may be even more complicated than climate change – so complicated, that in contrast to the strong consensus on climate change, there is not an expert consensus on what to do to mitigate income inequality. It remains to be seen whether this and other social issues may not be discussed as much as they could be in part because of the barriers identified in the current research – pluralistic ignorance and lack of knowledge about the topics.

Practical Implications

Despite the limitations of this research, these findings may have important implications for those interested in reversing the increasing public silence on climate change. By directly showing a causal link between climate science education and practical outcomes (at least under some circumstances), these findings may lead credence to the importance of increasing public knowledge about this topic. Climate change educators and communicators may wish to use these results to guide their curriculum, and further test the applicability of these findings to their program to determine whether these results hold in different settings.

Informal science learning centers (e.g. zoos, aquariums, national park, and museums) may be particularly interested in these findings. These institutions have the potential to significantly increase public discussion about climate change since hundreds of millions of people visit these institutions each year – 160 million at zoos alone (AZA, 2015). However, many of the educators working at these institutions have found it difficult to incorporate climate

science education into their presentations (Fraser et al., 2013; Swim & Fraser, 2014). The findings of the present research suggest that programs designed to promote effective presentations on this topic (e.g. Swim et al., under review; Anderson & Williams, 2013; Swim & Fraser, 2013) may be useful at increasing public discussion among many of these millions of visitors. This increased discussion, in turn, could potentially spread knowledge among friends and family of visitors and lead to increased discussion in these social networks as well.

Chapter 10: CONCLUSION

The results of this research may play a valuable role in facilitating public engagement in scientifically grounded topics such as climate change. The results of this research suggest that effective communication strategies designed to boost public understanding of climate change may be effective at fostering greater levels of interpersonal discussion on the topic, particularly in the context of others that are perceived to share one's opinions on the topic. My findings show that increased knowledge about climate change increases discussion through increased self-efficacy about one's ability to discuss the topic. However, given the limitations of my research, I suggest that any results in this study should be retested in a more realistic context before being directly applied to a climate change education program.

References

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global environmental change*, *23*(6), 1773-1785.

Anderson, J. C., & Williams, M. A. (2013). Engaging visitors to create positive futures. *Journal of Museum Education*, *38*(3), 256-259.

Association of Zoos and Aquariums (AZA) (2015). Visitor Demographics. Retrieved February, 26, 2015 from https://www.aza.org/visitor-demographics.

Bales, S. N. (2009). How to Talk About Climate Change and Oceans. Washington, DC: FrameWorks Institute.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, *84*(2), 191.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American psychologist*, *37*(2), 122.

Barabas, J. (2004). How deliberation affects policy opinions. *American Political Science Review*, *98*(04), 687-701.

Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change?. *Public Understanding of Science*, *9*(3), 205-218.

Byrd-Hagel Resolution. (1997). Retrieved from http://www.nationalcenter.org/KyotoSenate.html.

Cameron, J, Weintraub, T, and Schwarzenegger, A. (2014). Episode 1, Years of Living Dangerously. Electus International.

Change.gov (2014, March). Energy and environment agenda: The Obama-Biden plan. Retrieved from http://change.gov/agenda/energy_and_environment_agenda/

Chen, M. F. (2015). Self-efficacy or collective efficacy within the cognitive theory of stress model: Which more effectively explains people's self-reported proenvironmental behavior?. *Journal of Environmental Psychology*, *42*, 66-75

Cismaru, M., Cismaru, R., Ono, T., & Nelson, K. (2011). "Act on Climate Change": An Application of Protection Motivation Theory. *Social Marketing Quarterly*, *17*(3), 62-84.

Czopp, A. M. (2013). The passive activist: Negative consequences of failing to confront antienvironmental statements. *Ecopsychology*, *5*(1), 17-23.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of applied social psychology*, *30*(2), 407-429.

Frameworks (2013). Just the Earth Doing Its Own Thing. Mapping the gaps between expert and public understanding of oceans and climate change. Retrieved from http://www.frameworksinstitute.org/assets/files/cc_oceans_mtg.pdf.

Fraser, J., Pantesco, V., Plemons, K., Gupta, R., & Rank, S. J. (2013). Sustaining the Conservationist. *Ecopsychology*, *5*(2), 70-79.

Funk, S., Gilad, E., Watkins, C., & Jansen, V. A. (2009). The spread of awareness and its impact on epidemic outbreaks. *Proceedings of the National Academy of Sciences*, *106*(16), 6872-6877.

Gallup (2010). Americans' Global Warming Concerns Continue to Drop. Retrieved from http://www.gallup.com/poll/126560/Americans-Global-Warming-Concerns-Continue-Drop.aspx

Geiger, N. & Swim, J. (2015). Climate of silence: Pluralistic ignorance as a barrier to climate change discussion. Manuscript in preparation.

Glynn, C. J., Hayes, A. F., & Shanahan, J. (1997). Perceived support for one's opinions and willingness to speak out. *Public opinion quarterly*, *61*(3).

Hamilton, L. C. (2011). Education, politics and opinions about climate change evidence for interaction effects. *Climatic Change*, *104*(2), 231-242.

Hart, P. S., & Nisbet, E. C. (2012). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Communication Research*, 0093650211416646.

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling.

Hayes, A. F., Shanahan, J., & Glynn, C. J. (2001). Willingness to express one's opinion in a realistic situation as a function of perceived support for that opinion. *International Journal of Public Opinion Research*, *13*(1), 45-58.

Homburg, A., & Stolberg, A. (2006). Explaining pro-environmental behavior with a cognitive theory of stress. Journal of Environmental Psychology, 26(1), 1-14.

IPCC (2013). Climate Change 2013: The Physical Science Basis. IPCC WGI AR5 Summary for policymakers. Retrieved from http://www.ipcc.ch/report/ar5/wg1/

IPCC (2014). Climate change 2014: Impacts, adaptation, vulnerability. IPCC WGII AR5 Summary for policymakers. Retrieved from http://www.ipcc.ch/report/ar5/wg2/

Isenberg, D. J. (1986). Group polarization: A critical review and meta-analysis. *Journal of Personality and Social Psychology*, *50*(6), 1141.

Jones, J. M. (2014). Gallup: In U.S., Most Do Not See Global Warming as Serious Threat. Nearly two in three believe global warming will happen during their lifetimes. Retrieved from http://www.gallup.com/poll/167879/not-global-warming-serious-threat.aspx

Kasperson, R. E., & Kasperson, J. X. (1996). The social amplification and attenuation of risk. *The Annals of the American Academy of Political and Social Science*, 95-105.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., ... & Ratick, S. (1988). The social amplification of risk: A conceptual framework. Risk analysis, 8(2), 177-187.

Kenny, D. A., & Judd, C. M. (2014). Power Anomalies in Testing Mediation. *Psychological Science*, *25*(2), 334-339.

Kim, S. H. (2012). Testing Fear of Isolation as a Causal Mechanism: Spiral of Silence and Genetically Modified (GM) Foods in South Korea. *International Journal of Public Opinion Research*, *24*(3), 306-324.

Krosnick, J.A. (2010). The Climate Majority. New York Times. June 8th, 2010.

Lam, S. P. (2006). Predicting intention to save water: theory of planned behavior, response efficacy, vulnerability, and perceived efficiency of alternative solutions1. Journal of Applied Social Psychology, 36(11), 2803-2824.

Lam, S. P. (2014). Predicting support of climate policies by using a protection motivation model. *Climate Policy*, 1-18.

Lawlor, M., Kerridge, I., Ankeny, R., & Billson, F. (2007). Public education and organ donation: untested assumptions and unexpected consequences. *J Law Med*, *14*(3), 360-6.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Rosenthal, S. (2015). Climate change in the American mind: March, 2015. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G.,Rosenthal, S., & Marlon, J.(2014) Climate change in the American mind: Americans' global warming beliefs and attitudes in November, 2013. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication.

Leviston, Z., Walker, I., & Morwinski, S. (2013). Your opinion on climate change might not be as common as you think. *Nature Climate Change*, *3*(4), 334-337.

Lewandowsky, S., Ecker, U. K., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and its correction continued influence and successful debiasing. Psychological Science in the Public Interest, 13(3), 106-131.

Maibach, E. W., Leiserowitz, A., Roser-Renouf, C., Mertz C. K., & Akerlof, K. (2011). Global Warming's Six Americas screening tools: Survey instruments; instructions for coding and data treatment; and statistical program scripts. Yale University and George Mason University. Yale Project on Climate Change Communication, New Haven, CT. Available at http://climatechangecommunication.org/SixAmericasManual.cfm

Maibach, E. W., Roser-Renouf, C., & Leiserowitz, A. (2008). Communication and marketing as climate change–intervention assets: A public health perspective. *American journal of preventive medicine*, *35*(5), 488-500.

Matthes, J., Morrison, K. R., & Schemer, C. (2010). A spiral of silence for some: Attitude certainty and the expression of political minority opinions. *Communication Research*, *37*(6), 774-800.

McCright, A. M., & Dunlap, R. E. (2011). Cool dudes: The denial of climate change among conservative white males in the United States. Global environmental change, 21(4), 1163-1172.

McCright, A. M., Dunlap, R. E., & Xiao, C. (2013). Perceived scientific agreement and support for government action on climate change in the USA. *Climatic change*, *119*(2), 511-518.

McDonnell, T. (2015). Mitch McConnell Is Now Telling States To Ignore Obama's Climate Rules. Mother Jones. Retrieved from http://www.motherjones.com/blue-marble/2015/03/mitch-mcconnell-climate-rules-obama

McLeod, J. M., Scheufele, D. A., & Moy, P. (1999). Community, communication, and participation: The role of mass media and interpersonal discussion in local political participation. *Political Communication*, *16*(3), 315-336.

Miller, D. T., & McFarland, C. (1987). Pluralistic ignorance: When similarity is interpreted as dissimilarity. *Journal of Personality and social Psychology*, *53*(2), 298.

Muthén, L.K. and Muthén, B.O. (1998-2012). Mplus User's Guide. Seventh Edition. Los Angeles, CA: Muthén & Muthén

Nemeth, C. J. (1986). Differential contributions of majority and minority influence. *Psychological review*, *93*(1), 23.

Neuwirth, K., & Frederick, E. (2004). Peer and social influence on opinion expression combining the theories of planned behavior and the spiral of silence. *Communication Research*, *31*(6), 669-703.

Neuwirth, K., Frederick, E., & Mayo, C. (2007). The spiral of silence and fear of isolation. Journal of Communication, 57, 450-468.

Nisbet, M. C., Markowitz, E. M., & Kotcher, J. E. (2012). Winning the Conversation: Framing and Moral Messaging in Environmental Campaigns. In Ahern, L. & Bortree, D. S. (Eds). *Talking Green: Exploring Current Issues in Environmental Communication. New York: Peter Lang*.

Nisbet, M.C. (2015). Environmental Advocacy in the Obama Years: Assessing New Strategies for Political Change. In Norm J. Vig and Michael E. Kraft (Eds), Environmental Policy: New Directions for the Twenty-First Century, 9th Edition. Wash, DC: Congressional Quarterly Press.

Noelle-Neumann, Elisabeth (1993). The spiral of silence: Public opinion – our social skin. Second Edition. Chicago/London: University of Chicago Press.

Nolan, J. M. (2010). " An Inconvenient Truth" Increases Knowledge, Concern, and Willingness to Reduce Greenhouse Gases. Environment and Behavior.

O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk analysis*, *19*(3), 461-471.

Ojala, M. (2012). Hope and climate change: the importance of hope for environmental engagement among young people. *Environmental Education Research*, *18*(5), 625-642.

Oreskes, N. (2007). The long consensus on climate change. The Washington Post. Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2007/01/31/AR2007013101808.html

Owens, S. (2000). 'Engaging the public': information and deliberation in environmental policy. *Environment and planning A*, *32*(7), 1141-1148.

Pew. (2013). Keystone XL Pipeline Draws Broad Support: Continuing Partisan Divide in Views of Global Warming. http://www.people-press.org/2013/04/02/keystone-xl-pipeline-draws-broad-support/

Pidgeon, N., & Fischhoff, B. (2011). The role of social and decision sciences in communicating uncertain climate risks. *Nature Climate Change*, *1*(1), 35-41.

Presidential Climate Action Project (2011). Emissions reductions needed to stabilize climate. Retrieved from http://www.climatecommunication.org/wp-content/uploads/2011/08/presidentialaction.pdf

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. Simon and Schuster.

Renn, O. (2011). The social amplification/attenuation of risk framework: application to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(2), 154-169.

Reynolds, T. W., Bostrom, A., Read, D., & Morgan, M. G. (2010). Now what do people know about global climate change? Survey studies of educated laypeople. *Risk Analysis*, *30*(10), 1520-1538.

Riffkin, R. (2014). In U.S., 67% Dissatisfied With Income, Wealth Distribution. Gallup Polls. Retrieved from http://www.gallup.com/poll/166904/dissatisfied-income-wealth-distribution.aspx

Ruiter, R. A., Verplanken, B., Kok, G., & Werrij, M. Q. (2003). The role of coping appraisal in reactions to fear appeals: Do we need threat information?. *Journal of Health Psychology*, *8*(4), 465-474.

Scheufle, D. A., & Moy, P. (2000). Twenty-five years of the spiral of silence: A conceptual review and empirical outlook. *International Journal of Public Opinion Research*, *12*(1), 3-28.

Scheufele, D. A., Shanahan, J., & Lee, E. (2001). Real Talk Manipulating the Dependent Variable in Spiral of Silence Research. *Communication Research*, *28*(3), 304-324.

Schreiner, C., Henriksen, E. K., & Kirkeby Hansen, P. J. (2005). Climate education: Empowering today's youth to meet tomorrow's challenges.

Schultz, P. W. (1999). Changing behavior with normative feedback interventions: A field experiment on curbside recycling. Basic and Applied Social Psychology, 21(1), 25-36.

Schultz, W. P., Khazian, A. M., & Zaleski, A. C. (2008). Using normative social influence to promote conservation among hotel guests. Social Influence, 3(1), 4-23.

Scruggs, L., & Benegal, S. (2012). Declining public concern about climate change: Can we blame the great recession?. *Global Environmental Change*, *22*(2), 505-515.

Swim, J. K., & Fraser, J. (2013). Fostering Hope in Climate Change Educators. *Journal of Museum Education*, *38*(3), 286-297.

Swim, J. K, & Fraser, J. (2014). Zoo and aquarium professionals' concerns and confidence about climate change education. *Journal of Geoscience Education,* 62.

Swim, J. K., Fraser, J., Geiger, N. (2015). Teaching the choir to sing: Use of social science information to promote public discourse on climate change. *Journal of Land Use & Environmental Law. In press.*

Swim, J. K., Fraser, J., Geiger, N. (2015). Climate change education at informal science learning centers. Manuscript under review.

Swim, J, & Geiger, N. (2015). Climate Change Audience Segmentation: An Alternative Assessment of the "Six Americas". Manuscript in Preparation.

Swim, J. K., Stern, P. C., Doherty, T. J., Clayton, S., Reser, J. P., Weber, E. U., Gifford, R., & Howard, G. S. (2011). Psychology's contributions to understanding and addressing global climate change. *American psychologist*, *66*(4), 241.

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. Psychological Science, 18(5), 429-434.

Swim, J. K., & Fraser, J. (2013). Fostering Hope in Climate Change Educators. *Journal of Museum Education*, *38*(3), 286-297.10)

Swim, J. K., Hyers, L. L., Cohen, L. L., & Ferguson, M. J. (2001). Everyday sexism: Evidence for its incidence, nature, and psychological impact from three daily diary studies. *Journal of Social Issues*, *57*(1), 31-53.

van Kasteren, Y. (2014). How are householders talking about climate change adaptation?. *Journal of Environmental Psychology*, *40*, 339-350.

Visser, P. S., Krosnick, J. A., & Simmons, J. P. (2003). Distinguishing the cognitive and behavioral consequences of attitude importance and certainty: A new approach to testing the common-factor hypothesis. Journal of Experimental Social Psychology, 39(2), 118-141.

Walsh, B. (2010). Cap and Trade is Dead (Really, Truly, I'm Not Kidding). Who's to Blame? Time Magazine. Retrieved from http://science.time.com/2010/07/22/cap-and-trade-is-dead-really-truly-im-not-kidding-whos-to-blame/

White House (2015). FACT SHEET: U.S. Reports its 2025 Emissions Target to the UNFCCC Retrieved from https://www.whitehouse.gov/the-press-office/2015/03/31/fact-sheet-us-reports-its-2025-emissions-target-unfccc.

Zeller, T, Zelman, J. (2012). Climate Change Not Mentioned In Presidential Debates For First Time In A Generation. The Huffington Post. Retrieved from http://www.huffingtonpost.com/2012/10/23/climate-change-presidential-debate_n_2004067.html

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. Contemporary educational psychology, 25(1), 82-91.

Appendix A: Study 1 Measures

Measures used in Study 1.

1) How willing are you to participate in a discussion on climate change?
    a) Very hesitant
    b) Hesitant
    c) Somewhat hesitant
    d) Neither willing nor hesitant
    e) Somewhat willing
    f) Willing
    g) Very willing
2) How willing are you to lead a discussion on climate change?
    a) Very hesitant
    b) Hesitant
    c) Somewhat hesitant
    d) Neither willing nor hesitant
    e) Somewhat willing
    f) Willing
    g) Very willing
3) How enthusiastic would you be to participate in a discussion on climate change?
    a) Very unenthusiastic
    b) Unenthusiastic
    c) Somewhat unenthusiastic
    d) Neither enthusiastic nor unenthusiastic
    e) Somewhat enthusiastic
    f) Enthusiastic
    g) Very enthusiastic
4) How interested are you to share what you know about this topic?
    a) Very uninterested
    b) Uninterested
    c) Somewhat uninterested
    d) Neither interested nor uninterested
    e) Somewhat interested
    f) Interested
    g) Very interested
5) How interested are you to exchange opinions with other participations on this topic?
    a) Very uninterested
    b) Uninterested
    c) Somewhat uninterested
    d) Neither interested nor uninterested

   e) Somewhat interested
   f) Interested
   g) Very interested
6) How much do you know about this topic?
   a) Nothing at all
   b) Very little
   c) A moderate amount
   d) Quite a bit
   e) An extreme amount
7) To what degree do you think the other students in the room would like to discuss this topic?
   a) Not at all
   b) Not much
   c) A moderate amount
   d) Quite a bit
   e) An extreme amount
8) To what degree do you believe the other students in the room would agree with your opinions and beliefs on this topic?
   a) Strongly disagree
   b) Somewhat disagree
   c) Neither agree nor disagree
   d) Somewhat agree
   e) Strongly agree

Appendix B: Study 2 Measures

Measures used in Study 2. The order of items was randomized within each scale.

Concern about Climate Change

Which statement best represents your position on climate change?

Very Concerned: I am very concerned about climate change and think the government and individuals need to act now

Concerned: I am concerned and think we need to take action but we have time to decide what the appropriate responses should be

Cautious: I suspect that climate change is happening but I am not certain. We have time to make careful decisions about when and whether to respond

Disengaged: I have not really thought much about it

Doubtful: I suspect that climate change is NOT happening but I am not certain. I am concerned more about overreacting to climate change

Nonbeliever: I do not believe climate change is occurring and certainly do not think humans have caused it. So, I'm not motivated to take or support action to address it.

All remaining items were assessed on the following scale: Please indicate the extent to which you agree with the following items (Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree, Strongly Agree).

Willingness to Discuss Climate Change

1. I am willing to participate in a discussion on climate change.
2. I am enthusiastic to participate in a discussion on climate change.
3. I am interested to share what I know about climate change.
4. I am interested to exchange opinions with other participations on climate change.

Self-Efficacy

1. I know how to talk about climate change in a conversation with other students.
2. I know enough about climate change to be able to talk about it a conversation with other students.
3. I am not capable of discussing climate change with other students.
4. I wouldn't be able to have a good discussion about climate change with other students.

Response Efficacy

1. When average people talk about climate change, it increases awareness of the importance of climate change.
2. When average people talk about climate change, it helps people accurately understand the risks of climate change.
3. When average people talk about climate change it does NOT increase our ability to engage in effective solutions to climate change.
4. When average people talk about climate change it does NOT change anyone's opinions about climate change.

Fear of Isolation

1. I worry about being excluded in the discussion if I express my opinions about climate change.

2. I am concerned that if other participants know my opinions about climate change they would avoid me or act differently somehow.
3. I'm worried that the topic of climate change is touchy and I have to watch what I say about it in the discussion.
4. I'm worried that expressing my opinions about climate change in the discussion would lead other participants to see me as an outsider.
5. I'm worried that I will distance myself from other participants if I talk openly about how I feel about climate change in the discussion.