Employing Multivariate Logistic Regression Analysis to Better Understand the Relationship between Individuals’ Anthropogenic Climate Change Acceptance and Belief in Anti-Climate Change Dissenter Messages

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EMPLOYING MULTIVARIATE LOGISTIC REGRESSION ANALYSIS
TO BETTER UNDERSTAND THE RELATIONSHIP BETWEEN
INDIVIDUALS’ ANTHROPOGENIC CLIMATE CHANGE
ACCEPTANCE AND BELIEF IN ANTI-CLIMATE
CHANGE DISSENTER MESSAGES

by

Andrew Phillip Keller Bentley

A dissertation submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
Mallinson Institute for Science Education
Western Michigan University
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Doctoral Committee:

Heather Petcovic, Ph.D., Chair
David Rudge, Ph.D.
Sheldon Turner, Ph.D.
Organized climate change dissention groups spend a considerable amount of time and energy developing messages designed to convince the public that anthropogenic climate change is neither a reality nor a threat. These messages work against the efforts of climate educators and can be divided into two categories; messages that provide alternative explanations for warming, or messages that attack the work of scientists studying anthropogenic climate change. There has been a lack of research regarding any correlation between individuals’ agreement with these messages and their rejection of anthropogenic climate change. Establishing a correlation would be an indication that educators should take steps to inoculate individuals from dissenter messages.

This dissertation project answers this broad question via an analysis of responses to the anthropogenic climate change dissenter inventory (ACCDI). This survey tool measures individuals’ agreement with dissenter messages across six factors: naïve scientific statements which *assert no connection between atmospheric carbon dioxide and climate*, anti-science statements which *attack the credibility of climate scientists*, sophisticated scientific statements which *imply warming is not anthropogenic*, arguments that assert recent changes are *natural or out of our control*, arguments that imply *current warming is simply part of a larger cycle*, and statements that highlight *benefits of a warmer climate*.

Amazon’s Mechanical Turk was used to recruit 689 participants. Participants’ responses on the ACCDI were subjected to multivariate logistic regression analysis. Results indicate that agreement with dissenter messages is a predictor of dissent among the study population.
Particularly strong predictors are messages that attribute recent warming to natural climate cycles. Agreement with messages that describe anthropogenic climate change as beneficial, and agreement with naïve messages were not predictors of dissent. Other predictors include an individual’s preferred news network, and political ideology. The results of this dissertation strongly suggest that effective anthropogenic climate change instruction should include time dedicated to inoculating students from misinformation and discussion exploring why groups or individuals would spread this misinformation. This could be accomplished through misconception driven instruction where students discuss the flaws of logic within misconceptions to highlight why they are misconceptions. Teaching students the science behind, and the societal implications of, anthropogenic climate change policy may lead to a more climate literate public.
ACKNOWLEDGMENTS

A special thanks to Russel Stanley Bentley, Zachary Russel Keller Bentley, Brittany Rowe, Elizabeth Lara Eklund, Peter Roland Eklund, John Keller, John Bentley, Jim Burns, Joe Frederickson, Janessa Doucette-Frederickson, Jason Bracken, Janice Fulford, Matthew Ludwig, Cody Williams, Joe Lane, Barbara Agens, Selcuck Sahingo, Mr. Willis, Ilya Buynevich, Heather Petcovic, David Rudge, and Sheldon Turner.

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1. INTRODUCTION

1.1 Problem Statement

Understanding anthropogenic climate change is a crucial part of an individual’s overall scientific literacy, and will increasingly become more important as the world experiences environmental changes brought on by anthropogenic climate change. A population that understands the anthropogenic nature of climate change is far more likely to make positive personal and societal changes concerning energy use and carbon dioxide emissions (Vainio & Paloniemi, 2013). In the United States, the need for a climate literate society has pushed science education standards (e.g., Next Generation Science Standards, Earth Science Literacy Initiative) to place ever greater emphases on teaching the science behind anthropogenic climate change.

One of the proposed solutions to this global threat is the drastic reduction of CO₂ and other greenhouse gas emissions (IPCC, 2013). In response to these proposed policies, numerous fossil fuel, manufacturing, and mining industries have provided funds to organizations that attempt to increase anthropogenic climate change skepticism (Dunlap & McCright, 2011). The organizations that receive monetary donations are almost exclusively conservative think tanks whose own beliefs include promoting limited government (Boykoff & Boykoff, 2004; Brulle, 2013; Dunlap & McCright, 2011). These organizations are often well-funded and are capable of spreading anti-anthropogenic climate change information through “Congressional testimony, publication of documents on these [conservative think tank] organization’s websites, the publication of conservative anti-climate change editorials, and books critical of the need to address climate change” (Brulle, 2013, p. 133). Statements manufactured by these organizations are intended to foster doubt that climate change exists or that if it does, that it’s cause is anthropogenic (Boussalis & Coan, 2016; McCright & Dunlap, 2000). These anti-anthropogenic climate change statements are then repeated by major anti-anthropogenic climate change players in what researchers refer to as the “echo-chamber,” which includes news media, politicians, and online sources (Dunlap & McCright, 2011).
Organized climate change denial has the potential to make the positive efforts of formal and informal education difficult. Particularly, dissenter organizations use deceptive arguments that are scientific-sounding (e.g., “the sun is the sole controller of climate change”) and non-scientific (e.g., “climate change is a hoax proliferated by academics to receive funding”) to convince others of their position (A. P. K. Bentley, Petcovic, & Cassidy, 2016). Students are likely exposed to these messages before entering the classroom, making formal instruction difficult when students begin their education with preexisting biases.

Current educational initiatives aim to increase student’s understanding of climate change so that they can make informed decisions in their lives. However, educators who claim they teach climate change likely dedicate less than two hours of the entire school year to the topic (Plutzer et al., 2016). Researchers have found that even educators who are teaching climate change often fail to understand even basic concepts related to anthropogenic climate change, such as the difference between weather and climate (Lambert, Lindgren, & Bleicher, 2012; Papadimitriou, 2004; Wise, 2010).

Matkins and Bell (2007) illustrate the potential for science educators to fail to discern the difference between the science of climate change and the messages of the anti-anthropogenic climate change echo-chamber. Matkins and Bell (2007) investigated the impact of teaching the nature of science (NOS) alongside the socioscientific issue of climate change. They did find that teaching anthropogenic climate change increased students NOS understand that all scientists do not arrive at the same conclusions. However, Matkins and Bell (2007) appear to have failed to recognize that the majority of climate scientists agree climate change is occurring and is due to anthropogenic causes (Cook et al., 2013). The assigned readings in the authors’ intervention included anti-climate change blogs, writings by well-established contrarian scientists, and non-contrarian peer-reviewed journals. The anti-anthropogenic climate change readings were provided in order to demonstrate to students that scientists are not in agreement on anthropogenic climate change. The authors failed to disclose whether they taught students about the scientific credibility, or lack thereof, of some of the provided sources. Matkins and Bell (2007) conclude their paper by asserting their intervention was a success and quote one student who said, “[Studying GCC/GW [global climate change/global warming] and the nature of science] makes you realize that science isn’t always exact, and so you have a responsibility to teach both sides
and all angles of a scientific issue” (Matkins & Bell, 2007, p. 158). In this instance Matkins and Bell (2007) duplicated a common error made by news outlets through framing anthropogenic climate change as a debate with two valid sides (Boykoff & Boykoff, 2004, 2007). Matkins and Bell’s (2007) study demonstrates the effectiveness of the messages produced by anti-anthropogenic climate change organizations. To fully inoculate educators, students, and the public from anti-anthropogenic climate change rhetoric, anti-anthropogenic climate change messages must be documented and studied. Otherwise, educators may inadvertently teach anti-anthropogenic climate change messages in their classrooms. Unknown now is whether anti-anthropogenic climate change information negatively effects individuals’ anthropogenic climate change belief. If this were the case, then time should be dedicated to inoculating students and the public from misinformation.

1.2 Research Overview

This dissertation focuses on better understanding the relationship between anthropogenic climate change acceptance, and agreement with anthropogenic climate change dissenter messages. An understanding of this relationship would provide answers to two broad questions.

(1) What groups of people, as categorized by demographic factors, agree most with dissenter messages? If agreement with dissenter information is correlated with a rejection of anthropogenic climate change, then recommendations can be made for what groups should be targeted via education initiatives. To broaden the scope of this question, detailed comparisons between dissenter message “buy-in” and demographics were conducted to determine whether different segments of the population buy into particular dissenter messages. Understanding this relationship would be useful because tailored education initiatives could be developed for particular groups. These initiatives could go after rectifying particular dissenter messages.

(2) Does accurate anthropogenic climate change knowledge matter? As will be demonstrated in the literature review of this document (Chapter 2), many researchers find a strong relationship between an individual’s political ideology and climate change belief. This simple relationship is not a useful conclusion for science educators. This dissertation will answer whether buy-in to dissenter knowledge matters when it comes to anthropogenic climate change
acceptance. Furthermore, the instrument used in this research can tell science educators what dissenter messages have the highest correlation to dissent. This information would be vital for developing effective teaching materials.

1.3 Societal Understanding and Belief in Anthropogenic Climate Change

The vast majority of climate scientists and meteorologists hold that the current warming of earth’s oceans and atmosphere is anthropogenic (Anderegg, Prall, Harold, & Schneider, 2010; Cook et al., 2013; Maibach et al., 2016). However, many members of the public remain unconvinced that climate change is either occurring or anthropogenic (Anthony Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). Dissension has sparked numerous studies and surveys concerning individuals’ beliefs and understandings concerning anthropogenic climate change.

Extensive research in the field of public understanding of science, or public awareness of science, documents the public’s knowledge, opinions, and personal decision making surrounding a scientific topic. The U.S. public’s knowledge of climate change has changed over the last 30 years as the effects of anthropogenic climate change and media coverage increase. For instance, the percentage of individuals who self-identify as understanding climate change “very well” has increased from 11% in 1992, to 33% in 2014 (Saad, 2014). Between 2001 and 2014, Gallup found that the number of U.S. citizens who believe global warming is caused by humans rather than nature has remained largely static (Saad, 2014). In 2001, 61% of U.S. respondents believed in a human cause for global warming; in 2014, that number was 57% (Saad, 2014). According to the Yale Project on Climate Change Communication 2014 report (Anthony Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Rosenthal, 2014), approximately two thirds of the U.S. adult population thinks global warming is happening, whereas only half think global warming is caused by humans (Anthony Leiserowitz et al., 2014).

Anthropogenic climate change dissension is not unique to the United States. An international Gallup poll conducted in 2009 indicates public belief of the cause of global warming varies greatly by country (Pelham, 2009). This poll shows that South Koreans and Japanese are the most likely to blame human actives for the rise of global temperatures, 92% and
91% respectively. English speaking countries’ populations were more or less split on the cause of climate change (Canada 61%, Australia 54%, the United States 49%, & the United Kingdom 48%). The citizens of Tajikistan and Uzbekistan were least likely to believe humans are at fault, 18% and 15% respectively. These types of reports are important because public perceptions ultimately drive policy changes.
2. LITERATURE REVIEW

The literature review presented here is a shortened version of a comprehensive critical literature review. For a copy of this document contact Andrew Phillip Keller Bentley. The table below includes all the articles that were part of the comprehensive critical literature review.

Table 1: List of papers critiqued in the full comprehensive critical literature review.

<table>
<thead>
<tr>
<th>Introduction: Overview and History of the Anti-Environmental Movement</th>
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<tbody>
<tr>
<td>Dunlap and McCright (2011)</td>
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<td>Boussalis and Coan (2016)</td>
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<td>Akerlof, Rowan, Fitzgerald, and Cedeno (2012)</td>
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<td>Feldman, Maibach, Roser-Renouf, &amp; Leiserowitz (2012)</td>
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<th>Anthropogenic Climate Change Perception Papers</th>
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<td>Jelen and Lockett (2004)</td>
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<td>McCright (2010)</td>
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<td>Semenza et al. (2008)</td>
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<td>Dunlap and McCright (2008)</td>
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2.1 Organized Climate Denial: The Anti-Anthropogenic Climate Change Movement

According to many, the anti-environmental movement has been growing in size, power, and influence in the United States (Brulle, 2013; Dunlap & McCright, 2008, 2011; Jacques, Dunlap, & Freeman, 2008; McCright & Dunlap, 2000, 2003). Information produced by these organizations is counter to the scientific consensus on anthropogenic climate change, and is designed to foster doubt among citizens of the United States (A. P. K. Bentley et al., 2016; Dunlap & McCright, 2008; McCright & Dunlap, 2000; Oreskes & Conway, 2011). Below is a collection of research articles that establish the existence and structure of organized climate denial.
Riley Dunlap and Aaron McCright are among the most prominent scholars investigating the anthropogenic climate change movement and are widely cited within discussions of organized climate denial in the academic literature. In their 2011 book chapter entitled Organized Climate Change Denial, Dunlap and McCright (2011) detail the rise of organized climate denial, and provide a framework for how all the parts of organized denial integrate with each other. Much of the chapter describes the connections between all the parts of the climate change denial machine and how each part can potentially affect the public.

In Dunlap and McCright’s (2011) view, industrialized nations are going through “growing pains” of knowledge. Industrialized nations are becoming aware that their economy’s primary energy source, fossil fuels, has serious negative consequences. Dunlap and McCright (2011) argue that those who benefit from capitalistic economies stand to lose revenue if the public moves to support carbon dioxide regulation. The authors argue that organized denial comes about when influential and wealthy groups, like energy companies, are concerned they may lose some of their wealth and influence due to regulations. Dunlap and McCright (2011) cite others who believe the threat of carbon dioxide regulation to be a particular problem in the United States because corporations and environmental regulation have been at odds with each other since the 1980s.

Dunlap and McCright (2011) point to the Regan administration as the start of the anti-environmental movement of the political right-wing. This is a theme throughout these authors’ other works (see Dunlap & McCright, 2008). When the Regan administration attempted to relax environmental regulations they received pushback from the public. “…[E]xperience taught conservatives (and industry) that it was more efficacious to question the need for environmental regulation by challenging evidence of environment degradation, rather than the goal of environmental protection” (Dunlap & McCright, 2011, p. 146). Attacking science, rather than conducting science to refute anthropogenic climate change, seems to be a theme throughout dissenter literature discourse analyses (Boussalis & Coan, 2016; Dunlap & Jacques, 2013; Lewandowsky, Ballard, Oberauer, & Benestad, 2016; McCright & Dunlap, 2000).

Whereas the start of anti-environmentalism begins with the Regan administration, Dunlap and McCright (2011) see the formation of the Intergovernmental Panel on Climate Change (IPCC) as the start of organized climate denial. For those not familiar with the IPCC, it is an
international effort to establish a clear understanding of anthropogenic climate change and its possible effects on mankind. The organization was established in 1988 and is an integral part to the United Nation’s environmental policy efforts (IPCC, 2013). The information provided by the IPCC is meant to help guide policy efforts, but the IPCC itself does not write or recommend policy. During this period industry (predominantly the fossil fuel industry) linked with conservative think tanks in order to manufacture doubt. Dunlap and McCright (2011) assert that the organized spread of information is like framework used by the tobacco industry.

The first group described in the organized denial machine consists of the fossil fuel industry and corporate America. Per Dunlap and McCright (2011), the fossil fuel industry, corporate American and conservative philanthropists, fund the ‘organized climate denial machine.’ They supply capital to conservative think tanks and political leaders who oppose carbon dioxide regulations. Funding these organization allows industry to increase climate confusion among the public from a safe distance. Dunlap and McCright (2011) cite economical motivators for the fossil fuel industry and corporate America whereas, conservative philanthropists are more likely involved due to the ideology of limited government.

The second group in the ‘denial machine’ are conservative think tanks and foundations. These organizations are particularly of interest to science education because they are the source of most of the anti-anthropogenic climate change information. Dunlap and McCright (2011) describe conservative foundations and think tanks as “…sources of information, basically an alternative academia, and thus they have more credibility with much of the public, many media outlets, and some policy makers than do corporations” (Dunlap & McCright, 2011, p. 150). These organizations greatly influence many other parts of the organized climate denial machine, because they produce anti-anthropogenic climate change information, host conferences, provide literature to politicians and, most importantly, write policy (Dunlap & McCright, 2011).

The third group in the ‘denial machine’ are front groups. These groups are defined by Dunlap and McCright (2011) as organizations set up by industry to “…shield their anti-environmental activities from public scrutiny” (Dunlap & McCright, 2011, p. 150). Three groups are discussed in this section, The Global Climate Coalition (GCC), The Information Council on the Environment (ICE), and The Cooler Heads Coalition (CHC). The GCC was established in the late 1980s and spearheaded much of the campaign against the United States ratification of the
Kyoto protocol (Dunlap & McCright, 2011). The GCC dispersed in 2002, but during its height had prominent and powerful industry membership including British Petroleum, ExxonMobil, Chrysler, Ford, General Motors, and the National Association of Manufactures (Dunlap & McCright, 2011). ICE was established mainly by coal industry groups, and focused its efforts on stopping the United States from agreeing to curb carbon dioxide emissions at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (Dunlap & McCright, 2011). Dunlap and McCright (2011) state that the ICE shut down after their goals were leaked to the media in 1998. The last group covered in detail by Dunlap and McCright (2011) is the CHC. This group is comprised of conservative think tanks rather than fossil fuel companies. The CHC, similarly to individual conservative think tanks themselves, holds congressional briefings, and promotes contrarian scientists. Recently the CHC has been publicizing ‘Climategate,’ an artificial email scandal used to attack individual climate scientists.

The fourth group identified in the ‘organized climate denial machine’ is comprised of contrarian scientists. Per Dunlap and McCright (2011) early contrarian scientists employed by conservative think tanks and front groups were mostly physicists without climate experience and expertise. However, actual climate scientists who do not accept that human activities are causing climate change have joined the ranks. These individuals often act as the figureheads of ‘organized climate denial machine.’ When television news wants to discuss anthropogenic climate change, they often invite contrarian scientists to “balance” climate experts. As we will see later in this critical literature review, this has caused a separate and unique set of problems often referred to as the ‘bias as balance’ (Boykoff & Boykoff, 2004). From a science education perspective, these individuals likely do harm to the public’s understanding of anthropogenic climate change. Contrarian scientists are ubiquitous when examining the dissenter literature, especially that in the echo chamber (A. Bentley, Cassidy, & Petcovic, 2015; A. Bentley, Jones, Lane, & Petcovic, 2014).

The conveyors of anti-anthropogenic climate change rhetoric are fifth group in the ‘organized climate denial machine’ (Dunlap & McCright, 2011). Conveyors of anti-anthropogenic climate change messages include conservative talking heads (e.g., Sean Hannity, Rush Limbaugh, Glenn Beck), conservative television stations (e.g., Fox News), conservative newsprint (e.g., Wall Street Journal, New York Post), and conservative blogs. Dunlap and
McCright (2011) refer this network of message conveyors as the ‘echo-chamber.’ These groups ‘bounce’ around almost identical talking points to each other. These messages attack scientists, cast doubt on scientists, or publicize artificial scandals such as ‘Climategate’ (Dunlap & McCright, 2011).

Dunlap and McCright (2011) draw the boundaries of the ‘echo-chamber’ exclusively around the conservative media. While the ‘echo chamber’ does include most of the conservative media, I think that most readers would agree that the ‘echo chamber’ goes beyond conservative news outlets. Skeptics are found in non-conservative television, newsprint, and even in academic literature (Antilla, 2005; Boykoff & Boykoff, 2004, 2007; Hall et al., 2015). Failing to include all media into the ‘echo chamber’ works against the validity of Dunlap and McCright’s (2011) work. These authors seem to have a vendetta against all things conservative, and fail to address any other sources of misinformation. However, because the authors are focusing on the organized aspects of climate denial it seems acceptable they would focus on one aspect of misinformation.

The last two groups in the ‘organized climate denial machine’ as described by Dunlap and McCright (2011), are conservative politicians and Astroturf groups. The roles of conservative politicians in the ‘organized climate denial machine’ are to vote against pro-anthropogenic climate change policies, sponsor anti-anthropogenic climate change policies, and to spread misinformation provided to them by conservative think tanks or front groups (Dunlap & McCright, 2011). Astroturf groups and campaigns are almost identical to front groups except that they are akin to grass-roots movements sparked by the people rather than organizations (Dunlap & McCright, 2011). The authors use the term Astroturf because these groups on the surface seem as if they are grass-root groups, but are sponsored and organized by either front groups or conservative think tanks (Dunlap & McCright 2011).

Brulle’s (2013) research provides evidence to support the framework proposed by Dunlap and McCright (2011) by establishing financial connections between the players of the ‘organized denial machine.’ Brulle (2013) utilizes data from the Internal Revenue Service (IRS) to determine who is funding organizations he defines as part of the climate change counter-movement.
Brulle (2013) states that out of the 188 climate counter-movement organizations chosen for the study, 91 of those had accessible IRS data for analysis. These summed contributions to these organizations is ~$558 million dollars and originated from 140 foundations. The author goes further in dividing the 91 organizations into classifications based on their IRS designation (e.g., 501(c)(3), 501(c)(4), 501(c)(5), 501(c)(6)). Brulle (2013) found using the IRS designations necessary because the organizations themselves use very arbitrary self-descriptions.

The source of funding varies greatly depending on the IRS designation. Trades organizations (501(c)(5) & 501(c)(6)) receive most of their annual funding from membership dues ($800 million) whereas charitable organizations (501(c)(3)) and non-tax deductible groups (501(c)(4)) have considerably lower annual fund (~$250 million and ~$45 million respectively, Brulle, 2013). What I found most interesting in this section was that all the organizations receive a large percentage of money from unknown sources. These funds are often called ‘dark money.’ Brulle (2013) points out that Donors Trust and Donor Capital foundations are designed in a way that allows donors to provide money to specific groups while remaining anonymous.

...individuals or other foundations contribute money to the donor directed foundation, and it then makes grants based on the stated preferences of the original contributor. This process ensures that the intent of the contributor is met while also hiding that contributor’s identity. Because contributions to a donor directed foundation are not required to be made public, their existence provides a way for individuals or corporations to make anonymous contributions. In effect, these two philanthropic foundations form a black box that conceals the identity of contributors to various CCCM organizations. (Brulle, 2013, p. 7)

Using network analysis Brulle (2013) examined the strength through time of the relationships between donors and recipients. Interestingly Brulle (2013) found a correlation between decreased funding for climate counter-movement organizations and the increased funding of ‘dark money’ whenever large donors are accused by the public of funding organized climate denial. For instance, in 2003 both ExxonMobil and the Koch Corporations were “called out” for donating to organizations associated or climate denial. This marked a decline in their contributions, but at the same time, dark money to these climate counter-movement organizations increased. The author is quick to point out that there is no way to know for sure if the ‘dark money’ is coming from these organizations. However, he does note that between 2003 and 2010 ‘dark money’ increased from 3.3% to 23.7% of the total revenue of climate counter movement organizations.
Dunlap and Jacques (2013) work also supports the proposed organized climate change denial machine. These authors conducted an analysis of anti-anthropogenic climate change book authorship. Dunlap and Jacques (2013) proposed that conservative think tanks are the cornerstone in writing the anti-anthropogenic climate change literature. Dunlap and Jacques believe that publishing books offer another opportunity for conservative think tanks to establish their idea’s legitimacy. This is troubling to the authors who state:

Books confer a sense of legitimacy on their authors and provide them an effective tool for combating the findings of climate scientists that are published primarily in scholarly, peer-reviewed journals—at least within the public and policy (as opposed to scientific) arenas. (Dunlap & Jacques, 2013, p. 701)

The authors go on to say that once published, authors of these books can seem as if they are experts in the field, regardless of their professional background. An effort to build-up the legitimacy of contrarian scientific information is counter to science education, and therefore is important in examining in detail.

Dunlap and Jacques (2013) found that the frequency of anti-anthropogenic climate change book publication was low until 2007. Starting in 2007 the number of books published increases drastically (e.g., 13 in 2007, 14 in 2008, 21 in 2009, & 15 in 2010). Dunlap and Jacques (2013) speculate that the drastic increase in anti-anthropogenic climate change book publication is due to Al Gore’s Movie An Inconvenient Truth, the IPCC’s fourth Assessment Report, and the proposed climate legislation which all happened in 2006 and 2007.

The results of Dunlap & Jacques (2013) analysis indicate 72% of counter-ACC books are associated with conservative think tanks. Dunlap and Jacques (2013) go on to cite the Dunlap and McCright (2011) book chapter which asserted that more and more anti-anthropogenic climate change books are being published outside of the United States. Dunlap and Jacques (2013) study provides empirical evidence to support this assertion. In the 1980s the 80% of the anti-anthropogenic climate change books published originated in the United States, but this percentage had dropped to 60% in recent years. The authors also calculated that off-shore anti-anthropogenic climate change books are highly associated (79% of United Kingdom, and 87% of other nation’s anti-anthropogenic climate change books) with United States conservative think tanks.
2.2 The Dissenter Literature

Little research has examined the messages produced by the ‘organized climate denial machine.’ As we saw in the previous section ‘organized climate denial,’ specifically conservative think tanks, act as an anti-academia. These groups produce messages, arguments, or counterarguments regarding anthropogenic climate change. This is done as an attempt to sway individuals from accepting or investing any concern for the scientific phenomenon.

Few studies have attempted to uncover and document anti-anthropogenic climate change rhetoric. Those that do exist are not conducted from a science education perspective (See, Boussalis & Coan, 2016; McCright & Dunlap, 2000). They examine dissenter messages broadly. Thus, these studies’ results include information on public policy and politics. However, discourse analysis studies have uncovered dissenter statements that stand contrary to the efforts of science educators. It is reasonable to assume that science educators who can identify bizarro-knowledge are less likely to pass it on to students.

The term echo-chamber may create its own misconception by implying that anti-anthropogenic climate change messages remain within the sphere of conservative political groups and their ideologically like-minded audiences. However, dissenter rhetoric is designed to be consumed and spread by the public. Inadvertently spreading dissenter messages becomes especially troublesome when it comes to educators. McCaffrey and Buhr (2008) report that 30% of the teachers surveyed in their study taught students that global warming is due to natural causes. Most of the teachers in this study also failed to correctly identify what percentage of scientists are part of the consensus on anthropogenic climate change. Anthropogenic climate change confusion among students and teachers may also be exacerbated by how textbooks frame the scientific consensus of anthropogenic climate change. Román and Busch (2015) found that many textbooks present human contributions as only a possible contributor to climate change.

The earliest attempt to understand anti-anthropogenic climate change messages produced by the ‘organized climate denial machine’ comes from McCright and Dunlap (2000). The purpose of their study, “…is to examine the growing opposition [to climate change] which has heretofore been relatively ignored” (McCright & Dunlap, 2000, p. 499). McCright and Dunlap (2000) accomplish this through a content analysis of conservative organizations’ webpages between 1990 and 1997.
Starting in 1988 McCright and Dunlap (2000) state that media coverage of anthropogenic climate change began to rise significantly. The authors also report that during early media coverage anthropogenic climate change scientists were brought on television news to serve as topical experts. However, scientists’ dominance over anthropogenic climate change coverage began to slow as, “…economic and political specialists edged out scientific experts as the dominate sources in the news stories” (McCright & Dunlap, 2000, p. 500). This lead to the “…dueling scientists’ scenario…” that we see on television today (McCright & Dunlap, 2000, p. 500).

A total of 50 articles were pre-coded by the authors before the full analysis was completed. This was done because of the newness of the conservative counter movement, and the fact no other study has taken on this task. The authors stressed that overall the coding was inductive so that they could gather as much information as possible. McCright and Dunlap’s (2000) findings are presented in Table 2. Results from thematic coding indicated to the authors that conservative countermovement rhetoric falls into three categories. First, countermovement agents question the scientific evidence that climate change is happening. Second, the countermovement asserts that the effects of climate change would be beneficial. Third, any policy implemented put into place to reduce the effects of climate change would have overall detrimental effects.
Table 2: McCright and Dunlap’s (2000) coding results.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Counter-Claim One</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The evidentiary basis of global warming is weak and even wrong</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. The scientific evidence for global warming is highly uncertain</td>
<td></td>
<td>141</td>
<td>62.9</td>
</tr>
<tr>
<td>2. Mainstream climate research is “junk” science</td>
<td></td>
<td>159</td>
<td>71.0</td>
</tr>
<tr>
<td>3. The IPCC intentionally altered its reports to create a “scientific</td>
<td></td>
<td>16</td>
<td>7.1</td>
</tr>
<tr>
<td>consensus” on global warming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Global warming is merely a myth or scare tactic produced and</td>
<td></td>
<td>41</td>
<td>18.3</td>
</tr>
<tr>
<td>perpetuated by environmentalists and bureaucrats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Global warming is merely a political tool of the Clinton</td>
<td></td>
<td>31</td>
<td>13.8</td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Counter-Claim Two</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global warming would be beneficial if it were to occur</td>
<td></td>
<td>30</td>
<td>13.4</td>
</tr>
<tr>
<td>1. Global warming would improve our quality of life</td>
<td></td>
<td>10</td>
<td>4.5</td>
</tr>
<tr>
<td>2. Global warming would improve our health</td>
<td></td>
<td>10</td>
<td>4.5</td>
</tr>
<tr>
<td>3. Global warming would improve our agriculture</td>
<td></td>
<td>20</td>
<td>8.9</td>
</tr>
<tr>
<td><strong>Counter-Claim Three</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global warming policies would do more harm than good</td>
<td></td>
<td>139</td>
<td>62.1</td>
</tr>
<tr>
<td>1. Proposed action would harm the national economy</td>
<td></td>
<td>130</td>
<td>58.0</td>
</tr>
<tr>
<td>2. Proposed action would weaken national security</td>
<td></td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>3. Proposed action would threaten national sovereignty</td>
<td></td>
<td>9</td>
<td>4.0</td>
</tr>
<tr>
<td>4. Proposed action would actually harm the environment</td>
<td></td>
<td>7</td>
<td>3.1</td>
</tr>
</tbody>
</table>

As presented in the table above 71% of the rhetoric questioned the scientific evidence for the existence of climate change. Overall, messages within counter-claim one described the science of climate change as, “…‘contradictory,’ ‘flawed,’ and ‘murky’” (McCright & Dunlap, 2000, p.511). In other words, the rhetoric found within on these conservative think tank websites overall state that climate science is junk science. Other rhetoric categorized under counter-claim one includes: stressing that there is no scientific consensus exists on the science of climate change; that the IPCC unethically changed the results of experiments to support their narrative that climate change is happening; and climate change is a scare tactic perpetrated by environmental organizations.

Counter-claim two includes rhetoric that points to the beneficial nature of a warming climate. McCright and Dunlap (2000) state this is the smallest category. This type of rhetoric was only found in approximately 30% of the documents analysis, but nonetheless is broken down into three subcategories: Benefit to quality of life (less snow=lower heating costs & fewer power outages), benefit to human health, and benefit to agriculture. These categories are self-explanatory and need no further explanation. As bold as these claims are, the analyzed documents do not seem to go into detail supporting them.
Counter-claim three includes all the messages that allude to or outright declare that climate policy would have negative effects. This category is broken down into four sub-categories: Action would hurt the economy, action would hurt national security, action would damage national sovereignty, and actions would hurt the environment. The work conducted by McCright and Dunlap (2000) demonstrate that these organizations are working counter to the efforts of climate educators.

In 2016 Boussalis and Coan (2016) replicated the work of McCright and Dunlap (2000). Boussalis and Coan (2016) begin their work by stressing the threat of climate change, and pointing to conservative think tanks as the wall blocking climate policy. Boussalis and Coan’s (2016) analysis produced 47 meaningful topics. These topics can be seen in a reproduction of their table in table 3. Boussalis and Coan (2016) state that unlike other examination of counter-claims, their results are more inclusive. Their results include all the counter claims as well as the topics associated with climate change (e.g., law, mention of governing bodies, contrarian scientist names). The inclusive nature of the algorithm provides better topical detail, but data are also harder to interpret and less useful to science educators. For instance, knowing that Monckton (a climate dissenter) is mentioned in within these topics does not guide a sense of how science is being stretched or misrepresented to sway people from believing in anthropogenic climate change.
Table 3: Boussalis and Coan (2016) topics. ‘S’ = scientific topic; ‘P’ = policy topic.

<table>
<thead>
<tr>
<th>Id</th>
<th>S/P</th>
<th>Topic Name</th>
<th>Id</th>
<th>S/P</th>
<th>Topic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td>Climate sensitivity to CO2</td>
<td>25</td>
<td>P</td>
<td>Economic impact of climate policy</td>
</tr>
<tr>
<td>2</td>
<td>P</td>
<td>Fossil fuel production</td>
<td>26</td>
<td>S</td>
<td>Monclisetion mcclisetion graph</td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>Sea level rise</td>
<td>27</td>
<td>S</td>
<td>IPCC integrity chapter</td>
</tr>
<tr>
<td>4</td>
<td>S</td>
<td>No scientific consensus</td>
<td>28</td>
<td>S</td>
<td>Storms cyclone storm hurricane</td>
</tr>
<tr>
<td>5</td>
<td>S</td>
<td>Long-term climate trends</td>
<td>29</td>
<td>P</td>
<td>Emissions reduction carbon scheme credit trade</td>
</tr>
<tr>
<td></td>
<td></td>
<td>holocene millenium quaternari</td>
<td></td>
<td></td>
<td>diodid</td>
</tr>
<tr>
<td>6</td>
<td>P</td>
<td>Public opinion</td>
<td>30</td>
<td>S</td>
<td>Plant impacts seedli leaf mycorrhizic cultivari</td>
</tr>
<tr>
<td>7</td>
<td>P</td>
<td>US politics</td>
<td>31</td>
<td>P</td>
<td>Intl trade &amp; develop india china chine wto asia</td>
</tr>
<tr>
<td>8</td>
<td>P</td>
<td>Renewable energy</td>
<td>32</td>
<td>P</td>
<td>Tax &amp; spend tax dividend incom fiscal medicaid</td>
</tr>
<tr>
<td>9</td>
<td>P</td>
<td>Govt. intervention</td>
<td>33</td>
<td>P</td>
<td>Conservation timber eaq dl fisheri percreince</td>
</tr>
<tr>
<td>10</td>
<td>P</td>
<td>Environmentalism</td>
<td>34</td>
<td>S</td>
<td>Forest impacts npp radi shrub peatland flexi</td>
</tr>
<tr>
<td>11</td>
<td>S</td>
<td>Climate models</td>
<td>35</td>
<td>P</td>
<td>Cap &amp; trade markey wamxon lieberman warnerr cap</td>
</tr>
<tr>
<td>12</td>
<td>S</td>
<td>Solar forcing cloud models</td>
<td>36</td>
<td>P</td>
<td>Public transportation rail ridership travel passens vmt</td>
</tr>
<tr>
<td>13</td>
<td>S</td>
<td>Temperature data</td>
<td>37</td>
<td>P</td>
<td>Climate adaptation goklari adapt stern matiz resili</td>
</tr>
<tr>
<td>14</td>
<td>S</td>
<td>Scientific misconduct</td>
<td>38</td>
<td>P</td>
<td>EPA car epa endanger naaq anpr</td>
</tr>
<tr>
<td>15</td>
<td>P</td>
<td>Govt. agencies</td>
<td>39</td>
<td>P</td>
<td>Law court judici lawsuit constitut saprem</td>
</tr>
<tr>
<td>16</td>
<td>S</td>
<td>Alarmism goe morano rommi incenienvi depot</td>
<td>40</td>
<td>S</td>
<td>State climate reports viru cessaft vile wiley inch</td>
</tr>
<tr>
<td>17</td>
<td>P</td>
<td>Int'l relations militari nata misil afghanistan fahen</td>
<td>41</td>
<td>P</td>
<td>State climate policy ghp jersey greenhouse weve rgei</td>
</tr>
<tr>
<td>18</td>
<td>S</td>
<td>Agri. industry</td>
<td>42</td>
<td>S</td>
<td>Acidification calcif reef bleach coral phytoplankton</td>
</tr>
<tr>
<td>19</td>
<td>S</td>
<td>Human health dtt precautionari malaria dises cancer</td>
<td>43</td>
<td>P</td>
<td>Disaster costs iner pension mortag florida premium</td>
</tr>
<tr>
<td>20</td>
<td>P</td>
<td>Corporations &amp; env. boreal sharehold greenpeac doner philanthropi</td>
<td>44</td>
<td>P</td>
<td>Int'l climate agreements kyoko protocol treati ratifi ratif</td>
</tr>
<tr>
<td>21</td>
<td>P</td>
<td>Urban develop. california ab metropolitan schwanzemeg california</td>
<td>45</td>
<td>S</td>
<td>Pollution mercuri ozon toxic arthona particl</td>
</tr>
<tr>
<td>22</td>
<td>P</td>
<td>Reuse &amp; recycle bag mthe bible cil ress</td>
<td>46</td>
<td>S</td>
<td>Endangered species butterflyi stirt extinct bear polar</td>
</tr>
<tr>
<td>23</td>
<td>P</td>
<td>Nuclear power hydrogen reactor nuclear technolog cell</td>
<td>47</td>
<td>P</td>
<td>Auto. fuel standards cafe nthba mpg vehicl car</td>
</tr>
<tr>
<td>24</td>
<td>P</td>
<td>Green jobs job stimulu taxpay subsid green</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using their data Boussalis and Coan (2016) examine the claim that the denial of climate change science is over, and that pundits are moving more towards questioning policy itself.

Through use of several graphs that examine policy verses science topics through time, the authors dismiss the notion that science denialism is over, “We thus find little evidence for the ‘end of science denial’ and yet a rise in ‘policy sceptics’ remains consistent with the data” (Boussalis & Coan, 2016, p. 96). Based on my own analysis of the dissenter literature I agree with Boussalis and Coan (2016) wholeheartedly.

Boussalis and Coan (2016) conclude their work my restating their work is a continuation and expansion of McCright and Dunlap’s (2000) work. They highlight that the contrarian information has expanded significantly in the last decade, dissenters use political tactics to attack scientists, pundits have not moved away from denying climate change, dissenters counter established environmental claims rather than produce their own. Overall, besides the critiques already discussed, Boussalis and Coan (2016) provide an excellent overview of what is found within the dissenter literature.

Bentley, Petcovic, and Cassidy, (2016) set out to examine what dissenter information exists within Dunlap and McCright’s (2011) echo chamber. Unlike the work of McCright and Dunlap (2000) and Boussalis and Coan (2016), Bentley et al. (2016) are interested in which dissenter statements are being used by those outside of the contrarian-academia (e.g.,
conservative think tanks). In addition to understanding what messages are being used by the public, Bentley et al. (2016) build an instrument that gauges individual agreement with dissenter statements. The instrument development was useful in two ways. First, by providing a population of participants with a list of dissenter statements it was easy to gauge which were the most enticing. Understanding which messages are likely to be picked by the public is useful in building educational materials. Second, through exploratory and confirmatory factor analysis, the messages were distilled down into broad types of arguments. Bentley et al. (2016) uncovered five factors: 1. naïve scientific & non-scientific statements which attack the science of anthropogenic climate change, 2. sophisticated scientific statements which imply warming is not anthropogenic, 3. arguments that assert recent changes are natural or out of our control, 4. arguments that imply current warming is simply part of a larger cycle, and 5. statements that highlight benefits of a warming climate. The five-factor model is reproduced in Table 4.

Table 4: Reproduced from Bentley et al. (2016). Items and item loadings on the Anthropogenic Climate Change Dissenter Message Inventory.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item Loading</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1. Naïve statements refuting the science of anthropogenic climate change</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>0.94</td>
<td>Climate scientists change their data to get the results they want, not the results the data produces</td>
</tr>
<tr>
<td>13</td>
<td>0.94</td>
<td>Climate change science is not a science; it is a political propaganda</td>
</tr>
<tr>
<td>73</td>
<td>0.92</td>
<td>Climate scientists purposefully leave out past cooling events such as the Little Ice Age from their climate models in order to produce the results they want</td>
</tr>
<tr>
<td>26</td>
<td>0.90</td>
<td>Climate scientists made up the concept of climate change to order to make money from environmental companies</td>
</tr>
<tr>
<td>59</td>
<td>0.89</td>
<td>Climate scientists made up the concept of climate change to receive grant money for research</td>
</tr>
<tr>
<td>63</td>
<td>0.89</td>
<td>Climate scientists made up the concept of climate change to order to make money from alternative energy companies</td>
</tr>
<tr>
<td>52</td>
<td>0.87</td>
<td>The recent rapid warming of earth’s atmospheres and oceans is only a result of natural climate cycles</td>
</tr>
<tr>
<td>3</td>
<td>0.87</td>
<td>Climate scientists made up the concept of climate change in order to increase their revenue streams</td>
</tr>
<tr>
<td>56</td>
<td>0.87</td>
<td>Climate scientists remove collected data from their models in order to make the graphs look the way they want</td>
</tr>
<tr>
<td>31</td>
<td>0.86</td>
<td>The reported number of climate scientists that believe humans are causing Earth’s climate to change is inflated to convince more people to believe in climate change</td>
</tr>
<tr>
<td>32</td>
<td>0.85</td>
<td>The recent cold weather is evidence that the climate is not warming</td>
</tr>
<tr>
<td>4</td>
<td>0.85</td>
<td>The number reported of climate scientists that believe humans are causing Earth’s climate to change is inflated to convince more people to believe in climate change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>19</td>
<td>0.85</td>
<td>Climate change is fabricated by the media so they can increase their viewer ratings</td>
</tr>
<tr>
<td>60</td>
<td>0.84</td>
<td>Naturally occurring Earth cycles prevent mankind from being able to change Earth's climate</td>
</tr>
<tr>
<td>34</td>
<td>0.84</td>
<td>Carbon dioxide is natural, so we should not worry about how much is in the atmosphere</td>
</tr>
<tr>
<td>11</td>
<td>0.83</td>
<td>A large number of climate scientists do not believe that global warming is happening, but cannot make their beliefs public because they would be ridiculed by climate scientists who do believe in climate change</td>
</tr>
<tr>
<td>58</td>
<td>0.83</td>
<td>The winter of 2014, one of the coldest in decades in the northeastern United States, proves that Earth is not getting warmer</td>
</tr>
<tr>
<td>61</td>
<td>0.83</td>
<td>Climate change is designed to convince people to vote democrat</td>
</tr>
<tr>
<td>72</td>
<td>0.83</td>
<td>Climate models do not accurately depict earth's climate through time</td>
</tr>
<tr>
<td>10</td>
<td>0.83</td>
<td>Arctic sea ice is not shrinking in volume</td>
</tr>
<tr>
<td>49</td>
<td>0.81</td>
<td>Climate scientists who do not believe in human caused climate change cannot speak out because disagreeing with the majority could cost them their job</td>
</tr>
<tr>
<td>71</td>
<td>0.81</td>
<td>The level of carbon dioxide in Earth's atmosphere is not related to Earth's overall climate</td>
</tr>
<tr>
<td>19</td>
<td>0.79</td>
<td>Earth's overall temperature has nothing to do with the level of carbon dioxide in the atmosphere</td>
</tr>
<tr>
<td>57</td>
<td>0.78</td>
<td>The upper layers of Earth's atmosphere are not warming</td>
</tr>
<tr>
<td>37</td>
<td>0.78</td>
<td>Meteorologists cannot accurately predict the weather more than few days in advance, thus it is impossible to accurately predict Earth's climate years into the future</td>
</tr>
<tr>
<td>14</td>
<td>0.74</td>
<td>Climate scientists do not change their mind on climate change when presented with new scientific evidence</td>
</tr>
<tr>
<td>27</td>
<td>0.72</td>
<td>Natural Earth processes will keep our climate from changing</td>
</tr>
</tbody>
</table>

**Factor 2. Sophisticated scientific statements that distance anthropogenic climate change blame from mankind**

<p>| | | |</p>
<table>
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<tbody>
<tr>
<td>20</td>
<td>0.84</td>
<td>The release of carbon dioxide from volcanoes is responsible for the recent warming of Earth's oceans</td>
</tr>
<tr>
<td>44</td>
<td>0.82</td>
<td>A change in the energy output of the sun is responsible for the recent rapid warming of Earth's oceans</td>
</tr>
<tr>
<td>48</td>
<td>0.78</td>
<td>The location of earth's continents is driving earth's recent warming</td>
</tr>
<tr>
<td>30</td>
<td>0.78</td>
<td>The recent rapid warming of Earth's climate is caused by a change in Earth's tilt</td>
</tr>
<tr>
<td>68</td>
<td>0.77</td>
<td>Radiation from supernova events is responsible for the recent warming of Earth's atmosphere</td>
</tr>
<tr>
<td>36</td>
<td>0.77</td>
<td>Changes in Earth's tilt or orbit are responsible for the recent rapid warming of Earth's atmosphere</td>
</tr>
<tr>
<td>7</td>
<td>0.72</td>
<td>A change in the energy output of the sun is responsible for the recent rapid warming of Earth's atmosphere</td>
</tr>
<tr>
<td>33</td>
<td>0.71</td>
<td>Radiation from distant supernova events control Earth's climate</td>
</tr>
</tbody>
</table>

**Factor 3. The "natural" statements**

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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.81</td>
<td>Every year mother nature produces more carbon dioxide than humans</td>
</tr>
<tr>
<td>40</td>
<td>0.7</td>
<td>The Earth produces more carbon dioxide than mankind</td>
</tr>
<tr>
<td>9</td>
<td>0.67</td>
<td>Natural Earth processes keep Earth's climate stable</td>
</tr>
</tbody>
</table>

**Factor 4. Items stating the beneficial aspects to anthropogenic climate change**
An overall increase in Earth's average temperature would be better for mankind than the current average temperature.

A warmer Earth would be better for mankind than the current average temperature.

Increasing the level of carbon dioxide in the atmosphere would allow farmers to grow more food.

**Factor 5. Statements that assert anthropogenic climate change is simply part of a larger cycle**

The recent warming of Earth's atmospheres and oceans is a result of natural climate cycles, and our climate is headed into an ice age.

Earth's climate may not be warming, but instead be headed into another ice age.

Increases in carbon dioxide in the atmosphere is the result of changes in Earth's climate.

Bentley et al. (2016) stress that their work is foremost an instrument development piece, but do include ways teachers could use the first portion of their work in the classroom. Teaching students the process of science (e.g., publishing and peer review) may inoculate them from dissenter messages that imply climate science is ‘murky.’ The authors also cite the possible usefulness of the instrument in professional development courses. The instrument could be given to educators in professional development to gauge what dissenter messages they agree with. This could be used to guide instruction to ensure the inoculation of educators.

Three important points were highlighted during this section of the literature review. First, the results of all three papers contains messages that work to contradict the efforts of science educators. These messages include the dismissal of scientific discoveries, an attack on one of the strongest scientific consensuses, and the demonization of scientist themselves. The work by Bentley et al. (2016) includes findings that highlight the pseudo-academic nature of those who produce messages. For instance, these groups make erroneous, quasi-scientific claims that remove the human element of climate change and attempt to replace it with natural causes (e.g., volcanoes, sun strength variations, ocean circulation, etc.).

Second, the results of these papers demonstrate that dissenter messages prevail through time. Over a period of more than 16 years, some messages have remained the same. The long-term existence of some of these messages, while troubling, gives cause for the development of educational materials that would inoculate students from dissenter messages. These messages are thus worth documenting and countering.
Third, the results of Bentley et al. (2016) analysis of YouTube demonstrate that these messages leave the echo chamber and move into public discourse. The existence of these messages outside of the echo chamber also provides grounds for their study. Students are likely to hear these messages either before or after leaving the formal educational setting.

2.3 Anthropogenic Climate Change’s Representation in the Mass Media

Maxwell Boykoff and Jules Boykoff came up with the “bias as balance” concept in 2004. Simply, “bias as balance” arises when journalist norms get in the way of accurate report. In the case of climate change, the necessity for “balanced” reporting results in journalist providing equal time to those who accept anthropogenic climate change, and those who reject the theory. “Bias as balance” was established when Boykoff and Boykoff (2004) conduct a content analysis on the US prestige press.

Boykoff and Boykoff (2004) chose the timeframe of 1988 to 2002 for their search. 1988 is cited as the year chosen because of James Hansen’s talk to congress on the possible effects of anthropogenic climate change. The results were limited to U.S. newspapers, the New York Times, Washington Post, Los Angeles Times, and the Wall Street Journal. These newspapers were chosen because of their national coverage and prestige. The search returned 3543 news articles, and a random sample of 636 was used for analysis. Boykoff and Boykoff (2004) made the distinction that because anthropogenic climate change news coverage varies by year, that the articles used do not evenly distribute among the search years. I think this is an important distinction made by Boykoff and Boykoff (2004) because as we saw in Boussalis and Coan’s (2016) work, coverage varies wieldy depending on political cycle.

The results of Boykoff and Boykoff (2004) are quite staggering. They found that only 5.88% of the articles focused their coverage exclusively on the anthropogenic aspects of global climate change. Articles that were dominated by skepticism towards global climate change was 6.18%. Articles that included skeptical points, but were overall dominated with anthropogenic discussion made up 35.29% of the results. The overwhelming majority of the articles examined by Boykoff and Boykoff (2004) provided balanced coverage of the existence anthropogenic climate change.
Thus, any student entering a classroom who has read an article on climate change has very likely been exposed to dissenter messages. Based on the results of Boykoff and Boykoff’s (2004) Measure #1, there is only a 5.88% chance a student picking a random article from the Prestige Press will receive no dissenter messages. Even when looking beyond the simple exposure of dissenter statements, students are very likely (52.65% likely) to see a ‘balanced’ account on whether anthropogenic climate change exists.

The results of Boykoff and Boykoff’s (2004) Measure #2 are also dominated by ‘balanced’ reporting. The authors found that approximately 78% of the article reviewed provided balanced reporting in regards to action. “We found that 78.20% of US prestige-press articles from 1988 through 2002 featured balanced approaches in terms of what should be done about global warming, describing with “roughly equal attention” courses of action that ranged from cautious to urgent and from voluntary to mandatory” (Boykoff & Boykoff, 2004, p. 131). Articles that stressed immediate action made up 10.63% of the results, and those who stressed caution towards action made up 11.17% of the results.

Boykoff and Boykoff (2004) make the following conclusion based on their results:

We conclude that the US prestige press—the New York Times, the Washington Post, the Los Angeles Times, and the Wall Street Journal—has contributed in significant ways to this failed discursive translation through the adherence to journalistic norms, and more specifically to the journalistic norm of balance” (Boykoff & Boykoff, 2004, p. 134).

This conclusion should not be taken lightly by science educators because it indicates dissenter messages are distributed in the popular newspapers regardless of newspaper political affiliations. However, if you keep in mind the extent of power and organization of dissenter groups possess, you may not be surprised by these results. It may be possible that dissenter groups use their power to influence in unpolitical newspapers at the national level. After all, the Prestige Press would be a prime target for dissenter organizations because of its large audience.

The findings of Antilla (2005) compliment those by Boykoff and Boykoff (2004) as well as address the questions to light in the previous paragraph. Antilla (2005) also examined U.S. newspapers to see how they were covering anthropogenic climate change. However, unlike Boykoff and Boykoff (2004), Antilla (2005) did not limit their searches to the prestige press. A total of 215 newspapers across 43 states was examined for articles covering anthropogenic climate change. Antilla (2005) pulled a total of 298 anthropogenic climate change articles from
93 separate newspapers. These were chosen because they cover or reference one or more of highly cited (by newspapers) scientific publications. This allowed Antilla (2005) to make direction comparisons between what the article discussed, and what was found in the original science journal.

One of the examples used by Antilla (2005) includes the interpretation of a press release published by the Geological Society of America (GSA). The GSA press release discussed the impacts of climate change on wine regions’ ability to produce wine. Newspapers that reference the GSA press release greatly oversold the possible benefits of a changing climate.

Another example provided by Antilla (2005) was newspaper coverage of a scientific article that discussed the effects of soot on global climate change. Some of the newspapers used headlines that made the claim that scientists had found the source of climate change and it is soot. However, in the original article, scientists stated that soot was not the driving force by any means. Other newspapers used well known dissenters as ‘experts’ to provide context for a non-dissenting scientific article. Antilla (2005) when examining newspapers across the U.S. came to the same conclusions as Boykoff and Boykoff (2004).

…[A]rticles that framed climate change in terms of debate, controversy, or uncertainty were plentiful. Not only were there many examples of journalistic balance that led to bias, but some of the news outlets repeatedly used climate sceptics—with known fossil fuel industry ties—as primary definers. Worse yet, in some instances, such articles originated from wire or news service providers (including newspapers that provide such services or are affiliated with news service agencies)—which caused the exponential spread of misinformation (Antilla, 2005, p. 350).

The work by Feldman et al. (2012) further establishes the problem of “bias as balance.” Feldman et al. (2012) goes farther than Boykoff and Boykoff (2004) in understanding the problem of “bias as balance.” First Feldman et al. (2012) demonstrate that cable news networks depict climate change differently depending on their political leaning. From here the authors then establish the relationship between individual’s preferred news network and climate change belief.

Feldman et al. (2012) gathered transcripts of cable TV news segments from Lexis-Nexus. The authors chose to only examine news segments that aired between 5:00pm and 11:00pm. This time frame was chosen because this is the only timeframe that Fox News offers transcripts for.
Transcripts were coding per the overall stance that news segment took on climate change. If a transcript devoted 80% or more of its viewpoints to supporting climate change it was coded as “accepted.” If the opposite stance was coded as “dismissive.” Transcripts that did not make it to 80% on a stance in either direction was coded as “mixed viewpoints.” Transcripts that provided no opinion were coded as “no viewpoint.”

The results of the content analysis of cable news transcripts demonstrate a clear division of how networks depict climate change. CNN and MSNBC were the most likely to present accepting views on climate change and the least likely to dismiss the phenomena. The opposite was true for Fox News (figure 1). Fox News also more likely to host dissenters as guests, was the most likely to question the scientific consensus surrounding climate change, and to reject the anthropogenic nature of current warming. The opposite was the case for CNN and MSNBC. “In sum, the content analysis results suggest that, in 2007 and 2008, Fox News painted a very different picture of climate change than CNN and MSNBC, thereby supporting Hypotheses 1 through 3” (Feldman et al., 2012, p. 14).

![Figure 1: Tone towards the reality of climate change for major cable news networks. Reproduced from Feldman, et al. (2012).](image-url)
After establishing the ways anthropogenic climate change is portrayed in the media, Feldman et al. 2012 then discuss the methods for examining the relationship between individuals’ preferred news network and climate change belief. This was accomplished through surveying.

The results of the survey indicated that preferred news network is a good predictor of anthropogenic climate change views. “Consistent with expectations, Fox viewing manifests a significant, negative association with global warming acceptance, whereas CNN/ MSNBC viewing is positively related to global warming acceptance” (Feldman, et al., 2012, p. 18). Surprising to the authors was the strength of this relationship. Watching a network that leans towards your personal political views amplifies your views. However, Republicans who regularly watch CNN or MSNBC were less likely to reject anthropogenic climate change. This indicates that the messages and framing that individuals receive on climate change is more important than simple party identification. In other words, individuals seem to be making choices on climate change based on the information they receive, rather than simply matching the views of those they identify with.

2.4 Anthropogenic Climate Change Perceptions and Demographics/Individual Differences

Several studies have examined individuals’ perceptions and concern surrounding anthropogenic climate change. Several of these studies are produced by polling organizations such as the Pew Research Center and Gallup. The results produced by these organizations are often simple graphical representations or descriptive accounts of the collected data. Polling organizations such as the Pew Research Center and Gallup often fail to disclose detailed methodologies or limitations of their work—most importantly they are not subjected to peer review. However, some academics utilize the data produced by these organizations to make inferences or draw connections between demographics and concern about or belief in anthropogenic climate change. Thus, reports produced by the Pew Research Center, Gallup, and The Yale Project on Climate Change Communication will be used sparingly in this literature review.
Socioscientific issues, sometimes referred to as ‘contested science’ occasionally elicit pushback from some individuals and organizations. These issues are ones that receive pushback because of a conflict in ideology. In one example, evolution, the largest pushback often comes from Young-Earth Christians who believe in a literal translation of Genesis found in the King James Bible. It is easy to see the direct conflict between these two ideologies. Evolution, which among other things, asserts that mankind and all living things evolved over millions of years to become what we see today. The Young-Earth Christians view is that the earth is approximately 10-15 thousand years old, and that all ‘kinds’ of animals were fashioned in their current form by an all-powerful creator.

Other ‘contested science’ issues have ideological conflicts that are not so easily identified and tracking down correlations between demographics and belief is difficult. Those who dissent from anthropogenic climate change is a good example. Some believe that political affiliation is the largest determining factor (Dunlap & McCright, 2008; Fisher, Waggle, & Leifeld, 2012; Gauchat, 2015; Hornsey, Harris, Bain, & Fielding, 2016). Others assert that socioeconomic status or ethnicity are the main dividing factor (Herman, 2014). Gender, has also been viewed as a dividing factor in climate change belief (McCright, 2010).

Jelen and Lockett (2014) examined the relationship between individuals’ demographics and their views on contested science. Jelen and Lockett (2014) paper is concise, but stands as a good example of a perception paper. The authors use the General Social Survey to assess individuals’ attitudes towards evolution, STEM cell research, and anthropogenic climate change. Collected with these attitude responses were demographic information, age, sex, political party, ideology, and religion.

The authors provide a detailed literature review of contested science and individuals’ belief. The authors focus their literature review on the relationships between religiousness and political ideology towards climate change, and evolution. The literature review reveals that age, and education are not excellent predictors of attitudes towards evolution, stem cell research, or climate change. The critiques from the rest of section 2.4 will corroborate Jelen and Lockkett’s (2014) literature review. Jelen and Lockett (2014) finish their literature review by stating their research goals.
In this study, we examine public attitudes toward three issues involving what might be termed contested science: evolution, stem-cell research, and climate change…. We hypothesize that skeptical attitudes toward each of these issues will be related to doctrinally conservative religious affiliations and attitudes, Republican partisanship, and ideological conservatism. (Jelen & Lockett, 2014, p. 3)

Jelen and Lockett’s (2014) results coincide with those established in the literature. For instance, individuals who are older and less-educated are less likely to believe in evolution. Those with strong evangelical or biblical views are also likely to believe in evolution, and per Jelen and Lockett (2014) these individuals are also less likely to support stem cell research. The only demographic correlations that connected attitudes towards global warming were education, and ideology, and identification with evangelical religious identification. Individuals who are highly educated, identify as a democrat, and do not hold evangelical views were more likely to accept the scientific consensus of anthropogenic climate change. The authors conclude that the greatest predictor for general skepticism towards science is an individual’s view of the Bible.

2.4.1 Gender. There are a plethora of papers written on individuals' perceptions on climate change. Often this research aims to connect a demographic factor to the belief, concern, perception, or knowledge relating to anthropogenic climate change. Gender is one example. It has been well established that white men judge risks far lower than white women (Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000; Flynn, Slovic, & Mertz, 1994). McCright (2010) examined the connection between gender and climate change perceptions. McCright (2010) utilized polling data to theoretically examine the differences between the genders beliefs in anthropogenic climate change. This was accomplished by comparing the utilized polling data against a detailed literature review on gender differences in science understanding. McCright (2010) chose to focus exclusively on the differences between the genders because often other research projects only use gender as a “statistical control in multivariate models and then only discuss the performance of this viable in passing…” (McCright, 2010, p. 67). The research questions that frames McCright:

First, how, if at all, do men and women differ in their climate change knowledge and in their perception of this knowledge? Second, how, if at all, do men and women differ in their climate change concern? (McCright, 2010, p. 67)

McCright (2010) found that women are more knowledgeable of climate change than men, and men have greater perceived climate knowledge than women. In terms of concern, McCright
(2010) found that women on average are more concerned about anthropogenic climate change than men.

The results of McCright's (2010) study on the relationship between gender and anthropogenic climate change concern are similar to those found in previous studies. Brody et al. (2008) used a novel approach in assessing climate change concern by pairing geographical information systems (GIS) data with individual’s survey responses. The authors believed that individuals who are in areas of higher risk (e.g., flood, storms, droughts, etc.) would be more concerned about anthropogenic climate change. However, among their results, Brody et al. (2008) found that women are more concerned about climate change than men.

Earlier work by Flynn et al. (1994) also found a difference between men’s and women’s perceptions of anthropogenic climate change. These authors were not specifically looking at anthropogenic climate change perceptions, but the threat of anthropogenic climate change was an item on their instrument. They found that women ranked the risk of climate change higher than men. However, when attempting to explain the differences between men and women risk perceptions, they stated that a lack of knowledge on the women’s part provided the gap in risk assessment. This, we have seen from McCright’s (2010) work above to not be the case for climate change. The misdiagnosis proposed by Flynn et al. (1994), is likely because these authors did not assess individuals’ knowledge.

2.4.2 Age. Opinions, values, concerns and goals differ from one generation to the next. Generational knowledge also varies as state education standards adapt to meet the needs of a changing economy and scientific discovery. The Baby-Boomers (birth year between ~1946-1964), Generation X (birth year between ~1964-1979), and Millennials (birth year between ~1980-today) make up the majority of the United States’ population today, and their goals and values are different. Twenge, Campbell, and Freeman (2012) found that as we move between generations concern for others (e.g., charity, and empathy), intrinsic values (e.g., community), and civic orientation (e.g., willingness to save the environment) have all fallen. In other words, Millennials and Generation X are indeed the “Me” generation when compared to Baby-Boomers at the same age. However, Twenge et al. (2012) work does not shed light on the current differences between environmental concern and age.
Semenza et al. (2008) conducted a climate change awareness, concern, and behavior change survey of two geographically separate populations. Portland OR and Huston TX constituted the study sites and the authors report having a population of 1202 individuals. Semenza et al. (2008) found several strong predictors for behavioral change per logistic regression modeling. Participants’ age was one of the significant predictors of behavior change in response to climate change with younger individuals more likely to change their behavior. Other predictors included location, education level, and environmental concern. Portlanders, those with higher educations and those with heightened concern about climate change constituted those who were more likely to change their behavior.

2.4.3 Political Affiliation. Peppered throughout the literature review is the impression that an individual’s political affiliation or ideology greatly impacts their perception of anthropogenic climate change. Specifically, much of the literature states that Republicans have a lower concern for the environment when compared to Democrats. This has not always been the case, and Dunlap and McCright (2008) set out to document the growing divide through time.

Dunlap and McCright (2008) emperically back up the theory of a growing divide between Democrats and Republicans by analyzing a series of Gallup polls conducted between 1997 and 2008. Between 1997 and 2008 the divide between these groups grew in the following categories: (1) belief that global warming has begun; (2) belief that the seriousness of global warming is exaggerated in the news; (3) belief on the scientific consensus of climate change; (4) the cause of climate change (e.g., human or natural); and (5) the timing of climate change.

Dunlap and McCright (2008) found that political affiliation correlated significantly to these above mentioned categories, and more importantly, that the correlation increases through time. These authors also used regression models to determine if other demographic factors influenced an individual’s responses to the above topics. The authors found that political affiliation was the strongest predictor of the above categories even when factoring in sex, age, race, income, and education.
2.5 Literature Review Summary and Questions Left Unanswered

Several points regarding organized climate change dissention are made clear in this literature review. First, organizations that spread misinformation concerning anthropogenic climate change are organized, well-funded, and widespread (Dunlap & McCright, 2011). Second, information developed by these organizations reaches a wide audience through popular media, online video, and conservative think tank websites (Boykoff & Boykoff, 2004). Third, demographics can be used a predictor for dissent in the United States. These demographic factors include gender (McCright, 2010), age (Semenza et al., 2008), religiousness (Jelen & Lockett, 2014), and what many researchers identify as the strongest predictor - an individual’s political ideology (Dunlap & McCright, 2008; Hornsey et al., 2016; Jelen & Lockett, 2014). It is reasonable to assume that political ideology is a strong predictor because conservative think tanks, politicians, and media are all conveyers of anti-anthropogenic climate change information (Boykoff, 2008; McCright & Dunlap, 2000; Pruneau et al., 2001).

Left unanswered by this literature review is an understanding of the power of anti-anthropogenic climate change messages to affect a person’s acceptance of anthropogenic climate change. Here I revisit the overarching questions discussed in the problem statement of this manuscript (section 1.2). Hypotheses are made through a pairing of these overarching questions with my examination of the literature review.

(1) What groups of people, as categorized by demographic factors, agree most with dissenter messages? If dissent is correlated with agreement with dissenter messages, then science educators have cause to inoculate students from misinformation. If groups have higher levels of agreement, then I can recommend the development of targeted educational initiatives in either formal or informal settings.

**HYPOTHESIS 1:** Agreement with dissenter messages will be higher among conservatives, those who select conservative news as their primary news source, and those with lower education levels.

Hypothesis 1 was developed through an analysis of the literature as presented in section 2.4. The strongest demographic predictors of dissent were chosen for hypothesis one. The main purpose of this hypothesis is to establish that my population’s views on climate change are as expected based on the literature review. Political affiliation is the strongest predictor of dissent.
for many researchers. Thus, including this factor into my hypothesis one allows me to
demonstrate that this population is like previously conducted research. If dissent were not higher
for Republicans in my study, then it would be reasonable to assume that Republicans in my study
site are singular.

Somewhat associated with this relationship is the tendency for those who watch
conservative cable news to reject anthropogenic climate change. Feldman, Maibach, Roser-
Renouf, and Leiserowitz (2012) found higher levels of skepticism in FOX news broadcasts when
compared to CNN and MSNBC. They also found that those who watch FOX as their primary
news source were less concerned with anthropogenic climate change. If those who choose
conservative outlets as their primary news source dissent less than those who choose liberal
outlets, then my population may be significantly different than in the Feldman et al. (2012)
study. This would imply that either my chosen study site is unique or flawed. This would warrant
a further examination into this aspect of dissent

Education level was included in this hypothesis because it is reasonable to believe that
higher levels of education would be associated with an individual’s ability to identify
misinformation. While not included in the literature review, it is in the personal interest of the
primary researcher to test this relationship. If such a relationship is found, then more justification
is warranted for science educators to take the steps necessary to inoculate students from
misinformation regarding anthropogenic climate change.

Absent from this hypothesis are other demographic factors covered in the literature
review (e.g., age, gender, religiousness). Religiousness is not included because the survey site,
Amazon’s Mechanical Turk, underrepresents religious individuals. This limitation is covered in
more detail in section 3.2.1. Age, and gender were not included in hypothesis one for several
reasons. These demographic factors can be used to predict dissent, but are outweighed so
strongly by political ideology that differences found here will likely be so small it would be
difficult to accept or reject a hypothesis. Knowing who agrees more with dissenter messages for
these groups is not as helpful as what dissenter messages these distinct groups agree with.

Age and gender effects are also likely to have interactive effects with political ideology.
Older Americans tend to learn more conservative, while younger Americans tend to lean more
liberal (F. Newport, 2014). Likewise, women are more likely to be democrats regardless of their
age (F. (Gallup) Newport, 2009). These two demographic factors are still significant when discussing the U.S. population’s climate change views, and played an integral role in this literature review. Differences within these demographic factors are answered in research question 2 (R2). This research questions allows for a more nuanced and detailed examination of the differences, and provide more useful information to science educators than simply identifying who agree more with dissenter messages.

(2) Does accurate anthropogenic climate change knowledge matter? As demonstrated in the literature review of this proposal, many researchers find a strong relationship between an individual’s political ideology and climate change belief. This simple relationship is not a practical conclusion for science educators. This dissertation may answer whether buy-in to dissenter knowledge matters when it comes to anthropogenic climate change acceptance. Furthermore, the instrument used for this research may tell science educators what dissenter messages have the highest correlation to dissent. This information would be vital for developing effective teaching materials. Through instruction educators may be able to inoculate students from anti-anthropogenic climate change talking points.

**HYPOTHESIS 2: Agreement with dissenter knowledge will be a better predictor for dismissing anthropogenic climate change than political ideology.**

The guiding questions above inform the following suite of research questions:

- **R1:** What type of dissenter message (as identified by factors in Bentley et al., 2016) is the most correlated with climate change dissent?

- **R2:** Are the predictors for dissent similar or dissimilar for various groups of individuals as categorized by demographics, specifically political affiliation, age, or gender?

- **R3:** Does the level of agreement with dissenter messages vary by participants’ primary news source, outside of their own political affiliation?

The results of **R1** will likely be the most informative for science educators. If any one class of dissenter messages is strongly correlated with dissent, then educators will know what kinds of messages they should inoculate their students from. For instance, if factor one of Bentley et al. (2016) is the most highly correlated with dissent, I would recommend that educators should focus on teaching the nature of science.
The results of R2 would help public educators and political groups better understand how to target educate the masses. My results may show that different segments of the population “buy-in” to different classes of dissenter messages. If an organization wanted to convey the reality of climate change to a particular group, then it can tailor an intervention or presentation to the beliefs of a particular audience. Realistically, the answers to this research question would have the least helpful results because we do not know if the participants in this study have seen these messages before. It is likely that they are agreeing with them at face value, rather than because they have heard them before. Thus, depending on the results of this research question, we may simply advocate how to inoculate these groups from misinformation they may come across in the future.

The results of final research question (R3) will look deeper into the relationship between news source, political affiliation, dissenter message agreement and anthropogenic climate change belief. Many science communicators (it may be more appropriate to say the majority) believe that knowledge is not a significant influencer when it comes to an individual’s belief in anthropogenic climate change. These researchers contribute dissent to personal political identification. Research question three (R3) will attempt to identify which of these three factors have the largest effect on individuals’ acceptance or rejection of anthropogenic climate change.
3. METHODOLOGY

3.1 Overview

This study employs a cross-sectional, correlational design (Creswell & Plano Clark, 2007) to discover predictive relationships between different segments of the adult US population as characterized by demographic variables, and agreement with types of dissenter messages. The Anthropogenic Climate Change Dissenter Inventory (ACCDI; Bentley et al., 2016) was the survey tool chosen to test the hypotheses and address research questions in section 2.5. The adult US population was sampled by using Amazon’s Mechanical Turk. A further discussion of this service and population is covered in section 3.2.1 and section 3.2.3. The knowledge deficit theory was chosen as the theoretical framework for this study. Justification for employing this framework is found in section 3.2. In short, this framework states that individuals fail to accept a scientific theory because they do not understand it well enough. Multivariate logistic regression analysis was chosen as the statistical tool for this project because the dependent variable pulled from the ACCDI is dichotomous. Further information regarding this technique can be found in section 3.2.6.

Table 5 shows the types of statistical analyses that will be employed to test the research hypotheses and address the research questions. Details of the multivariate logistic regression models are further discussed in section 3.2.6.

Table 5: Research question and methodological overview of research project.

<table>
<thead>
<tr>
<th>Hypothesis or research question</th>
<th>Analysis technique</th>
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<tbody>
<tr>
<td>What groups of people, as categorized by demographic factors, agree most with dissenter messages?</td>
<td>Descriptive statistics (t-test, ANOVA)</td>
</tr>
<tr>
<td>H1: Agreement with dissenter messages will be higher among conservatives, those who select conservative news as their primary news source, and those with lower education levels.</td>
<td></td>
</tr>
<tr>
<td>Does accurate anthropogenic climate change knowledge matter?</td>
<td></td>
</tr>
<tr>
<td>H2: Agreement with dissenter knowledge will be a better predictor for dismissing anthropogenic climate change than political ideology.</td>
<td>MLR Model 2</td>
</tr>
<tr>
<td>R1: What type of dissenter message is the most correlated with climate change dissent?</td>
<td>MLR Model 1</td>
</tr>
</tbody>
</table>
R2: Are the predictors for dissent similar or dissimilar for various groups of individuals as categorized by demographics, specifically political affiliation, age, or gender?  

R3: Does the level of agreement with dissenter messages vary by participants’ primary news source, outside of their own political affiliation?  

| MLR Model 3 | MLR Model 4 |

3.1.1 Theoretical Framework. The framework I use for this work is the knowledge deficit theory. The theory states that individuals reject science, or an aspect of it, because they are ignorant of it. Thus, the more accurate understanding an individual has of a scientific topic, the less likely they are to reject it.

This may seem almost elementary to science educators; more education equals more belief. However, many science communication researchers reject the knowledge deficit theory on grounds that attitudes towards a scientific topic are not predicted by knowledge of that topic. As demonstrated in the following paragraphs however, fundamental flaws exist in how science communicators researchers conduct their studies.

Kahan et al. (2012) asserts that the deficit model is insufficient in terms of anthropogenic climate change concern, but utilized an assessment that focuses on physics and biology knowledge as a proxy for overall scientific literacy. It is reasonable to believe that a deep understanding of biology and physics does not necessarily translate to anthropogenic climate change literacy. Whitmarsh (2011) asserts that demographic variables, particularly political ideology, better predicted anthropogenic climate change skepticism over knowledge. However, Whitmarsh (2011) utilized self-assessed knowledge instead of attempting to assess actual anthropogenic climate change knowledge. Self-assed knowledge as a proxy for actual knowledge will lead to inconclusive results because of the Dunning-Kruger effect. Those with a poor understanding of a subject overestimate their knowledge of that subject (Kruger & Dunning, 1999). The Dunning-Kruger effect may be amplified for topics which have readily available and wildly spread contrarian knowledge. Individuals whose schema contains anti-rhetoric will likely believe they have a firmer understanding of the topic than they actually do.

The effects of contrarian knowledge and the Dunning-Kruger effect may be evident in Kellstedt, Zahran, and Vedlitz (2008) study of the relationship between personal efficacy and attitudes towards anthropogenic climate change. In this study the authors assessed individuals’
anthropogenic climate change knowledge with the following prompt, “how informed do you consider yourself to be [about global warming and climate change]” (Kellstedt, Zahran, & Vedlitz, 2008, p. 118). Kellstedt, Zahran, and Vedlitz’s (2008) found that, “Directly, the more information a person has about global warming, the less responsible he or she feel for it; and indirectly, the more information a person has about global warming, the less concerned he or she is for it” (Kellstedt, Zahran, & Vedlitz, 2008, p. 122). The authors go on to say that the knowledge deficit model is insufficient for understanding the public’s attitudes towards anthropogenic climate change. However, the results presented by Kellstedt, Zahran, and Vedlitz (2008) are expected when considering the Dunning-Kruger effect and organized contrarian knowledge. Those individuals who think they know the subject well are likely to be those who know the least about anthropogenic climate change, and thus hold less concern for anthropogenic climate change.

Not all researchers in the realm of the public understanding of science are critical of the knowledge deficit theory. Sturgis and Allum (2004) paired the Oxford scale of scientific knowledge with a survey assessing individuals’ attitudes towards science. They found a relationship between individuals’ understanding of science on the Oxford scale, and attitudes towards science. However, they do admit that one tenant that was also a strong predictor alongside knowledge was an “…[U]nderstanding of the “patronage, organization, and control” operating in and around science and the scientific community” (Sturgis & Allum, 2004, p. 67). Science educators with a firm understanding of the nature of science will not be discouraged by this finding because in their eyes, knowledge on the patronage, organization and control of science is a vital part of scientific literacy.

3.1.2 Research Design. This work uses a correlational design to explore relationships between anthropogenic climate change acceptance and demographic factors in a cross-sectional population of US adults. This research started as a mixed methods study where authentic dissenter messages were utilized to develop a quantitative instrument which gauges individuals buy-in to those messages. For an in-depth review of this work see Bentley et al. (2016). However, much of that work will be covered in the methodology section below as I review the instrument used in this research.
The use of this instrument for this dissertation can be divided into four steps. First, a suitable population was identified for its distribution. Amazon’s Mechanical Turk was chosen based on recommendations gleaned from the anthropogenic climate change perceptions literature. Second, the instrument will be coded into hyper text markup language (HTML) and cascading style sheets (CSS) for online distribution. Included in this digital version are attention check questions. These ensure that individuals filling out the survey are indeed humans, and reading all the items thoroughly. Third, data will be sanitized. Fourth, appropriated multivariate regression models will be developed for analysis. These models will be built based on results presented in the literature review above and will be discussed further in the relevant section below. Finally, models will be run in R via the graphical interface RStudio. These results will be interpreted based on knowledge from the literature and disseminated.

3.2 Procedure

3.2.1 Participant Recruitment and Informed Consent. Anthropogenic climate change views, vary by population. For instance, liberals on average tend to accept climate change over their conservative counterparts (Hornsey et al., 2016; Jelen & Lockett, 2014; Rolfe-Redding, Maibach, Feldman, & Leiserowitz, 2012) Younger Americans are more likely to accept climate change than older Americans (Hornsey et al., 2016; O’Connor, Bord, & Fisher, 1999). Women over men are more likely to accept climate change, and have a more accurate understanding of the science (McCright, 2010). Geographical location also seems to be correlated to an individual’s climate change views (Brody, Samuel D., Zahran, S., Vedlitz, A., Grover, 2008; Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015; Whitmarsh, 2008).

The strong differences in individuals’ climate views make choosing a sample population difficult. Often researchers use a convenience sample of college students when distributing an instrument. Using a convenience sample of college students will hinder the explanatory power of the instrument for several reasons. College students tend to be liberal, well educated, wealthier, and white (Digest of Education Statistics: Chapter 3, 2014). Also, college students tend to be younger than the United States Population.
Understanding college students’ perception of anthropogenic climate change is a very important mission. However, the mission of this dissertation is to provide recommendations for increasing climate literacy among all Americas. Thus, a convenience sample of college students is not suited for this research. In order gather a more representative sample, a different approach will be employed.

Amazon’s Mechanical Turk is quickly becoming widely used by social scientists to gather data in a quick, efficient, and economic manner. Originally, Amazon’s Mechanical Turk was designed as a tool for quickly gathering data impossible for computers to generate. For instance, imagine that a company has a repository of 10,000 photographs that need to be indexed via subject. Computers would be unfit for the job because even the best program is incapable of identifying and describing a photograph. It would be impractical for the company to hire staff for a one-off project such as this. Instead they could upload those photos to Amazon’s Mechanical Turk, and crowd source the results for as little as a penny a photo.

Social scientists and science education researchers have successfully employed Amazon’s Mechanical Turk works to quickly and cheaply collect data (Paolacci, Chandler, & Ipeirotis, 2010; Tingley & Tomz, 2013). Experiments indicate that data returned from Amazon’s Mechanical Turk workers is as reliable as traditional methods (Buhrmester, Kwang, & Gosling, 2011). However, no sampling technique is perfect, and Amazon’s Mechanical Turk has its limitations. For instance, Lewis, Mockabee, Djupe, and Su-Ya Wu (2015) found that Amazon’s Mechanical Turk vastly underrepresents those with strong religious views. They found that approximately 10-22% of Amazon’s Mechanical Turk workers attend religious services weekly. They cite this as far lower than the US average of 31%. Other polls have indicated that weekly religious attendance is ~37% (Lipka, 2013). Some have argued that Christians report lower concern for environmental issues (Clements, McCright, & Xiao, 2013). While others have argued the opposite (Hitzhusen, 2007). Understanding that the population I wish to sample is more secular then the US populations is important when developing logistic regression models and interpreting results.

Another drawback to utilizing online-only survey techniques is that it can under sample older Americans, people of color, lower educated Americans, and Americans with a household income of less than $20,000 when compared to mail-in surveys (Keeter et al., 2015). However,
the opposite is true when using mail-in only surveys. As stated above, no one sampling technique is perfect. This information will also be taken into consideration when building regression models and interpreting results.

3.2.2 Instrumentation. The Anthropogenic Climate Change Dissenter Inventory (ACCDI) was selected for use in the dissertation. For a full description of the development of the instrument please refer to Bentley et al. (2016). A short overview of the instrument’s development is provided below.

The development of the ACCDI used a sequential, two phase, mixed methods approach (Creswell & Plano Clark, 2007). The first was a qualitative exploratory phase aimed at identifying the emerging themes that exist within an authentic source of dissenter messages. The study of this phenomenon resulted in the identification of two major themes each with multiple sub categories, or codes. These codes were each used to develop several Likert-type statements of anthropogenic climate change dissent in a broad survey instrument (K=73). The second was a quantitative confirmatory phase aimed at developing a model for the instrument from the emergent codes, and validating it. There were two surveys administered for this purpose. The first was used to narrow the range of statements from K=73 to K=44, by identifying the response-model via exploratory factor-analysis (EFA) alongside other statistical measures. The second was used to verify the model via confirmatory factor-analysis (CFA) alongside other statistical measures. This two-phase approach was chosen because the variables (e.g., dissenter statements) necessary for instrument design were unknown.

Phase one of the mixed methods instrument development involved a qualitative analysis of anthropogenic climate change dissenter videos hosted on YouTube. YouTube proved to be an ideal study site because anyone can produce and publish videos. Videos produced by amateurs, businesses, policy groups, educators, media outlets, think-tanks, and bloggers are all equally likely to be viewed or “go viral.” Thus, dissenters, and dissenting group’s videos are equally as likely to be viewed as those portraying accurate scientific accounts of anthropogenic climate change.

A list of search terms that would result in dissenter videos was compiled (e.g., “climate change hoax,” global warming hoax,” “climate change is fake,” etc.). Then, before searching for these terms on YouTube, an in-browser web proxy was loaded to keep the researcher’s internet
Anonymous browsing, which prohibited YouTube from skewing search results based on previous visits, was used to uncover videos that would be found by a first-time visitor to this subject. Results from anonymous browsing were narrowed down to relevant videos (videos whose topic match the search query), and those with high views (>15,000).

Videos were then loaded into NVivo, and subjected to numerous rounds of emergent coding. Initial coding consisted of highlighting statements that directly refute anthropogenic climate change (i.e., “Climate change is not real because…”). This initial “high bar” coding scheme evolved through repetitive views to include more nuanced codes that involved highlighting sections of videos that point to reasons why scientists, politicians, or others wanted anthropogenic climate change to be real (e.g., financial gains, political power, world domination, etc.). All codes were flexible throughout analysis and evolved through repeated examination of the videos. The first author completed all coding. After compiling codes, a coding comparison query was conducted with a second researcher (not an author). The initial coding comparison query resulted in an average Cohen’s kappa of 0.72 indicating substantial agreement between researchers (Landis & Koch, 1977).

A total of three hours of videos was used for analysis. These videos constitute over 2,000,000 combined views on YouTube. A total of 41 echoed messages were uncovered, which were divided into two major themes. Approximately 30% of video runtime used by dissenters to refute anthropogenic climate change contained scientific statements. Approximately 22% of the video runtime used by dissenters utilized non-scientific arguments to challenge climate change. The remaining 48% of the video runtime contained conversation unrelated to this study (e.g., filler conversation, questions, runtime containing no talking).

The survey was initially populated with 73 six-point Likert items derived from the qualitative phase of this study. A six-point scale was chosen to cut down on survey completion time and eliminates a neutral position. Providing no neutral position on a statement pushed participants to take a stance (albeit a small position) for each item. Response options were “strongly agree,” “agree,” “slightly agree,” “slightly disagree,” “disagree,” and “strongly disagree.”
Individual codes had multiple statements written from them when applicable. Writing multiple statements based on each code helped assure that a range of specific examples authentically grounded in the YouTube videos were generated from each broader code. When possible, actual phrasing and examples from the YouTube videos were used in generating survey items. Demographic questions designed after Leiserowitz, Maibach, and Roser-Renouf (2009) (e.g., age, income, political affiliation, gender, career, and religiousness) were also included in this initial survey.

The original 73 item survey and demographic questions were shown to three education researchers with expertise in public communication of science for review and face validation. Based on their recommendations, several items were modified to be more appropriate for public reading level, and several demographic questions were revised to be more inclusive of individual identity (e.g., the addition of a transgender option for gender). Modifications were completed before the survey was administered.

EFA was completed using PSPP, a free open source alternative to IBM’s SPSS. Likert items were subjected to Cronbach’s alpha and item-total correlation. Likert items that returned values less than 0.3 for item-total correlation were eliminated per convention. The elimination of these items resulted in an overall Cronbach’s alpha of 0.98. Likert data was then subjected to principal component factor analysis (PCA). The Kaiser criterion was applied, and the number of factors was reduced until all had an eigenvalue greater than or equal to 1 (Beavers et al., 2013). The number of factors were further reduced iteratively for sake of parsimony using Cattel’s scree method and the variance explain criteria (VCE ~ 50%; Beavers et al., 2013). Likert items with factor loadings less than 0.5 were eliminated from the survey. Further Likert items were eliminated to shorten the survey. Likert items with lower factor loadings that originated from the same code were eliminated. PCA and item elimination resulted in a five-factor model containing 44 Likert Items. Each of these factors contain at least three items with factor loadings ~>0.6.

The resulting 44 item Likert instrument was subjected to Cronbach’s alpha and item-total correlation. All 44 items scored over 0.3 on their item-total correlation, and the overall Cronbach’s alpha score was 0.98. Principal component factor analysis was conducted again on the 44 Likert item list and all the items re-factored into their original groups.
CFA was calculated using the statistical software package R. The script for CFA used within R, known as lavaan, was written by Yves Rosseel (2012). We invited an additional 190 Mechanical Turk workers to participate in the CFA stage using our updated survey developed from the EFA stage. Data sanitation procedures were identical to those used in the EFA stage except for the completion cut-off time, which was shortened because of the reduced number of items used in the CFA stage. After data sanitation, 151 surveys remained for analysis for a retention rate of ~79%. The results of CFA are as follows. The standardized root mean square residuals (SRMR) of the five-factor model during CFA was 0.69, which is considered well fitting (Hu & Bentler, 1999). The root mean square error of approximation (RMSEA) of the five-factor model was 0.101 which falls into the 90% confidence interval (0.095-0.107) considered sufficient for low N confirmation (Hu & Bentler, 1999; MacCallum, Browne, & Sugawara, 1996). Subsequent checks of the model fit will be conducted in future distributions of the instrument.

3.2.2.1 Dependent Variable. The dependent variable used in this survey reads as, “Do you believe that humans are driving the current warming of Earth's climate?” The participant has the choice to select “no” or “yes.” This question was designed to be a ‘low-bar’ representation of anthropogenic climate change acceptance. This question leaves no room for argument and is imperially bound.

3.2.2.1 Independent Variables. The independent variables proposed are the five factors developed during the validation of the ACCDI. These items can be found in table 6, a reproduction of a table found in Bentley et al. (2016). The largest category contains what we describe as the naïve statements refuting anthropogenic climate change. These naïve statements include those who contain a scientific sounding rebuttal for anthropogenic climate change, and those that include misunderstandings on how the process of science works. It is feasible that these items factored together because individuals who have a poor understanding of the basic tenants of climate science are also likely to have a poor understanding of how science operates. However, for the purposes of this proposed dissertation project, this factor will be divided into two. From an educator’s perspective, these concepts would be taught separate from one another.
Table 6: Proposed independent variables. The items from this table come from Bentley et al. (2016). The only major difference is that the original factor one has been divided into the first two factors presented here.

<table>
<thead>
<tr>
<th>Item #</th>
<th>Item Loading</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Factor 1. Non-science messages refuting anthropogenic climate change</td>
</tr>
<tr>
<td>64</td>
<td>0.94</td>
<td>Climate scientists change their data to get the results they want, not the results the data produces</td>
</tr>
<tr>
<td>13</td>
<td>0.94</td>
<td>Climate change science is not a science; it is a political propaganda</td>
</tr>
<tr>
<td>73</td>
<td>0.92</td>
<td>Climate scientists purposefully leave out past cooling events such as the Little Ice Age from their climate models in order to produce the results they want</td>
</tr>
<tr>
<td>26</td>
<td>0.9</td>
<td>Climate scientists made up the concept of climate change to order to make money from environmental companies</td>
</tr>
<tr>
<td>59</td>
<td>0.89</td>
<td>Climate scientists made up the concept of climate change to receive grant money for research</td>
</tr>
<tr>
<td>63</td>
<td>0.89</td>
<td>Climate scientists made up the concept of climate change to order to make money from alternative energy companies</td>
</tr>
<tr>
<td>3</td>
<td>0.87</td>
<td>Climate scientists made up the concept of climate change in order to increase their revenue streams</td>
</tr>
<tr>
<td>56</td>
<td>0.87</td>
<td>Climate scientists remove collected data from their models in order to make the graphs look the way they want</td>
</tr>
<tr>
<td>31</td>
<td>0.86</td>
<td>The reported number of climate scientists that believe humans are causing Earth's climate to change is inflated to convince more people to believe in climate change</td>
</tr>
<tr>
<td>4</td>
<td>0.85</td>
<td>The number reported of climate scientists that believe humans are causing Earth's climate to change is inflated to convince more people to believe in climate change</td>
</tr>
<tr>
<td>29</td>
<td>0.85</td>
<td>Climate change is fabricated by the media so they can increase their viewer ratings</td>
</tr>
<tr>
<td>11</td>
<td>0.83</td>
<td>A large number of climate scientists do not believe that global warming is happening, but cannot make their beliefs public because they would be ridiculed by climate scientists who do believe in climate change</td>
</tr>
<tr>
<td>61</td>
<td>0.83</td>
<td>Climate change is designed to convince people to vote democrat</td>
</tr>
<tr>
<td>49</td>
<td>0.81</td>
<td>Climate scientists who do not believe in human caused climate change cannot speak out because disagreeing with the majority could cost them their job</td>
</tr>
<tr>
<td>14</td>
<td>0.74</td>
<td>Climate scientists do not change their mind on climate change when presented with new scientific evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Factor 2. Scientific statements refuting anthropogenic climate change</td>
</tr>
<tr>
<td>57</td>
<td>0.78</td>
<td>The upper layers of Earth's atmosphere are not warming</td>
</tr>
<tr>
<td>19</td>
<td>0.79</td>
<td>Earth's overall temperature has nothing to do with the level of carbon dioxide in the atmosphere</td>
</tr>
<tr>
<td>71</td>
<td>0.81</td>
<td>The level of carbon dioxide in Earth's atmosphere is not related to Earth's overall climate</td>
</tr>
<tr>
<td>10</td>
<td>0.83</td>
<td>Artic sea ice is not shrinking in volume</td>
</tr>
<tr>
<td>37</td>
<td>0.78</td>
<td>Meteorologists cannot accurately predict the weather more than few days in advance, thus it is impossible to accurately predict Earth's climate years into the future</td>
</tr>
<tr>
<td>72</td>
<td>0.83</td>
<td>Climate models do not accurately depict earth's climate through time</td>
</tr>
<tr>
<td>58</td>
<td>0.83</td>
<td>The winter of 2014, one of the coldest in decades in the northeastern United States, proves that Earth is not getting warmer</td>
</tr>
<tr>
<td>34</td>
<td>0.84</td>
<td>Carbon dioxide is natural, so we should not worry about how much is in the atmosphere</td>
</tr>
<tr>
<td>32</td>
<td>0.85</td>
<td>The recent cold weather is evidence that the climate is not warming</td>
</tr>
</tbody>
</table>
**Factor 3. Sophisticated scientific statements that distance anthropogenic climate change blame from mankind**

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.84</td>
<td>The release of carbon dioxide from volcanoes is responsible for the recent warming of Earth's oceans</td>
</tr>
<tr>
<td>44</td>
<td>0.82</td>
<td>A change in the energy output of the sun is responsible for the recent rapid warming of Earth's oceans</td>
</tr>
<tr>
<td>48</td>
<td>0.78</td>
<td>The location of earth's continents is driving earth's recent warming</td>
</tr>
<tr>
<td>30</td>
<td>0.78</td>
<td>The recent rapid warming of Earth's climate is caused by a change in Earth's tilt</td>
</tr>
<tr>
<td>68</td>
<td>0.77</td>
<td>Radiation from supernova events is responsible for the recent warming of Earth's atmosphere</td>
</tr>
<tr>
<td>36</td>
<td>0.77</td>
<td>Changes in Earth's tilt or orbit are responsible for the recent rapid warming of Earth's atmosphere</td>
</tr>
<tr>
<td>7</td>
<td>0.72</td>
<td>A change in the energy output of the sun is responsible for the recent rapid warming of Earth's atmosphere</td>
</tr>
<tr>
<td>33</td>
<td>0.71</td>
<td>Radiation from distant supernova events control Earth's climate</td>
</tr>
</tbody>
</table>

**Factor 4. The "natural" statements**

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.81</td>
<td>Every year mother nature produces more carbon dioxide than humans</td>
</tr>
<tr>
<td>40</td>
<td>0.7</td>
<td>The Earth produces more carbon dioxide than mankind</td>
</tr>
<tr>
<td>9</td>
<td>0.67</td>
<td>Natural Earth processes keep Earth's climate stable</td>
</tr>
<tr>
<td>60</td>
<td>0.84</td>
<td>Naturally occurring Earth cycles prevent mankind from being able to change Earth's climate</td>
</tr>
<tr>
<td>27</td>
<td>0.72</td>
<td>Natural Earth processes will keep our climate from changing</td>
</tr>
</tbody>
</table>

**Factor 5. Items stating the beneficial aspects to anthropogenic climate change**

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>0.81</td>
<td>An overall increase in Earth's average temperature would be better for mankind than the current average temperature</td>
</tr>
<tr>
<td>28</td>
<td>0.8</td>
<td>A warmer Earth would be better for mankind than the current average temperature</td>
</tr>
<tr>
<td>25</td>
<td>0.78</td>
<td>Increasing the level of carbon dioxide in the atmosphere would allow farmers to grow more food</td>
</tr>
</tbody>
</table>

**Factor 6. Statements that assert anthropogenic climate change is simply part of a larger cycle**

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>0.74</td>
<td>The recent warming of earth's atmospheres and oceans is a result of natural climate cycles, and our climate is headed into an ice age</td>
</tr>
<tr>
<td>22</td>
<td>0.66</td>
<td>Earth's climate may not be warming, but instead be headed into another ice age</td>
</tr>
<tr>
<td>47</td>
<td>0.41</td>
<td>Increases in carbon dioxide in the atmosphere is the result of changes in Earth's climate</td>
</tr>
<tr>
<td>52</td>
<td>0.87</td>
<td>The recent rapid warming of earth's atmospheres and oceans is only a result of natural climate cycles</td>
</tr>
</tbody>
</table>

Naïve scientific statements are those whose assertion(s) would likely be identified as fundamentally incorrect to anyone with a basic understanding of earth science. Leading examples include items 71 and 19, which outright dismiss the connection between atmospheric carbon dioxide and warming. Naïve scientific statements within this factor also include items that actually support the science of anthropogenic climate change, but were likely meant to be misleading. Item 57, which states that the upper atmosphere is not warming, stands as a good example of a scientifically accurate statement that is actually evidence supporting the theory of anthropogenic climate change. If the upper atmosphere was warming, or warming faster than the
lower atmosphere, the change in temperature could be contributed to changes in solar output. However, if the lower atmosphere is warming faster than the upper atmosphere, its likely due to an abundance of greenhouse gases at the surface (Santer et al., 2003).

Naïve statements that attempt to refute anthropogenic climate change based on explanations outside of scientific explanation are also include within this factor. For example, items 13 and 61 assert that climate change is not science, but rather part of some political ideology. Similarly, items 64 and 73 both state that scientists purposefully alter their data to get the results they want. This factor also contained items that attempt to dismiss the scientific consensus. In general, these non-scientific statements demonstrate distrust in both scientists and the scientific process. Recent studies have demonstrated that trust in science has been decreasing among Republicans since the rise of the New Right (Gauchat, 2012); however looking for this relationship was beyond the scope of instrument development.

McCright and Dunlap (2000) uncovered similar naïve statements in previous studies of dissenter literature. For example, in their category entitled “The evidentiary basis of global warming is weak and even wrong,” they include “global warming is merely a political tool of the Clinton Administration,” and “the scientific evidence for global warming is highly uncertain” (McCright & Dunlap, 2000, p. 510). The appearance of these messages in the current echo-chamber, as well as McCright and Dunlap’s 2000 study, suggests that either organized climate change denial is still using these types of messages, or that old messages persist.

The third factor in this study contains what we consider to be sophisticated scientific statements that refute anthropogenic climate change. The term “sophisticated” is used because in many ways these statements are “half-true.” The energy output of the sun (items 7 and 44), the location of continents (item 48), volcanic activity (item 20), and changes in Earth’s tilt (items 30 and 36) all affect climate, but are not driving Earth’s recent rapid warming. These items attempt to remove anthropogenic carbon dioxide as an explanation for the recent increase in Earth’s temperature, or remove mankind’s role. These statements may appeal to individuals who have a basic understanding of earth science. Early studies of anti-anthropogenic climate change literature did not include sophisticated scientific explanations of climate change and instead dismissed its existence (McCright & Dunlap, 2000). The use of these sophisticated scientific statements may indicate a transition from dismissing anthropogenic climate change to
“explaining away” climate change in the organizations that supply messages to the echo-chamber.

The fourth factor in this model contains statements that only use “natural” explanations for a changing climate. Unlike the sophisticated scientific explanations found in the second factor, these items are unique in that they frame “Earth” or “Mother Nature” as the sole driving force of carbon dioxide emissions. These types of statements were not identified in either the McCright and Dunlap (2000) or the Boussalis and Coan (2016) studies of dissenter literature. Thus, these items may not arise from organized climate change denial, but may come from individuals within the echo-chamber. This sentiment may be grounded in a worldview, whereas “Mother Nature” takes the position of climate controller. This sentiment may also be a part of the “appeal to nature” ideology that has grown in recent years with the increasing number of people who dismiss vaccines and genetically modified foods (GMOs). A quick examination of this literature shows they reject scientific advancement on the ground that natural is better (for example, see www.NaturalNews.com). Individuals who hold this ideology may be producing or supporting statements found within this factor. While there are other ‘natural’ arguments elsewhere we decided to keep this factor because only ‘natural’ arguments factored into it. Some of the descriptions of the factors runs parallel to the coding done in the first portion of this project and we found that the ‘natural’ argument is fluid and can be paired to other arguments. For instance, there were some instances in the videos where individuals would argue that the current warming is natural, current cooling is natural, CO2 is natural, or that human activities themselves are natural. Thus, based on our prior experience with these arguments in usage we decided to keep this factor even though similar items fall into other factors. We recognize that this factor may dissolve into others upon further distributions of the instrument.

The fifth factor in the model contains items that promote the beneficial nature of anthropogenic climate change. This topic was one of the main themes in McCright and Dunlap’s (2000) study of conservative counter claims, but is not found in a more recent study by Boussalis and Coan (2016). Its existence here may indicate that organized climate change denial has moved on from using this type of argument, but it is persisting in the echo-chamber.

The sixth factor in this study contains items suggesting that the current warming of Earth’s climate is only part of a larger cycle and that we may be headed into another ice age. This type of message, when documented in the qualitative phase of this study, is often paired
with diagrams of ice age cycles. These types of statements may appeal to those who want to ignore the issue of climate change in hopes that eventually it will correct itself. These types of messages were uncovered in Boussalis and Coan's (2016) study, but not McCright and Dunlap’s (2000) study, suggesting that these messages are part of the current organized climate change denial repertoire.

3.2.3 Data Collection. The data for this proposed study will come from workers on Amazon’s Mechanical Turk. As stated in Section 3.2.1 this service has benefits and drawbacks. Data can be quickly and cheaply acquired; however Mechanical Turk workers are not completely representative of the US population. Workers tend to be less religious, less racially diverse, and younger (Keeter et al., 2015; Lewis et al., 2015). These limitations are recognized and will be taken into consideration when making recommendations with the results of this study. Previous Mechanical Turk Workers from the validation stage of the ACCDI will be blocked from taking this round of the ACCDI distribution. Baring these participants will ensure that data from the completed surveys will not be skewed by repetitive completions.

The survey questions found in table 6, the dependent variable question, and additional demographic questions will be coded into HTML and CCS. Qualtrics™, an online survey program could have been used for this, however, I know HTML and CCS, and am not familiar with Qualtrics™. The main difference of using Qualtrics™ over an HTML coded survey is that Qualtrics™ would allow me to have multiple pages in the survey. Having questions on various pages that participants click through would ensure that individuals would not change responses based on new items. However, the HTML was coded as such that only 4-5 items can be seen at a time. Mechanical Turk Workers are also attempting to finishing surveys as quickly as possible, thus I do not believe that there is much worry of participants changing responses based on newly observed items. The independent variables in table 6 were answered on a six point Likert scale. I chose a six-point scale for this distribution because it does not have neutral position. I plan on dichotomizing the responses into “agree” and “disagree.” The purpose of dichotomization is covered in section 3.2.4 of this proposal. Two “attention check” items were placed within the survey to test participant’s devotion to reading each item completely. Approximately 500 surveys will be collected from Amazon’s Mechanical Turk.
3.2.4 Data Sanitation. For this project, we will restrict what workers can take the survey by age, location, and task success rate. Participants will be over the age of 18, reside in the United States, and have a minimum success rate of 95% for their first 100 tasks. The age restriction is built into Mechanical Turk, no individual under the age of 18 may be an Amazon Mechanical Turk worker. The successful completion rate criterion was implemented to ensure that participants of this study produce reliable results. Most the literature review focuses on the perceptions of individuals within the United States. If the survey was distributed globally, it would be difficult if not impossible to make comparisons to what was found in the literature. For more information on the differences in anthropogenic climate change perceptions between countries, refer to section 1.2.

Participants who failed both test questions, those who finish the survey in less than 220 seconds, and those who left most the survey blank will have their work rejected. Failing both test questions (“The recent warming test select strongly agree” & “Climate change test select strongly agree”) would indicate to the researcher that the participant is not reading survey items completely. Likewise, finishing the survey in less than 220 seconds likely indicates that the participant was not reading each item completely. Rejection rates will likely be low because many high-paying tasks require individuals to have a high success rate to complete. In previous distributions of this survey on Amazons’ Mechanical Turk the retention rate was >86%.

After data sanitization, the independent variables were simplified through dichotomization and weighting. For each item, any response with either a “strongly agree,” “agree,” or “slightly agree” was coded as a 1. For each item, any response with either a “strongly disagree,” “disagree,” or “slightly disagree” was coded as a 0.

Much of the statistical community disagrees with the dichotomizing of continuous data. MacCallum, Zhang, Preacher, and Rucker (2002) argue that dichotomizing continuous data results a loss of power and effect size. However, they do not make recommendations on the dichotomization of ordinal data. Others have argued that dichotomizing ordinal data is an ineffective means of analysis. Sankey and Weissfeld (1998) argue that dichotomizing ordinal data that is meant to represent continuous data results in a loss of power (i.e., when binning age or income into ranges). However, these authors do not provide recommendations for dichotomizing ordinal data when the items are level of agreement. Farrington and Loeber (2000)
justify the practice of dichotomizing data because it simplifies the results. The results then can be easily interpreted by practitioners. Admittedly, dichotomizing the Likert data in this study will likely result in a loss of power. However, the results of this dissertation need to be easily interpreted by science educators, and science education researchers. Such a project as this has also never been conducted, so it would not be unreasonable to take an exploratory stance. The justification of dichotomizing Likert data will become more evident in the next section of this proposal.

3.2.5 Instrument Modification. The option to choose “independent” as a political ideology was removed from the present distribution of the ACCDI. Political ideology presented here represents the dichotomization of a six point Likert scale with either end indicating “strong conservative” or “strong liberal.” Eliminating a middle option was done in response to the current political climate. We were concerned that individuals would reject their typical political leaning because of the unfavorable candidates in the last presidential election. Also, other researches often use ideology over political affiliation when disseminating climate change views.

Three items in the ACCDI were moved between factors. These items originally factored into categories that do not reflect their message. For instance, item 52 (“The recent rapid warming of earth's atmospheres and oceans is only a result of natural climate cycles”) originally factored into the sophisticated scientific message category (factor 2), but fits better into the cycle category (factor 6). Items 60 and 27 were moved from the same category into nature category (factor 4) for the same reason. These changes are reflected in table 6.

3.2.6 Analysis. Multivariate logistic regression analysis will be used to answer the research questions and test the hypotheses proposed in section 3.1. The methods for the use of this analysis are taken from Hosmer and Lemeshow (2000). The following description comes from their book Applied Logistic Regression. In the introduction chapter, they discuss why simple linear regression is not applicable when the dependent variable is dichotomous. One of the main reasons is that linear regression assumes that the plotted mean can be anywhere from infinity to negative infinity. This is not the case for this proposed project because the dichotomous nature of the dependent variable rejects this assumption. A simple example is presented in figure 2 below.
Figure 2: Hypothetical test data. X-axis represents test scores of individuals. Y-axis represents whether that individual was accepted into a program. The line represents a best-fit linear model.

Figure 2 depicts a hypothetical scenario of scholastic program admittance based on participant test scores. The X-axis represents individual’s test scores and the Y-axis represents whether the student was accepted into the scholastic program. As demonstrated by the best-fit line, linear regression is not appropriate for this application. In the mode above the linear regression formula is as follows

\[ y(x) = (m \ast x) + b \]

Where \( y(x) \) is the value of \( y \) based on the value of \( x \). The notation ‘\( m \)’ represents the slope of the line, and ‘\( b \)’ represents the y intercept. Hosmer and Lemeshow (2000) state that a logistic model bounded by zero and one is more appropriate.

\[ L(x) = \frac{e^{b+(m+x)}}{1 + e^{b+(m+x)}} \]

In this formula, the results of \( L(x) \) are bounded by one and zero because the plotted line is the exponent of the natural log \( (e) \). In figure 3 we see that the formula above better resembles the data plotted in figure 2.
When conducting linear regression, researchers express the results in logit form. This is accomplished by conducting the logit transformation, which is simply taking the natural log of the regression model over one minus the regression model.

$$g(x) = \ln\left(\frac{e^{\beta_0 + \beta_1 x}}{1 + e^{\beta_0 + \beta_1 x}}\right)$$

Or...

$$g(x) = \ln\left(\frac{L(x)}{1 - L(x)}\right)$$

$$= \beta_0 + \beta_1 x$$

For the formula directly above, $\beta_0$ can be thought of as the y-intercept in a linear regression, and $\beta_1$ can be thought of as the slope. Maximum likelihood estimation will be utilized to compute the values of $\beta_1$ and $\beta_0$. Describing the math used by the statistical program to compute the maximum likelihood is beyond the scope of this proposal, which intends to utilize these already established tools, rather than evaluate their abilities. What is important is understanding the $g(x)$
formula above, which is how data will be entered into the program to compute odds ratios. To add more than one independent variable to the model, you simply include more $\beta_i$ terms.

$$g(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \ldots + \beta_p x_p$$

In the case of this proposed project, the $\beta_i$ terms will be the dichotomized and scaled factor scores variables.

Multivariate logistic regression was chosen for this study over the similar discriminate analysis for two reasons. For social scientists, multivariate logistic regression is far more common, and thus more easily understood by the largest audience. Also, it is recommended to use multivariate logistic regression when data may not be normally distributed (Press & Wilson, 1978).

Multivariate logistic regression analysis has been successfully used to evaluate anthropogenic climate change perceptions in the past. Hunter and Toney (2005) used this analytical technique to evaluate environmental concern among members of the Church of Latter-day Saints (LDS). They found through regression analysis that LDS members were less likely to be part of an organization that aims to protect the environment, were less likely to give money to such an organization, or sign a petition about an environmental issue. Hunter and Toney's (2005) results, like most multivariate regression analysis were reported via calculated coefficients. Table 7 is reproduction of their results table.
Multivariate logistic regression analysis was also used by Gauchat (2012) to evaluate the public’s trust in science. Gauchat (2012) found that highly educated individuals trusted science more over individuals with less education. He also found that increasing rates of church attendance was associated with lower levels of trust towards science. The same negative association was found among women in the study.

While Gauchat (2012) and Hunter and Toney (2005) studies stand as examples of logistic regression analysis in action, they fail to provide details accounts on how their statistics were conducted. This seems to be the norm in the social sciences who are more interested in multivariate logistic regression analysis as a tool, rather than a technique to study. Because the social science literature lacks detailed accounts on how statistics are carried out, text books such as Applied Logistic Regression will be used to conduct my analysis. An outside mathematician was consulted during analysis.

All the statistics proposed in this project will be run using the stats program known as R with the graphical interface RStudio. The package that is being utilized to conduct the logistic regression analysis is ‘car’ (https://cran.r-project.org/web/packages/car/car.pdf).
3.2.6 Proposed Model Building. Several proposed models have been selected for analysis. These have been informed by the literature review as well as the research questions and hypotheses discussed in section 3.1. These models are meant to be flexible through the research process, as there is no way to perfectly predict what models will be best.

3.2.6.1 Model 1: Total Population, All Factors. The first model will include the entire participant population (excluding the sanitized data). The dependent variable will be the results of the question “Do you believe that humans are driving the current warming of Earth’s climate?” The independent variables will be the dichotomized factor scores variables.

\[ g(x) = \beta_0 + \beta_{f1}x_{f1} + \beta_{f2}x_{f2} + \beta_{f3}x_{f3} + \beta_{f4}x_{f4} + \beta_{f5}x_{f5} + \beta_{f6}x_{f6} \]

This model was chosen to answer research question one (R1). After maximum likelihood estimations are run, the resulting coefficients should provide clues to what factor is the most highly correlated with dissent. If necessary backwards selection will be used to eliminate insignificant coefficients to hone in on what factor is the most highly correlated.

3.2.6.2 Model 2: Total Population, All Factors, Including Ideology. The second model will include the entire participant population (excluding the sanitized data). The dependent variable will be the same as in model one. The independent variables will be the dichotomized and scaled factor scores variables in addition to political ideology.

\[ g(x) = \beta_0 + \beta_{f1}x_{f1} + \beta_{f2}x_{f2} + \beta_{f3}x_{f3} + \beta_{f4}x_{f4} + \beta_{f5}x_{f5} + \beta_{f6}x_{f6} + \beta_{PI}x_{PI} \]

This model was chosen to test hypothesis two. After maximum likelihood estimations are run, the resulting coefficients should provide clues to what factor is the most highly correlated with dissent. If necessary backwards selection will be used to eliminate insignificant coefficients to hone in on what factor is the most highly correlated. If political ideology outweighs the other factors significantly, then we will know that criticism of the knowledge deficit model is warranted.
One drawback to the model above is that knowledge is divided among six variables and tested against the one political ideology variable. We may find it more reasonable to use dissenter message agreement as a control variable and divide the model into two (high agreement with dissenter knowledge vs. low agreement). Then use political ideology as a single independent variable in two separated models. Then we can test to see if political ideology increases the odds of dissent among the two population.

3.2.6.3 Model 3: Total Population, All Factors, Using Demographic Control Variables. Model three will be several versions of model one using pertinent demographic information as control variables. These models will be used to address research question three (R2). After maximum likelihood estimations are run, the resulting coefficients should provide clues to what factor is the most highly correlated with dissent for each demographic population. If necessary backwards selection will be used to eliminate insignificant coefficients for each of the models to hone in on what factor is the most highly correlated. The results of these models will provide information regarding the differences or non-differences in agreement and dissent among groups of the US population.

3.2.6.1 Model 4: Total population, Dissenter Messages vs. Political Ideology vs. Primary News Source. The fourth model will include the entire participant population (excluding the sanitized data). The dependent variable will be the same as the other models in this study. The independent variables will include factor scores, political ideology, and primary news source. Comparing the relative predictive strength of these items will help me determine what has the biggest influence on an individual’s acceptance or rejection of anthropogenic climate change. This will help answer research question three (R3).

3.2.7 Methodology Limitations (Not Already Specified). One limitation of this proposed project comes from the instrumentation. Some dissenter messages seem to have a long shelf life, but new messages are likely to emerge. Highlighted in section 2.2 are the differences between dissenter statements of the past and those found in the echo-chamber today. Thus, the instrument to be used in this dissertation may have an undetermined shelf life. Already mentioned in section 3.2.1 are the limitations of the chosen population. Amazon Mechanical Turk Workers tend to be more educated, younger, and less religious than the general US public.
4. RESULTS AND DISCUSSIONS

4.1 Population

A total of 971 Mechanical Turk users participated in this study. Data were sanitized per the criteria discussed in 3.2.4 of this manuscript. Participation in this study were filtered by age, location, and task success rate. Participants were limited to individuals over the age of 18, who resided in the United States and had a minimum success rate of 95% for their first 100 tasks. The age restriction is built into Mechanical Turk; no individual under the age of 18 may be an Amazon Mechanical Turk worker.

Participants who failed both test questions, those who finished the survey in less than 220 seconds, and those who left most the survey blank had their work rejected. Failing both test questions (“The recent warming test select strongly agree” & “Climate change test select strongly agree”) indicated to the researcher that the participant was not reading survey items completely. Likewise, finishing the survey in less than 220 seconds likely indicates that the participant was not reading each item completely.

One consideration not made when originally sanitizing data was the problem of missing data. Any participant who failed to answer all the survey times had to be removed due to the requirements of the statistics package used in this study. Thus, rejections rates were higher than previously anticipated and far more Mechanical Turk workers were invited to participate in this study. After data was sanitized, a total of 698 worker’s data was viable for use in this study resulting in a retention rate of ~71%.

As anticipated (Section 3.2.1) the Amazon Mechanical Turk workers in this study are not a representative sample of the US population (table 8). The population of this study are slightly more educated, older and poorer than the US average. However, when compared to a convenience sample, this population is far more reflective of the US population. The geographic diversity of this population is also superior to a convenience sample which often only represents one location (figure 4).
Table 8: Demographic Information for participants in this study.

<table>
<thead>
<tr>
<th></th>
<th>Mechanical Turk Workers</th>
<th>National Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (% female)</td>
<td>58%</td>
<td>50%(^a)</td>
</tr>
<tr>
<td>Age (mean, stdev)</td>
<td>40, 10</td>
<td>37.8(^a)</td>
</tr>
<tr>
<td>Political Ideology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liberal</td>
<td>62%</td>
<td>28%(^b)</td>
</tr>
<tr>
<td>Independent</td>
<td>-</td>
<td>42%(^b)</td>
</tr>
<tr>
<td>Conservative</td>
<td>37%</td>
<td>28%(^b)</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 24k</td>
<td>21%</td>
<td>21%(^c)</td>
</tr>
<tr>
<td>25-39k</td>
<td>19%</td>
<td>18%(^c)</td>
</tr>
<tr>
<td>40-59k</td>
<td>20%</td>
<td>21%(^c)</td>
</tr>
<tr>
<td>60-84k</td>
<td>19%</td>
<td>17%(^c)</td>
</tr>
<tr>
<td>85k+</td>
<td>20%</td>
<td>23%(^c)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some high school, no degree</td>
<td>1%</td>
<td>13%(^c)</td>
</tr>
<tr>
<td>GED or equivalent</td>
<td>3%</td>
<td>-</td>
</tr>
<tr>
<td>High school degree</td>
<td>21%</td>
<td>32%(^c)</td>
</tr>
<tr>
<td>Associates degree</td>
<td>17%</td>
<td>28%(^c)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>40%</td>
<td>28%(^c)</td>
</tr>
<tr>
<td>Masters or PhD</td>
<td>17%</td>
<td>-</td>
</tr>
<tr>
<td>Number of science classes taken post high school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>17%</td>
<td>-</td>
</tr>
<tr>
<td>1-2</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td>3-4</td>
<td>22%</td>
<td>-</td>
</tr>
<tr>
<td>5+</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td>Preferred news network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNN</td>
<td>20%</td>
<td>-</td>
</tr>
<tr>
<td>ABC</td>
<td>6%</td>
<td>-</td>
</tr>
<tr>
<td>FOX</td>
<td>16%</td>
<td>-</td>
</tr>
<tr>
<td>MSNBC</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>NPR</td>
<td>14%</td>
<td>-</td>
</tr>
<tr>
<td>BBC</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>CBS</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>19%</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^a\) Averages from Central Intelligence Agency (2013)
\(^b\) Averages from Gallup (2015)
\(^c\) Averages from Leiserowitz, Maibach, and Roser-Renouf (2009)
Figure 4: Map of precipitant’s locations. Compiled using participant zip codes and easymapmaker.com.

4.2 Results: Comparison to Previous Studies

One way to help establish validity in this study is to compare participant’s climate change acceptance to other studies. Hornsey et al. (2016) conducted a meta-analysis of 171 academic papers that looked for demographic predictors of climate change views and belief. They found that political affiliation had the strongest power when predicting individual’s climate change belief. Gender, age, income, education, race, and political ideology were also predictors. The correlation table of their meta-analysis can be seen in figure 5.
Figure 5: Reproduction of Hornsey et al. (2016) figure1 demonstrating the strength of demographic variables on climate change acceptance.

To make a comparison to Hornsey et al.’s (2016) results, a multivariate logistic regression model with similar demographic was built as described in section 3.2.6 of this manuscript. Our results can be found in table 9 and figure 6. We found that increasing age is associated with dissent. Increasing education level, number of science classes, and income had the opposite effect. Women and those with a liberal political ideology are also associated with anthropogenic climate change acceptance. The relative strength and direction for demographic predictors of our participants are similar to the results of Hornsey et al. (2016) meta-analysis.

Hornsey et al.’s (2016) results are based on a meta-analysis statistics, whereas ours are from a multivariate logistic regression. These models cannot be compared directly due to the nature of the statistics. However, the results of these independent models are what should be expected based on an understanding of the literature (see section 2.4).

Another difference between these two sets of results is that age is a dichotomized variable in my work, whereas in Hornsey et al.’s (2016) work it is likely continuous, though this is not specified in their work. If nothing else, demonstrating that political ideology is the strongest demographic predictor is important at this step in my data analysis because most scholars come to the same conclusion (Dunlap & McCright, 2008; Hornsey et al., 2016; Jelen & Lockett, 2014; Rolfe-Redding et al., 2012).
Table 9: Multivariate Logistic Regression table of climate change disbelief using demographic variables as predictors. Beta values for each predictor are in the right column.

<table>
<thead>
<tr>
<th>Dependent variable: Rejection of the reality of climate change</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.334 (0.222)</td>
</tr>
<tr>
<td>Age</td>
<td>0.203 (0.222)</td>
</tr>
<tr>
<td>Political Ideology</td>
<td>2.272*** (0.245)</td>
</tr>
<tr>
<td># science classes since high school</td>
<td>-0.063 (0.12)</td>
</tr>
<tr>
<td>Education level</td>
<td>-0.174 (0.306)</td>
</tr>
<tr>
<td>Income</td>
<td>0.067 (0.081)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.971*** (0.481)</td>
</tr>
</tbody>
</table>

Observations: 672
Log Likelihood: -261.111
Akaike Inf. Crit.: 536.222

Note: *p<0.1; **p<0.05; ***p<0.01
Standard error in parentheses
Gender, female=0; Age, <40yo=0; Ideology, liberal=0
Figure 6: Multivariate logistic regression coefficients for various demographic variables predicting dissent. Error bars represent standard error for each independent variable. Gender, female=0; Age, <40yo=0; Ideology, liberal=0.

4.3 Results: Hypothesis One, Level of Agreement

Most the climate change acceptance research concerns itself with which individuals are most likely to dissent. As seen in section 4.2, political ideology or affiliation are the best predictors. This information is useful to science communicators because it allows them to adapt their message to demographically distinct groups. However, science educators use knowledge, not ideology, when attempting to increase anthropogenic climate change acceptance among their students. Thus, it may be useful to educators to know what groups of people agree with dissenter messages. For instance, imagine an individual is running a teacher professional workshop and most of the attendees are over the age of 40. Does the individual need to spend more time addressing misinformation when compared to teaching a group under 40? Education level may also be a factor in predicting the need to address dissenter information in the classroom. As someone moves through the education system, does it because less necessary to dispel dissenter messages as they gain knowledge? To address these questions, we developed hypothesis one. The development of this hypothesis was based on a review of the literature found in section 2.4 of this manuscript:
HYPOTHESIS 1: Agreement with dissenter messages will be higher among conservatives, those who select conservative news as their primary news source, and those with lower education levels.

Simple descriptive statistics were employed to test this hypothesis and the results can be seen in table 10 and figure 7.
Table 10: Descriptive statistics highlighting the average score of the ACCDI for each demographic group. The far-right column represents the p-values of either a Student’s two tailed t-test or a one-way ANOVA for either each pair or group.

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>Avg. # of Question Agreement</th>
<th>One Std. Deviation</th>
<th>Percentage of Dissent</th>
<th>Student's T-Test OR ANOVA p-value that population are significantly different</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political ideology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liberal (N=432)</td>
<td>4</td>
<td>7.6</td>
<td>6.00%</td>
<td>0.00</td>
</tr>
<tr>
<td>Conservative (N=261)</td>
<td>17</td>
<td>13.7</td>
<td>38.70%</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;40 years old (N=404)</td>
<td>8</td>
<td>11.0</td>
<td>15.10%</td>
<td>0.07</td>
</tr>
<tr>
<td>&gt;40 years old (N=288)</td>
<td>10</td>
<td>12.0</td>
<td>22.20%</td>
<td></td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some high school, but not degree (N=8)</td>
<td>11</td>
<td>10.1</td>
<td>12.5</td>
<td>0.21</td>
</tr>
<tr>
<td>GED or equivalent (N=20)</td>
<td>10</td>
<td>11.9</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>High School diploma (N=147)</td>
<td>9</td>
<td>11.4</td>
<td>15.60%</td>
<td></td>
</tr>
<tr>
<td>Associates or other 2-year degree (N=120)</td>
<td>11</td>
<td>13.4</td>
<td>25.80%</td>
<td></td>
</tr>
<tr>
<td>Bachelor degree (N=281)</td>
<td>8</td>
<td>11.1</td>
<td>14.90%</td>
<td></td>
</tr>
<tr>
<td>Master degree (N=95)</td>
<td>10</td>
<td>14.2</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>PhD degree (N=24)</td>
<td>11</td>
<td>14.5</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td># of Sci classes post HS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 post-high school sci classes (N=119)</td>
<td>10</td>
<td>12.0</td>
<td>21.80%</td>
<td>0.64</td>
</tr>
<tr>
<td>1-2 post-high school sci classes (N=207)</td>
<td>10</td>
<td>12.3</td>
<td>15.90%</td>
<td></td>
</tr>
<tr>
<td>3-4 post-high school sci classes (N=153)</td>
<td>8</td>
<td>12.1</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>5+ post-high school sci classes (N=209)</td>
<td>8</td>
<td>12.1</td>
<td>18.70%</td>
<td></td>
</tr>
<tr>
<td>Primary news source</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNN (N=141)</td>
<td>9</td>
<td>12.4</td>
<td>11.30%</td>
<td>0.00</td>
</tr>
<tr>
<td>ABC (N=40)</td>
<td>9</td>
<td>12.5</td>
<td>22.50%</td>
<td></td>
</tr>
<tr>
<td>FOX (N=111)</td>
<td>20</td>
<td>13.3</td>
<td>44.10%</td>
<td></td>
</tr>
<tr>
<td>MSNBC (N=72)</td>
<td>5</td>
<td>9.1</td>
<td>11.10%</td>
<td></td>
</tr>
<tr>
<td>NPR (N=99)</td>
<td>3</td>
<td>5.7</td>
<td>4.00%</td>
<td></td>
</tr>
<tr>
<td>BBC (N=70)</td>
<td>7</td>
<td>11.7</td>
<td>8.60%</td>
<td></td>
</tr>
<tr>
<td>CBS (N=28)</td>
<td>7</td>
<td>10.1</td>
<td>14.30%</td>
<td></td>
</tr>
<tr>
<td>OTHER (N=135)</td>
<td>8</td>
<td>10.7</td>
<td>22.20%</td>
<td></td>
</tr>
</tbody>
</table>
4.3.1 Discussion: Hypothesis One, Level of Agreement. The error bars of figure 7 no doubt draw attention. Variation within each group is substantial, however the large variation is due to outliers. Within each population a few individuals answered yes to all the items, while others answered no to all. Extreme agreement and disagreement, paired with a possible score ranging from 0 to 44, results in a large standard deviation for each group. However, excluding these error bars, some groups did differ significantly between each other. Based on one-way ANOVAs and student’s t-test results, political ideology and primary news source were significantly different from each other (table 10). Thus, we fail to reject only a portion of hypothesis one. Conservatives, and those who self-select conservative news as their primary news source agree with dissenter messages more than liberals and those who self-select liberal news as their primary news source. However, increasing levels of education are not associated with lower agreement with dissenter messages. The same can be said for the increasing number of science classes.
The differences in mean agreement between young and old participants is suggestive at a p-value of 0.07. We chose to use 40 years old as the partition between young and old in this population because that was the mean age of the population. However, we imagine that if the division between young vs. old was lowered, the p-value would also lower (i.e., placing the division between young and old at 30 instead of 40). Several studies have found that as age increases so does skepticism about climate change or its cause (Hornsey et al., 2016; Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011). Other have found that when compared to adults, teens on average knew more about some of the key concepts concerning climate change (A Leiserowitz, Smith, & Marlon, 2011). It is not unreasonable to assume that the younger an individual is, the more likely they are to have had a course or other educational experience (formal or informal) that discussed anthropogenic climate change. If increasing climate change education equates to reduced belief in dissenter messages, then we could assume that the average agreement with dissenter messages would be lower for younger individuals.

Political ideology is often a strong predictor for dissent (Dunlap & McCright, 2008; Hornsey et al., 2016; Jelen & Lockett, 2014; Rolfe-Redding et al., 2012). Thus, it is not unreasonable assume that conservatives would on average agree with more messages on the ACCDI. It has also been established that conservative television news, for example FOX, are more likely to depict a skeptical narrative towards climate change (Feldman et al., 2012).

The lack of association between education level and agreement with dissenter information may be disheartening to some educators. However, level of education does not equal level of climate change understanding. Anthropogenic climate change is not currently a standard in most states’ curriculums. Increased level of education does not necessarily equate to a better understanding of anthropogenic climate change. Likewise, the number of science classes and individual takes should not necessarily increase their understanding of anthropogenic climate change or their ability to recognize and discredit misinformation. One could argue that the more science classes an individual takes, the better their understanding of the nature of science will be. However, as is demonstrated in several studies the public’s understanding of the nature of science is low, even among scientists (Lederman, 2006; Schwartz & Lederman, 2008).

4.3.2 Conclusions: Hypothesis One, Level of Agreement. Based on the results in this section, it seems that ideology or information source has the greatest impact on an individual’s
belief in dissenter knowledge and acceptance of anthropogenic climate change. Age, depending on how it is divided, may also be associated with dissenter message agreement. Level of science education and the number of post-high school science classes do not seem to affect the level of agreement with dissenter messages. These results represent the simplest depiction of the data collected. Results provide evidence that agreement with dissenter messages may also be associated with dissent. The multivariate logistic regression models in the next few sections provide more evidence of this association.

4.4 Results: Hypothesis Two, Dissenter knowledge vs. Political Affiliation

The knowledge deficit theory is often used to describe why portions of the public fail to accept the reality of anthropogenic climate change. The theory states that individuals who fail to accept a scientific concept do so because they lack an understanding of said concept. However, a large portion of the science communication community dismisses this theory. A critique of their work can be found in the theoretical framework section of this manuscript (section 3.11).

Model two in section 3.2.6.2 was developed to address the knowledge vs. ideology arguments above. In this model, agreement with dissenter knowledge and political ideology are set as the independent variables against the dependent variable of anthropogenic climate change belief. Initially all factor scores were included and a reverse step-wise process was employed. All the items left in model two have a p-value of <0.05 (table 11).

This model demonstrates that political ideology is the strongest predictor of dissent when compared to the other items in the model. Imagine a scenario where two individuals answered yes to the same number of items for each factor, but one individual chose a liberal ideology while the other identified as conservative. This model predicts that the individual who chose the conservative ideology would be ~70% more likely to be a dissenter. This probability is calculated by raising exponent via the beta value, then dividing this value by one plus that result. Note, the other items on this list have more than one division. The coefficients represent increased chances of dissent based on answering one more item yes in that category. More divisions exist in the dissenter message categories than the conservative/liberal category. The probability of dissent will be higher for a liberal who answers yes to many dissenter messages vs. a conservative who only answered yes to a few items. Agreement with cycle messages are the
strongest predictor of dissent among the dissenter message categories for this model. This is followed by nature and anti-science messages. As in the other models, agreement with sophisticated messages predict acceptance of anthropogenic climate change.

Table 11: Multivariate logistic regression model with dissenter message agreement by factor and political ideology. Beta values are expressed in the right column.

<table>
<thead>
<tr>
<th>Dependent Variable: Rejection of the reality of anthropogenic climate change</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti- science</td>
<td>0.145***</td>
</tr>
<tr>
<td>[0.036]</td>
<td></td>
</tr>
<tr>
<td>Sophisticated</td>
<td>-0.213***</td>
</tr>
<tr>
<td>[0.072]</td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td>0.382***</td>
</tr>
<tr>
<td>[0.114]</td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>0.569***</td>
</tr>
<tr>
<td>[0.14]</td>
<td></td>
</tr>
<tr>
<td>Political Ideology</td>
<td>0.872***</td>
</tr>
<tr>
<td>[0.316]</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-3.878***</td>
</tr>
<tr>
<td>[0.293]</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>687</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-178.293</td>
</tr>
<tr>
<td>Akaike Inf. Crit.</td>
<td>368.586</td>
</tr>
</tbody>
</table>

*Note:* p<0.1; **p<0.05; ***p<0.01
Standard errors in parentheses
Ideology, 0=Liberal

4.4.1 Discussion: Hypothesis Two, dissenter Knowledge vs. Political Affiliation. The results of table 11 indicate that political ideology is a better predictor for dissent than agreement with dissenter messages. We thus reject my second hypothesis. However, unlike the model depicted in table 9, agreement with dissenter messages remains a significant component of the model when compared to political ideology. These results indicate that dissenter knowledge is an important component of anthropogenic climate change acceptance. If this was not the case, it would have put science educators into an awkward position for it is not their mission to change the values of students. Because dissenter knowledge is a component of anthropogenic climate change rejection, educators can be a part of increasing acceptance.

4.4.2 Conclusions: Hypothesis Two, Dissenter Knowledge vs. Political Affiliation. Demonstrating the importance of political ideology as a predictor for dissent will require a
modification to the theoretical framework of my future work. We plan on incorporating social learning theory into the knowledge deficit theory. The social learning theory states that one way individuals make decisions is by mimicking those they hold in high regard (Bandura, 2001). The results of table 10 indicate that an individual’s trusted source of news may affect their level of belief. Section 4.7 of this manuscript will further probe the relationship of preferred news source and anthropogenic climate change acceptance.

4.5 Results: Research Question One, Strongest Dissenter Message Category

The results provided in section 4.4 establish that dissenter message agreement plays a role in an individual’s anthropogenic climate change acceptance. Science educators and communicators will likely want to know what messages are most likely to sway an individual’s anthropogenic climate change belief. This knowledge would also be useful to those developing science education standards. Educators teaching climate change only spend one to two hours a year on the topic (Plutzer et al., 2016). With such short time devoted to the topic, it would be useful to know what messages should be refuted. The results of this section answer our first research question:

R1: What class of dissenter message is the most correlated with climate change dissent?

Table 12 shows the results of model 1 of section 3.2.6.1. In table 11, a backwards stepwise process was employed. The items retained in this model all had a p-value of <0.05. The item with the highest coefficient value are the cycle messages, followed by nature messages, and anti-science messages. The value of these coefficients represent increasing chances of dissent for each item agreed with in that category. Thus, agreeing with one more cycle message, with everything remaining the same, is the biggest predictor of dissent for this model. The negative coefficient of the sophisticated scientific messages indicates that agreement with these messages increases anthropogenic climate change acceptance. The reason for these results are discussed in the next section (4.5.1).
Table 12: Multivariate logistic regression comparing dissent messages. Beta values are expressed in the right column.

<table>
<thead>
<tr>
<th>Dependent Variable: Rejection of the reality of anthropogenic climate change</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-science</td>
<td>0.180***</td>
</tr>
<tr>
<td>(0.034)</td>
<td></td>
</tr>
<tr>
<td>Sophisticated</td>
<td>-0.230***</td>
</tr>
<tr>
<td>(0.072)</td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td>0.366***</td>
</tr>
<tr>
<td>(0.112)</td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>0.606***</td>
</tr>
<tr>
<td>(0.141)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-3.587***</td>
</tr>
<tr>
<td>(0.253)</td>
<td></td>
</tr>
</tbody>
</table>

Observations 692
Log Likelihood -183.233
Akaike Inf. Crit. 376.466

Note: *p<0.1; **p<0.05; ***p<0.01
Standard errors in parentheses

4.5.1 Discussion: Research Question One, Strongest Dissenter Message Category.

The results in table 12 do not include two of the types of dissenter message categories identified in the instrument development portion of this study. Surprisingly, naïve statements are not a significant predictor of anthropogenic climate change dissent in this population. It would be reasonable to surmise that individuals who agree with the most basic of misinformation would also be those to reject a well-established scientific theory. However, naïve statements were not a predictor of dissent for this population, and this factor was removed during stepwise analysis. It may be that Americans do have a basic understanding of the theory of anthropogenic climate change. Thus, these statements are not agreed with even among dissenters. The second category of dissenter messages not present in table 12 are those that claim a beneficial outcome of climate change. These types of message were found as early as the 1990s by McCright and Dunlap (2000), and were expected to be a predictor in this study. These items may have fallen out of favor among Americans due the national attention given to climate related disasters such as Hurricane Sandy, Katrina, and the droughts in southern California.

The weakest category of dissenter messages included within the final model includes the sophisticated scientific messages (e.g., “the recent rapid warming of Earth’s climate is caused by a change in Earth’s tilt,” and “the release of carbon dioxide from volcanoes is responsible for the recent warming of Earth’s oceans.”). Unlike the other categories, increasing agreement with
these messages predicts anthropogenic climate change acceptance. We expected that sophisticated messages would be more appealing to dissenters with a higher order understanding of the theory of anthropogenic climate change. It was originally thought that these individuals would reject naive messages, but agree more with ‘science-y sounding’ items. The results we see in table 12 are likely the result of higher order scientific thinkers. However, their understanding may go beyond dissention. In other words, the individuals who are likely to agree with sophisticated scientific messages are the individuals who have already made up their mind that anthropogenic climate change is a reality.

Agreement with anti-science messages (e.g., “climate scientists made up the concept of climate change to receive grant money for research,” “climate scientists change their data to get the results they want, not the results the data produces.”) predicts dissent within the study population. These messages cast doubt that scientists are honest, or asserts that climate science is a political tactic developed by Democrats. It is difficult for anyone to believe someone who they distrust. The tactic of questioning the integrity of scientists and scientific organizations was found in Boussalis and Coan (2016) and McCright and Dunlap’s (2000) analysis of dissenter messages. The predictive power of these messages and political ideology may go hand in hand. Distrust of the scientific community among Republicans has been growing over the last 40 years (Gauchat, 2012).

Nature messages (e.g., “the Earth produces more carbon dioxide than mankind,” an “natural Earth processes keep our climate from changing.”) and Cycle messages (e.g., “Earth’s climate may not be warming, but instead headed into another ice age,” “The recent warming of earth’s atmosphere and oceans is a result of natural climate cycles, and our earth is headed into an ice age.”) are both significant predictors of dissent. These types of arguments may be appealing because of how generic they are. These messages require no understanding of the theory of anthropogenic climate change to interpret or assert. The idea that everything is normal and okay with the climate is likely an appealing concept to most Americans who dissent. Cycle arguments were not found in McCright and Dunlap’s (2000) analysis of dissenter websites in the 1990s, but have been identified in Boussalis and Coan’s (2016) update to McCright and Dunlap’s (2000) original study. The cycle and nature arguments may be the latest trend in organized dissention, and examples are highlighted in Boussalis and Coan’s (2016, p. 93) research. Cycle
messages also made up a large portion of the anti-anthropogenic climate change talking points found during the instrument development portion of this study (A. P. K. Bentley et al., 2016).

4.5.2 Conclusions: Research Question One, Strongest Dissenter Message Category.
The results presented in this section are useful to science educators who have a limited amount of time to teach anthropogenic climate change. Agreement with messages that assert recent warming is part of a natural cycle is the strongest predictor of overall dissent. To maximize their effectiveness at increasing belief educators should focus their efforts on dispelling this misinformation. Another component of increasing anthropogenic climate change acceptance would be to increase students’ trust of scientists and the scientific community. My recommendation is to spend time teaching students the nature of science to increase scientific trust. This tactic may already be in use by many science educators. When asked what strategies Colorado public school Earth Science teachers used when teaching about the controversial topic of global warming, 87% said they stressed the nature of science (Wise, 2010).

4.6 Results: Research Question Two, Variances in Dissent Among Different Populations

The results of section 4.5 provide a generic tactic for science educators to increase students’ belief in climate change, or to possibly inoculate them from misinformation in the future. However, differences in dissenter predictors may exist between segments of the population. Understanding these differences may be useful to science educators building targeted educational materials. Research question two was offered to address this possible need:

**R2:** Are the predictors for dissent similar or dissimilar for various groups of individuals as broken down by demographics: political affiliation, age, gender?

To answer this research question model one was run for demographic subsets of the participant population (table 13).
Table 13: Multivariate logistic regression models of population subgroups (gender, age, political ideology). Values are expressed as beta.

<table>
<thead>
<tr>
<th>Dependent Variable: Rejection of the reality of anthropogenic climate change</th>
<th>Men</th>
<th>Women</th>
<th>Age (&lt;40)</th>
<th>Age (&gt;40)</th>
<th>Liberal</th>
<th>Conservative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naïve</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.453***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anti- science</td>
<td>0.229***</td>
<td>0.164***</td>
<td>0.194***</td>
<td>0.114*</td>
<td>0.190**</td>
<td>0.137***</td>
</tr>
<tr>
<td></td>
<td>(0.397)</td>
<td>(0.043)</td>
<td>(0.049)</td>
<td>(0.058)</td>
<td>(0.081)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Sophisticated</td>
<td>-</td>
<td>-0.348***</td>
<td>-0.323***</td>
<td>-</td>
<td>-0.333**</td>
<td>-0.206***</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.101)</td>
<td>-</td>
<td>(0.167)</td>
<td>(0.079)</td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td>-</td>
<td>0.655***</td>
<td>0.416***</td>
<td>0.396**</td>
<td>0.474**</td>
<td>0.319**</td>
</tr>
<tr>
<td></td>
<td>(0.163)</td>
<td>(0.157)</td>
<td>-</td>
<td>(0.217)</td>
<td>(0.133)</td>
<td></td>
</tr>
<tr>
<td>Cycle</td>
<td>0.640***</td>
<td>0.465**</td>
<td>0.396**</td>
<td>0.748***</td>
<td>0.822***</td>
<td>0.481***</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.201)</td>
<td>(0.180)</td>
<td>(0.217)</td>
<td>(0.299)</td>
<td>(0.158)</td>
</tr>
<tr>
<td></td>
<td>(0.397)</td>
<td>(0.327)</td>
<td>(0.296)</td>
<td>(0.464)</td>
<td>(0.432)</td>
<td>(0.343)</td>
</tr>
<tr>
<td>Observations</td>
<td>284</td>
<td>403</td>
<td>406</td>
<td>300</td>
<td>430</td>
<td>257</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-73.301</td>
<td>-104.536</td>
<td>-116.263</td>
<td>-58.343</td>
<td>-60.535</td>
<td>-115.394</td>
</tr>
</tbody>
</table>

*Note:* p<0.1; **p<0.05; ***p<0.01

Standard errors in parentheses
4.6.1 Discussion: Research Question Two, Variances in Dissent Among Different Populations. The nature of multivariate logistic regression does not allow for the comparison of coefficient values between models. However, the presence or absence of an item within each group and the relative strength of coefficients within each model can provide important information. For instance, the largest difference between the paired groups above is between younger (<40 years old) and older Americans (>40 years old).

Apart from naïve messages being a predictor or dissent for older Americans, the same dissenter message categories are absent in these models for these groups as in section 4.5. As stated before, beneficial messages are likely not strong predictors because of the widespread news coverage of the negative effects of anthropogenic climate change. Naïve messages are likely not strong predictors for dissent for most groups because they can be easily identified as false or misleading.

Agreement with naïve messages is a predictor of dissent for older Americans. One reason for this may be that when compared to younger Americans, older Americans are less likely to have had a science class containing climate change content. Older Americans are also more likely to be conservative and therefore watch conservative television containing more dissenter messages of this type. Unknown at present is the reason(s) why sophisticated and nature messages are not a predictor of dissent for older Americans, but are for younger Americans. Nature messages are a particularly strong predictor of dissent among younger Americans in this study.

Predictors for dissent among men and women in this study are strikingly different. Agreement with cycle messages is a strong predictor for both groups, just as we saw for the whole population in section 4.5. Agreement with sophisticated messages is a predictor of anthropogenic climate change acceptance among women and may be for the same reasons brought up in section 4.5.1. Individuals who are likely to agree with “science-sounding” items are likely to be pro-science and thus agree with the scientific consensus that anthropogenic climate change is a reality. Like for young Americans, agreement with messages in the nature category is a strong predictor for dissent among women; at present, there are no explanations for this relationship in the literature.
The messages that predict dissent among conservative and liberal participants are similar. Both subgroups exhibit the same ratio of coefficients as the model containing the total population in section 4.5 except for cycle messages, which are a stronger predictor of dissent among liberals. The predictive strength of cycle arguments among conservatives is still higher than the other messages. Overall the coefficient values for conservatives are lower than for liberals. Likely the predictive power of dissenter message agreement is lower for conservatives because ideology is playing a large role in their choice to dissent.

The reoccurring theme among these is the ability for cycle messages to predict dissent. As discussed in section 4.5.1 cycle messages require no understanding of the theory of anthropogenic climate change to interpret or assert. The idea that everything is normal and okay with the climate is likely an appealing concept to most Americans who dissent. These types of messages were not found in McCright and Dunlap’s (2000) analysis of conservative think tank webpages during the 1990s, but were found in a more recent analysis of these same groups ((Boussalis & Coan, 2016). Cycle messages were found in abundance during an analysis of dissenter videos hosted on YouTube (A. P. K. Bentley et al., 2016).

4.6.2 Conclusions: Research Question Two, Variances in Dissent Among Different Populations. The answer to research question two is a definite yes; different segments of the population agree differently with dissenter messages. Furthermore, the predictive power of message categories does vary among groups. However, except for younger Americans, agreement with cycle messages make for the best predictor of dissent. My recommendation for climate change education for subgroups is the same as the recommendation made for the whole population (section 4.5.2). Educators and science communicators should focus their efforts on dispelling the misconception that recent warming is simply part of a larger cycle.

4.7 Results: Research Question Three, Primary News vs. Political Ideology vs. Dissenter Knowledge

The theoretical framework for this research, the knowledge deficit theory, is discussed in section 3.1.1 of this manuscript. This theory asserts that individuals who do not accept a scientific concept do so because they do not understand the topic well enough. The results of section 4.4 of this manuscript indicate that agreement with dissenter messages are likely not the
main contributor to belief. Political ideology was a far stronger predictor for dissent than agreement with any of the message category. However, these messages were still a strong predictor, and had low enough p-values (<0.05) to remain in the final model. This indicates that agreement with dissenter knowledge and political ideology both play a role in predicting dissent.

Model three (section 2.3.6.3) was developed to examine this relationship further. Feldman et al. (2012) conducted an analysis CNN, MSNBC and Fox cable news coverage of climate change. The purpose of their work was to establish the frequency of skepticism presented on these networks. They found that when compared to CNN and MSNBC Fox was far more likely host skeptical scientists and present skeptical messages. Feldman et al. (2012) took this one step further and surveyed viewers of these networks. Feldman et al. (2012) found through multivariate logistic regression that viewing Fox news was a strong predictor or skeptical attitudes towards science. The opposite was found for CNN and MSNBC viewers.

Model three included primary news source, political ideology, and agreement with dissenter message categories. Items on the ACCDI were not divided into individual message categories for this model to focus on the research question at hand. Item agreement here represents the increased chance of dissent with increased yes responses across the instrument. The results presented here demonstrate that an individual’s primary news source is a better predictor than their political ideology or agreement with dissenter messages (table 14).

Table 14: Multivariate logistic regression models comparing political ideology, dissenter message agreement, and primary news source. Values are expressed as beta.

<table>
<thead>
<tr>
<th>Dependent Variable: Rejection of the reality of anthropogenic climate change</th>
<th>Model w/ ideology</th>
<th>Model w/o ideology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary News Source</td>
<td>1.104*** (0.424)</td>
<td>1.226*** (0.404)</td>
</tr>
<tr>
<td>Item Agreement</td>
<td>0.108*** (0.016)</td>
<td>0.113*** (0.016)</td>
</tr>
<tr>
<td>Political Ideology</td>
<td>0.464 (0.496)</td>
<td>-</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.996*** (0.522)</td>
<td>-3.827*** (0.469)</td>
</tr>
<tr>
<td>Observations</td>
<td>248</td>
<td>249</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-87.175</td>
<td>-87.637</td>
</tr>
<tr>
<td>Akaike Inf.Crit.</td>
<td>182.350</td>
<td>181.274</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01
Standard errors in parentheses
4.7.1 Discussion: Research Question Three, Primary News vs. Political Ideology vs. Dissenter Knowledge. The results of table 14 demonstrate that an individual’s primary news source is the best predictor for dissent when compared to ideology and dissenter message agreement. A model with all three independent variables results in a high p-value the resulting for political ideology (p=0.35). Political ideology being removed from the model results in a more accurate understanding of the relationship between dissenter message agreement, primary news source, and anthropogenic climate change acceptance (based on log likelihood and p-values).

An individual’s primary news source is more influential in shaping their anthropogenic climate change views than their political ideology. This makes sense for two reasons. First, it is unlikely that someone would reject the theory of anthropogenic climate change without the knowledge that your group (in this case political party) rejects the theory. In other words, it is unlikely that you would know your group rejects anthropogenic climate change without watching conservative television. Second, the results of Feldman et al. (2012) align with the results above. Feldman et al. (2012) found liberals and conservatives who watched Fox news often were more likely reject anthropogenic climate change than those who only seldom chose the network. The opposite was found for CNN. Increased viewing of CNN was associated with higher acceptance of anthropogenic climate change for both liberals and conservatives. Feldman et al. (2012) argue that “direct persuasion” (p. 23) is likely causing the climate views in their population. We would argue that this persuasion probably contains a fair amount of dissenter messages in this study and may be why agreement with dissenter messages remains in the models in table 14.

4.7.2 Conclusions: Research Question Three, Primary News vs. Political Ideology vs. Dissenter Knowledge. The results of this section signify that trusted news source has the greatest effect on an individual’s anthropogenic climate change acceptance when compared to ideology or agreement with various dissenter messages. To increase anthropogenic climate change acceptance, it may be useful for educators to spend time teaching students how to evaluate the trustworthiness of information. Spending time discussing the disconnect between the scientific community and the public may be a way to inoculate students from misinformation. It
may be useful to pair the results of Feldman et al. (2012) with classroom discussions on the societal impacts of anthropogenic climate change policy.
5. SYNTHESIS AND CONCLUSIONS

Science educators often believe that individuals with an accurate understanding of anthropogenic climate change will accept the reality of anthropogenic climate change. Increasing acceptance would then revolve around providing accurate knowledge and dispelling misconceptions. Unlike most scientific topics, anthropogenic climate change is a socioscientific issue with vested groups on both sides of associated policy. There are many environmental and science groups (e.g., Sierra Club, Union of Concerned Scientists) pushing policy makers to write laws limited carbon emissions. On the other side of this divide are carbon emitters (i.e. fossil fuel companies) who do not want such policies written into law. As seen in sections 2.1 through 2.3 these organizations fund groups that attempt to spread misinformation about climate change. The actions of these groups work against the efforts of science educators.

The overarching question guiding this dissertation is whether this misinformation matters when individuals are deciding to accept or reject anthropogenic climate change. As seen in section 4, belief in misinformation is a predictor of dissent. Results indicate that inoculating students from this misinformation will likely increase their level of belief. However, the results in section 4 also indicate that belief in dissenter messages is not the strongest predictor for dissent. Political affiliation and chosen primary news source are stronger predictors for dissent when compared to agreement with dissenter messages. This puts science educators in an awkward position. Educators need to incorporate non-scientific topics into their curriculum to increase anthropogenic climate change acceptance.

5.1 Reflections on the Strengths and Weaknesses of the Theoretical Framework

The results of this study require a reflection on the chosen theoretical framework. The knowledge deficit theory states that the reasons an individual rejects a scientific topic is because they fail to understand the topic. Thus, increasing understanding will lead to increased levels of belief. This theory underpins most science educators’ work. After all, the job of a science educator is to teach students science. The results of this study demonstrate that more goes into an individual’s decision to accept a scientific theory than simply their understanding of the theory.
To strengthen the lens of this research it will be vital to modify the theoretical framework for future iterations of this study. Social learning theory states that individuals can obtain new information or behaviors through a process called observational learning (Bandura, 1971). The following account of observational learning comes from Bandura’s 1971 work. Observational learning occurs when someone models an action or belief held by someone they are observing and consists of four components. The first component in attention. For observational learning to work an individual’s attention must be obtained and held. An individual is going to prioritize attention towards their primary news source. Sources of information that are not valued by an individual are not given attention, and thus observational learning cannot occur. Here we can already see why an individual’s primary new source would influence their climate change beliefs.

The second component to observational learning is retention. An individual must have the cognitive ability to retain the information provided to them. For instance, in this study simple arguments countering climate change were strong predictors of dissent. It requires little cognitive stress to remember and model the idea that climate change is simply part of a large cycle. This argument is not only easy to learn and obtain, but allows one to remove blame from oneself when reflecting climate change.

The third component of observational learning is action or reproduction. For the case of learning about climate change, the action here would be to either accept or reject anthropogenic climate change. Action or reproduction for this example can be expressed through voting habits and personal actions concerning carbon related activities (e.g., purchasing habits, transportation, energy saving or wasting actions at home, etc.).

The final component of observational learning deals with motivation. An action or behavior is going to be reproduced only if the outcomes are favorable for the individual. Bandura (1971) states that consequences are internalized and come from external forces. These are both heavily influenced via social means. To continue our example, decisions an individual makes concerning anthropogenic climate change are controlled by their social group. If an action, in this case rejection of climate change, is viewed as correct or honored by your group then you will make that action. For Bandura (1971) it is not necessary for the motivator to be external, because
individuals can anticipate what their peers would say or think about their actions. In other words, individuals can self-regulate their behavior based on what they know about others beliefs.

The theoretical lens of future administrations of the ACCDI will combine the knowledge deficit theory and social learning theory. The results presented in section 4 indicate that agreement with dissenter knowledge, political ideology, and information source all play a role in shaping an individual’s acceptance or rejection of anthropogenic climate change. Changes to study design(s) under the new theoretical framework would include targeted distributions of the ACCDI. Differences in political ideology are significant enough that populations should be examined in isolation. In other words, when examining the results of future distributions of the instrument, subgroups should be analyzed separate from one another (e.g., republicans vs. democrats; FOX news viewers vs. CNN viewers). By examining these populations in isolation, our efforts could focus more on the aspects of the ACCDI most important to science educators (agreeing with misleading information).

5.2 Inoculating Students from ‘Recent Warming is a Cycle’ and Other Dissenter Messages

The most powerful predictors of dissent among the dissenter messages are the cycle messages. These messages assert that the recent warming of Earth’s atmosphere and oceans are a result of natural climate cycles. These messages paired with the natural messages highlight an attraction to a “wait and see approach” to dealing with changing climate. As mentioned in section 5.1, these messages require little to no knowledge of the theory of anthropogenic climate change to interpret and pass on. The ease at which these messages can be remembered and passed on may be key to their widespread acceptance. At the surface these messages also seem reasonable. A large portion of the population likely know that many Earth processes occur as cycles (e.g., seasons, water, rock, sun, weather, etc.). It would be reasonable to think that Earth’s climate is one of the many cycles already occurring on Earth. Superficial examinations of Earth’s climate over the last 450,000 years also lead to this conclusion. At this scale, the ice age cycles (largely controlled by Milankovitch cycles) make it seem like we are simply part of an interglacial period. Graphs such as these are often shown in dissenter videos (A. Bentley et al., 2014).
Presenting students the dissenter messages along with accurate instruction may be the key to inoculating students. McCuin, Hayhoe, and Hayhoe (2014), guided by conceptual change theory, tested the effectiveness of presenting misconceptions on the greenhouse effect alongside accurate information. These researchers developed two separate activates designed to teach two groups of students the greenhouse effect. One activity was a traditional reading-based instruction and the other was a misconception reading-based instruction. Both methods were significantly effective at increasing students’ understanding of the greenhouse effect. However, students given the misconception reading-based instruction retained more knowledge for longer in the delayed post-test.

For McCuin et al. (2014) cognitive dissonance was the key for dispelling misconceptions. This method may also be useful when attempting to combat dissenter messages. Instruction would demonstrate that dissenter messages are incompatible with the sound scientific information. For instance, students could be introduced to the ice age cycle chart and informed that many people think that warming today is simply part of this cycle. Then the instructor could demonstrate (or guide students through) an activity that shows the rate we see warming today is unlike anything we have seen in the past 450,000 years.

5.3 Climate and Society

The results of this dissertation make clear that effective anthropogenic climate change education will likely require teaching students more than just the science behind the phenomenon. Originally we thought that belief in contrarian information was the catalyst for dissent. However, strong predictors of dissent include individuals’ primary news source, political ideology, and belief in dissenter messages. These three factors are likely intertwined and thus should be addressed in the classroom.

Anthropogenic climate change and evolution are two of many socioscientific issues in the public sphere today. Those who argue against evolution often do so based on its contradiction of creation stories, such as those found in Genesis. Those who do not believe in evolution are often up front for their reason to reject the theory. Unlike evolution, anthropogenic climate change rejection is accompanied with scientific misinformation. This misinformation either provides
non-anthropogenic causes for warming or attacks the credibility of climate science. In other words, anthropogenic climate change dissenters attempt to use science to reject science.

When building this dissertation, it was through that belief in these messages was the reason people rejected the theory of anthropogenic climate change. However, as demonstrated in sections 4.4 and 4.7, primary news source and political ideology are strongly associated with dissent. Thus, we recommend that these results should be taken into consideration when teaching students anthropogenic climate change. Without understanding why individuals’ trusted sources of information are telling them inaccurate information, students may find themselves unsure of who to trust.

When building a climate change curriculum, we would start with the history of science of anthropogenic climate change. It may be helpful to students to know that even scientists need to be convinced with evidence and do not simply agree with whatever their peers believe. Weart (2011) provides a short but effective overview of this history. This includes crediting Swedish physical chemist Svante Arrhenius as the first to predict the results of an atmosphere with increased amount of carbon dioxide in 1896. Students may be surprised to know that the majority of the scientific community at the time rejected this idea on the grounds that the abundance of carbon dioxide and water vapor currently in the atmosphere were already blocking all the infrared radiation (Weart, 2011). Weart (2011) states that scientists at the time believed in the ‘balance of nature,’ e.g., “The vast climate system of atmosphere, ocean, rock, and ice was self-regulating, maintaining its temperature and chemical composition over millennia. This grand equilibrium seemed far beyond anything mere humans could affect” (Weart, 2011, p. 42). This concept was widely held among meteorologists though the 1970s (Weart, 2011). It was not until after a series of conferences and collective scientific efforts that scientists began to agree upon anthropogenic climate change in the late 1980s (Weart, 2011). This time period was also marked with severe droughts, providing concerned scientists with a phenomenon to engage the public. A concerned public, paired with potential policy changes regarding anthropogenic climate change, marks the start of the anti- anthropogenic climate change movement and organized climate denial (Weart, 2011). As the students learn about the theory they should be reminded that they are obtaining the same knowledge that convinced the scientific community of the reality of climate change.
Once students understand that the science of anthropogenic climate change is a human endeavor, it would likely be useful to understand why groups or individuals would reject the theory. Climate change policies would change the direction of energy production in the United States from fossil fuels to renewables such as wind, solar, geothermal, and tidal. This means that large powerful companies stand to lose a lot if they are slow to adapt. These companies provide large sums of money to conservative think tanks who attempt to either spread scientific misinformation, promote contrarian scientists, or attack climate policies (Boussalis & Coan, 2016; Cann, 2015; McCright & Dunlap, 2000). These organizations are often driven by a free-market ideology which stands counter to climate policies. Brulle (2013) and McCright and Dunlap (2011) both provide details descriptions of the motives behind organized climate change dissention. Students could possibly come to terms with why their trusted sources of information and leaders and spreading misinformation. This may simultaneously help students understand where to identify accurate scientific information.

The theory of anthropogenic climate change is likely to remain a contested science in the public sphere for years to come. During the writing of this dissertation, the current administration has removed mention of climate change from the White House, Environmental Protection Agency, and National Park Service websites. Many scientists have been frantically attempting to download government data in fear that it may be purged. These actions have encouraged conservative think tank organizations such as the Heartland institute who recently sent out 20,000 copies of a propaganda piece titled, “Why Scientists Disagree About Global Warming” (Worth, 2017). These actions do not make the job of science educator easy. However, developing education initiatives based on the work presented here, and by others, may hold the key to a more climate literate society.
REFERENCES


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APPENDICES

A: HTML Version of the ACCDI

<!-- Bootstrap v3.0.3 --><link href="https://s3.amazonaws.com/mturk-public/bs30/css/bootstrap.min.css" rel="stylesheet" />
<section class="container id="Survey" style="margin-bottom:15px; padding: 10px 10px; font-family: Verdana, Geneva, sans-serif; color:#333333; font-size:1.0em;">
<div class="row col-xs-12 col-md-12"><!-- Instructions --></div>
<div class="panel panel-primary">
<div class="panel-heading"><strong>Instructions</strong></div>
<div class="panel-body"><paragraph> Please read this consent information before you begin the survey.<br /></paragraph>
<br />
You are invited to participate in a research project entitled &quot;Anthropogenic climate change message inventory: Instrument validation&quot; designed to develop an instrument that can be used to better understand individuals' agreement with or dismissal of particular climate change messages. The study is being conducted by Dr. Heather Petcovic and Mr. Andrew Bentley from The Mallinson Institute for Science Education at Western Michigan University. This research is being conducted as part of the dissertation requirements for Andrew Bentley.<br />

This survey is comprised of 50 Likert items and 14 demographic items, and will take approximately 20 minutes to complete. At the end, your Amazon Mechanical Turk account will be credited forty cents, $.40.<br />

Your replies will be completely anonymous. Please be aware that any work performed on Amazon MTurk can potentially be linked to information about you on your Amazon public profile page, depending on the settings you have for your Amazon profile. We will not be accessing any personally identifying information about you that you may have put on your Amazon public profile page. We will store your MTurk worker ID separately from the other information you provide to us.<br />

When you begin the survey, you are consenting to participate in the study. If you do not agree to participate in this research project simply exit now. If, after beginning the survey, you decide that you do not wish to continue, you may stop at any time. You may choose to not answer any question for any reason. If you have any questions prior to or during the study, you may contact Heather Petcovic at 269-387-5498, Andrew Bentley at 484-883-3052, The Mallinson Institute for Science Education at Western Michigan University, the Human Subjects Institutional Review Board (269-387-8293) or the vice president for research (269-387-8298).<br />

This study was approved by the Western Michigan University Human Subjects Institutional review Board (HSIRB) on { date }. Please do not participate in this study after (one year after approval).<br />

Participating in this survey online indicates your consent for use of the answers you supply. </paragraph></div>
<h3 class="panel-body">Please do not fill out this survey a second time.</h3>
</section>
The recent warming of Earth

climate change

are causing Earth

order to increase their revenue streams

statments?

How much do you agree or disagree with the following statements?

Strongly Dissagree

Dissagree

Slightly Dissagree

Slightly Agree

Agree

Strongly Agree

1. Climate scientists made up the concept of climate change in order to increase their revenue streams

2. The number reported of climate scientists that believe humans are causing Earth’s climate to change is inflated to convince more people to believe in climate change

3. A change in the energy output of the sun is responsible for the recent warming of Earth’s atmospheres

4. Natural Earth processes keep Earth’s current climate stable

5. Artic sea ice is not currently shrinking in volume
Humans result of natural climate cycles, and our climate is headed into an ice age when presented with new scientific evidence by climate scientists who do believe in climate change.

Global warming is happening, but cannot make their beliefs public because they would be ridiculed by climate scientists who do believe in climate change.

6. A large number of climate scientists do not believe that global warming is happening, but cannot make their beliefs public because they would be ridiculed by climate scientists who do believe in climate change.

7. Climate change science is not a science, it is a political propaganda.

8. Climate scientists do not change their mind on climate change when presented with new scientific evidence.

9. The recent warming of earth’s atmospheres and oceans is a result of natural climate cycles, and our climate is headed into an ice age.

10. Every year mother nature produces more carbon dioxide than humans.

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94
How much do you agree or disagree with the following statements?

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<th>Earth's overall temperature has nothing to do with the level of carbon dioxide in the atmosphere</th>
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<th>The release of carbon dioxide from volcanoes is responsible for the recent warming of Earth's oceans</th>
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<th>Earth's climate may not be currently warming, but instead be headed into another ice age</th>
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How much do you agree or disagree with the following statements?

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<th>Strongly Dissagree</th>
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<td>Climate scientists made up the concept of climate change to order to make money from environmental companies</td>
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<td>Natural Earth processes will keep our climate from changing</td>
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<td>A warmer Earth would be better for mankind than the current average temperature</td>
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<td>Climate change is fabricated by the media so they can increase their viewer ratings</td>
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20. Climate change is fabricated by the media so they can increase their viewer ratings.
How much do you agree or disagree with the following statements?

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<th>Slightly Agree</th>
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<td>21. The recent warming of Earth's climate is caused by a change in Earth's tilt</td>
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<td>24. Radiation from distant supernova events control Earth's current climate</td>
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<td>25. Carbon dioxide is natural, so we should not worry about how much is in the atmosphere</td>
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How much do you agree or disagree with the following statements?

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<thead>
<tr>
<th>S1. Overall, I trust climate scientists</th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S2. Changes in Earth's tilt or orbit are responsible for the recent warming of Earth's atmosphere</th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S3. Meteorologists cannot accurately predict the weather more than few days in advance, thus it is impossible to accurately predict Earth's climate years into the future</th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S4. The Earth currently produces more carbon dioxide than mankind</th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S5. A change in the energy output of the sun is responsible for the recent warming of Earth's oceans</th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
How much do you agree or disagree with the following statements?

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Dissagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;1&quot; /&gt;</td>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;2&quot; /&gt;</td>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;3&quot; /&gt;</td>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;4&quot; /&gt;</td>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;5&quot; /&gt;</td>
<td>&lt;input name=&quot;47&quot; type=&quot;radio&quot; value=&quot;6&quot; /&gt;</td>
</tr>
</tbody>
</table>

The increased level of carbon dioxide in the atmosphere we see today is the RESULT of changes in Earth's climate and not the other way around.

The location of Earth's continents is driving Earth's recent warming.

Climate scientists who do not believe in human caused climate change cannot speak out because disagreeing with the majority could cost them their jobs.

The recent warming of Earth's atmospheres and oceans is only a result of natural climate cycles.

Climate change test select strongly agree.
How much do you agree or disagree with the following statements?

- Strongly Dissagree
- Dissagree
- Slightly Dissagree
- Slightly Agree
- Agree
- Strongly Agree

36. Climate scientists remove collected data from their models in order to make the graphs look the way they want.

37. The upper layers of Earth’s atmosphere are not currently warming.

38. The winter of 2014, one of the coldest in decades in the northeastern United States, proves that Earth is not getting warmer.

39. Climate scientists made up the concept of climate change to receive grant money for research.

40. Naturally occurring Earth cycles prevent mankind from being able to change Earth’s climate.
How much do you agree or disagree with the following statements?

<table>
<thead>
<tr>
<th></th>
<th>Strongly Dissagree</th>
<th>Dissagree</th>
<th>Slightly Dissagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65</td>
<td>64</td>
<td>63</td>
<td>62</td>
<td>61</td>
<td>Radio</td>
</tr>
<tr>
<td>2</td>
<td>64</td>
<td>63</td>
<td>62</td>
<td>61</td>
<td>60</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>63</td>
<td>62</td>
<td>61</td>
<td>60</td>
<td>59</td>
<td>Radio</td>
</tr>
<tr>
<td>4</td>
<td>62</td>
<td>61</td>
<td>60</td>
<td>59</td>
<td>58</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>61</td>
<td>60</td>
<td>59</td>
<td>58</td>
<td>57</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Climate change is designed to convince people to vote democrat.

Climate scientists made up the concept of climate change to order to make money from alternative energy companies.

Climate scientists change their data to get the results they want, not the results the data produces.

Radiation from supernova events is responsible for the recent warming of Earth's atmosphere.

The level of carbon dioxide in Earth's atmosphere is not related to Earth's overall climate.
<table>
<thead>
<tr>
<th>How much do you agree or disagree with the following statements?</th>
</tr>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Agree</th>
<th>Slightly Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>46. Overall, I trust scientists</td>
<td><input name="S2" type="radio" value="1" /></td>
<td><input name="S2" type="radio" value="2" /></td>
<td><input name="S2" type="radio" value="3" /></td>
<td><input name="S2" type="radio" value="4" /></td>
<td><input name="S2" type="radio" value="5" /></td>
<td><input name="S2" type="radio" value="6" /></td>
</tr>
<tr>
<td>47. Climate models do not accurately depict Earth's climate through time</td>
<td><input name="72" type="radio" value="1" /></td>
<td><input name="72" type="radio" value="2" /></td>
<td><input name="72" type="radio" value="3" /></td>
<td><input name="72" type="radio" value="4" /></td>
<td><input name="72" type="radio" value="5" /></td>
<td><input name="72" type="radio" value="6" /></td>
</tr>
<tr>
<td>48. Climate scientists purposefully leave out past cooling events such as the Little Ice Age from their climate models in order to produce the results they want</td>
<td><input name="73" type="radio" value="1" /></td>
<td><input name="73" type="radio" value="2" /></td>
<td><input name="73" type="radio" value="3" /></td>
<td><input name="73" type="radio" value="4" /></td>
<td><input name="73" type="radio" value="5" /></td>
<td><input name="73" type="radio" value="6" /></td>
</tr>
</tbody>
</table>

<!-- Suplimentary questions -->

<!-- level of human involvement -->
<table>
<thead>
<tr>
<td>49. On the scale provided, please indicate the level of human involvement in Earth's changing climate.</td>
<td>Not human caused</td>
</tr>
</thead>
</table>
Demographic Questions here

<tr>
  <th>.............</th>
  <th>.............</th>
  <th>Human caused</th>
</tr>

</thead>
</tbody>

</table>

<!-- climate belief -->

<fieldset>
  <div class="input-group">
    <label>50. Do you believe that humans are driving the current warming of Earth's climate?</label>
  </div>

  <div class="radio">
    <input name="climatecause" type="radio" value="1" />
    No
  </div>
  <div class="radio">
    <input name="climatecause" type="radio" value="2" />
    Yes
  </div>
</fieldset>

<!-- End of the tables containing Likert items -->

<section> <!-- Demographic Questions here -->
  <h1>Demographic Questions</h1>
</section>

<fieldset>
  <label>1. What gender do you identify with?</label>

  <div class="radio">
    <input name="Gender" type="radio" value="1" />
    Male
  </div>
  <div class="radio">
    <input name="Gender" type="radio" value="2" />
    Female
  </div>
  <div class="radio">
    <input name="Gender" type="radio" value="3" />
    Other
  </div>
</fieldset>

<fieldset>
  <label>2. Are you Transgender?</label>

  <div class="radio">
    <input name="transgender" type="radio" value="1" />
    Yes
  </div>
  <div class="radio">
    <input name="transgender" type="radio" value="2" />
    No
  </div>
</fieldset>

<!-- Political Affiliation -->

<fieldset>
<div class="input-group"><label>3. What political party do you most often vote for?</label></div>

<fieldset><label><input name="Politics" type="radio" value="1" />Constitution Party</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="2" />Democrat</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="3" />Green Party</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="4" />Independent</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="5" />Libertarian</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="6" />Republican</label></fieldset>

<fieldset><label><input name="Politics" type="radio" value="7" />Other</label></fieldset>

<fieldset><label>4. How often do you attend religious services?</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="1" />Never</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="2" />Less than once a year</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="3" />Once or twice a year</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="4" />Several times a year</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="5" />Once a month</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="6" />2-3 times a month</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="7" />About weekly</label></fieldset>

<fieldset><label><input name="religious" type="radio" value="8" />Several times a week</label></fieldset>

<fieldset><label>5. In what year were you born?</label><input class="form-control" name="Age" size="10" type="text" /></fieldset>

<fieldset><label>6. What is your job title?</label><input class="form-control" name="job" size="20" type="text" /></fieldset>

<fieldset><label>7. What is the highest degree you have obtained?</label><input name="school" type="radio" value="1" />Some high school, but not degree</fieldset>
<!-- New questions for last round of survey -->

<!-- Race -->

<fieldset>
<div class="input-group"><label>10. Please choose the race that most identifies you.</label>
<div class="radio"><input name="race" type="radio" value="1" />Native or Pacific Islander</div>
<div class="radio"><input name="race" type="radio" value="2" />White non-Hispanic</div>
</fieldset>
On a scale of 0% to 100% to what degree do your friends and family hold the same climate change views as you?

- Strong Conservative
- Conservative
- Slightly Conservative
- Slightly Liberal
- Liberal
- Strong Liberal
- Do not wish to disclose
- Other

What is your zipcode?

Please choose your preferred news network:

- CNN
- ABC
- FOX
- MSNBC
- NPR
- BBC
- CBS
- Other
- Do not wish to disclose

On the scale provided, please indicate where your political beliefs lie.
<tbody>
  <tr>
    <td></td>
    <th><input name="conservativeliberal" type="radio" value="1" /></th>
    <th><input name="conservativeliberal" type="radio" value="2" /></th>
    <th><input name="conservativeliberal" type="radio" value="3" /></th>
    <th><input name="conservativeliberal" type="radio" value="4" /></th>
    <th><input name="conservativeliberal" type="radio" value="5" /></th>
    <th><input name="conservativeliberal" type="radio" value="6" /></th>
  </tr>
</tbody>
B: R Code for Analysis

---
title: "Bentley Dissertation R Code"
author: "Peter Eklund & Andrew Bentley"
date: "March, 7 2017"
output: word_document
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antiscience=Answer.14+Answer.49+Answer.61+Answer.11+Answer.29+Answer.04+Answer.31+Answer.56+Answer.03+Answer.63+Answer.59+Answer.26+Answer.73+Answer.64+Answer.13, sophisticated=Answer.20+Answer.44+Answer.48+Answer.30+Answer.68+Answer.36+Answer.07+Answer.33, nature=Answer.18+Answer.40+Answer.09+Answer.60+Answer.27, actuallygood=Answer.21+Answer.28+Answer.25, cycle=Answer.17+Answer.22+Answer.47+Answer.52, totalyes=naive+antiscience+sophisticated+nature+actuallygood+cycle, #Create factor scores. Simply divides the score of each factor by the total number of items for that factor. Now everyone has a % score for each factor naive=naive/9, antisciencef=antiscience/15, sophisticatedf=sophisticated/8, naturef=nature/5, actuallygoodf=actuallygood/3, cyclef=cycle/4, totalyesf=totalyes/44

modeleverything = glm(Answer.yesnobelief~Answer.27+Answer.57+Answer.19+Answer.71+Answer.10+Answer.72+Answer.58+Answer.34+Answer.60+Answer.32+Answer.52+Answer.37+Answer.14+Answer.49+Answer.61+Answer.11+Answer.29+Answer.04+Answer.31+Answer.56+Answer.03+Answer.63+Answer.59+Answer.26+Answer.73+Answer.64+Answer.13+Answer.20+Answer.44+Answer.48+Answer.30+Answer.68+Answer.36+Answer.07+Answer.33+Answer.18+Answer.40+Answer.09+Answer.21+Answer.28+Answer.25+Answer.17+Answer.22+Answer.47+Answer.51, data=data3, family="binomial")

summary(modeleverything)

exp(coef(modeleverything))

step(modeleverything)

modelsteppedeverything = glm(formula = Answer.yesnobelief ~ Answer.27 + Answer.57 + Answer.72 + Answer.60 + Answer.32 + Answer.52 + Answer.11 + Answer.31 + Answer.63 + Answer.64 + Answer.13 + Answer.68 + Answer.36 + Answer.28 + Answer.17 + Answer.22, family = "binomial", data = data3)

summary(modelsteppedeverything)

exp(coef(modelsteppedeverything))

```
```

```
```
```r
Basic models with dissonant knowledge terms
```

# Small Model all the factors without interaction terms. This makes things a little more black and white for educators. modelfractions is the name of an object. glm is the regression program.
modelfractionsallfactors = glm(Answer.yesnobelief~antisciencef+sophisticatedf+naturef+actuallygoodf+cyclef, data=data3, family="binomial")

summary(modelfractionsallfactors)

# This converts coefficients to odds ratio
exp(coef(modelfractionsallfactors))

# Small Model Without actuallygood. Actually good had a very high p value
modelfractionsnoactuallygood = glm(Answer.yesnobelief~antisciencef+sophisticatedf+naturef+cyclef, data=data3, family="binomial")

summary(modelfractionsnoactuallygood)

# This converts coefficients to odds ratio
exp(coef(modelfractionsnoactuallygood))

# Small Model Without actuallygood. Actually good had a very high p value

109
modelfractionsnaactuallygoodornaive = glm(Answer.yesnobelief~antisciencef+sophisticatedf+naturef+cyclef,data=data3, family="binomial")
summary(modelfractionsnaactuallygoodornaive)
#This converts coefficients to odds ratio
exp(coef(modelfractionsnaactuallygoodornaive))

#Unlike the above models. This doesn't use the model % score, it by agreement with individual items in each factor. Without actuallygood, Actually good had a very high p value
modelbyitem = glm(Answer.yesnobelief~antiscience+sophisticated+nature+cycle,data=data3, family="binomial")
summary(modelbyitem)
#This converts coefficients to odds ratio
exp(coef(modelbyitem))

#Unlike the above models, this lumps all the factors together.
modelunfactored = glm(Answer.yesnobelief~totalyes,data=data3, family="binomial")
summary(modelunfactored)
#This converts coefficients to odds ratio
exp(coef(modelunfactored))

..."r Gender"
#Models for gender Took out models that do not work (low p values)
databoyz=subset(data3,data3$Answer.Gender==1)
datagirlz=subset(data3,data3$Answer.Gender==2)
modelboyz = glm(Answer.yesnobelief-naive+antiscience+sophisticated+nature+cycle+actuallygood,data=databoyz, family="binomial")
modelboyz<-step(modelboyz)
summary(modelboyz)
#This converts coefficients to odds ratio
exp(coef(modelboyz))

#model of just men, with total yes as independent variable
modelboyzlump=glm(Answer.yesnobelief-totalyes,data=databoyz, family="binomial")
summary(modelboyzlump)
#This converts coefficients to odds ratio
exp(coef(modelboyzlump))

#model just for the girls
modelgirlz = glm(Answer.yesnobelief-naive+antiscience+sophisticated+nature+cycle+actuallygood,data=datagirlz, family="binomial")
modelgirlz<-step(modelgirlz)
summary(modelgirlz)
#This converts coefficients to odds ratio
exp(coef(modelgirlz))

#model of just women, with total yes as independent variable
modelgirlzlump=glm(Answer.yesnobelief-totalyes,data=datagirlz, family="binomial")
summary(modelgirlzlump)
#This converts coefficients to odds ratio
exp(coef(modelgirlzlump))

```r
# age old vs young
datayoung <- subset(data3, data3$Answer.Age >= 1977)
dataold <- subset(data3, data3$Answer.Age < 1977)

modelyoung <- glm(Answer.yesnobelief ~ naive + antiscience + sophisticated + nature + cycle + actuallygood, data = datayoung, family = "binomial")
summary(modelyoung)

#This converts coefficients to odds ratio
exp(coef(modelyoung))

modelold <- glm(Answer.yesnobelief ~ naive + antiscience + cycle, data = dataold, family = "binomial")
summary(modelold)

#This converts coefficients to odds ratio
exp(coef(modelold))
```

```
# politics vs dissenter agreement

# Overwrite part data3 via a function that dichotomizes the values for the likert question about political ideology. Originally it was low for conservative (<3) and high for liberal. The code below makes liberals a 0 and conservatives a 1. This makes is so I can easily compare false knowledge to ideology.
data3[,57] <- sapply(data3[,57], function(x) ifelse(x > 3, 0, 1))

# political ideology vs. agreement with dissenter messages
modelpolitics <- glm(Answer.yesnobelief ~ antiscience + sophisticated + nature + cycle + Answer.conservativeliberal, data = data3, family = "binomial")
summary(modelpolitics)

exp(coef(modelpolitics))

# A model political ideology vs dissenter messages lumped together.
modelpoliticslump <- glm(Answer.yesnobelief ~ totalyes + Answer.conservativeliberal, data = data3, family = "binomial")
summary(modelpoliticslump)

exp(coef(modelpoliticslump))

# Creates a subset of just liberals
dataLib <- subset(data3, data3$Answer.conservativeliberal == 0)

# agreement with dissenter messages FOR LIBERALS
modelLib <- glm(Answer.yesnobelief ~ totalyes, data = dataLib, family = "binomial")
summary(modelLib)

exp(coef(modelLib))

# Factor model with just liberals
modelfulllib <- glm(Answer.yesnobelief ~ naive + antiscience + sophisticated + nature + cycle + actuallygood, data = dataLib, family = "binomial")
modelfulllib <- step(modelfulllib)
```
summary(modelfulllib)
exp(coef(modelfulllib))

#Creates a subset of just republicans
datareb <- subset(data3, data3$Answer.conservativeliberal == 1)

#agreement with dissenter messages FOR LIBERALS
modelreb <- glm(Answer.yesnobelief ~ totalyes, data = datareb, family = "binomial")
summary(modelreb)
exp(coef(modelreb))

#Factor model with just Republicans
modelfullreb <- glm(Answer.yesnobelief ~ naive + antiscience + sophisticated + nature + cycle + actuallygood, data = datareb, family = "binomial")
modelfullreb <- step(modelfullreb)
summary(modelfullreb)
exp(coef(modelfullreb))
```
```r
news
```

#Creates a subset those that chose fox or cnn as news source
datanews <- subset(data3, data3$Answer.news %in% c("1", "3"))

#Overwrite part datanews to make 1 a 0 and 3 a 1. originally 1 was cnn and 3 was fox
datanews[, 61] <- sapply(datanews[, 61], function(x) ifelse(x > 2, 1, 0))

#primary news source as a predictor for belief
modelnews <- glm(Answer.yesnobelief ~ Answer.news, data = datanews, family = "binomial")
summary(modelnews)
exp(coef(modelnews))

#primary news vs agreement with dissenter messages vs political affiliation
modelnewsmessagespolitical <- glm(Answer.yesnobelief ~ Answer.news + totalyes + Answer.conservativeliberal, data = datanews, family = "binomial")
summary(modelnewsmessagespolitical)
exp(coef(modelnewsmessagespolitical))

stargazer(modelnewsmessagespolitical, type = "html", flip = TRUE, out = "modelnewsmessagespolitical.htm")

#primary news vs agreement with dissenter messages WITHOUT POLITICAL IDEOLOGY
modelnewsmessages <- glm(Answer.yesnobelief ~ Answer.news + totalyes, data = datanews, family = "binomial")
summary(modelnewsmessages)
exp(coef(modelnewsmessages))

stargazer(modelnewsmessages, type = "html", flip = TRUE, out = "modelnewsmessages.htm")

car::vif(modelnewsmessagespolitical)
```
```
```
```
[r Political ideology vs dissenter agreement when controlling for primary news source]

# makes a subset of the news data for those who chose fox as their primary news source
datanewsfox <- subset(datanews, datanews$Answer.news == "1")

# model to figure out what factor is strongest predictor of dissent for fox news watchers
modelfoxnewsdissent <- glm(Answer.yesnobelief ~ naive + cycle, data = datanewsfox, family = "binomial")
summary(modelfoxnewsdissent)

exp(coef(modelfoxnewsdissent))

# model of fox viewers. Totalyes vs belief
modelfoxnewsdissentlump <- glm(Answer.yesnobelief ~ totalyes, data = datanewsfox, family = "binomial")
summary(modelfoxnewsdissentlump)

exp(coef(modelfoxnewsdissentlump))

# model compares the predictive power of agreement with dissenter messages vs political affiliation. NOT ENOUGH LIBERALS IN THIS POPULATION TO BE USEFUL
modelfoxnewspolvsmessages <- glm(Answer.yesnobelief ~ totalyes + Answer.conservativeliberal, data = datanewsfox, family = "binomial")
summary(modelfoxnewspolvsmessages)

exp(coef(modelfoxnewspolvsmessages))

# makes a subset of the news data for those who chose CNN as their primary news source
datanewscnn <- subset(datanews, datanews$Answer.news == "0")

# model to figure out what factor is strongest predictor of dissent for CNN viewers
modelcnnnewsdissent <- glm(Answer.yesnobelief ~ naive + antiscience + sophisticated + nature + cycle + actuallygood, data = datanewscnn, family = "binomial")
modelcnnnewsdissent <- step(modelcnnnewsdissent)
summary(modelcnnnewsdissent)

exp(coef(modelcnnnewsdissent))

# model CNN viewers. Totalyes vs belief
modelcnnnewsdissentlump <- glm(Answer.yesnobelief ~ totalyes, data = datanewscnn, family = "binomial")
summary(modelcnnnewsdissentlump)

exp(coef(modelcnnnewsdissentlump))

# model compares the predictive power of agreement with dissenter messages vs political affiliation. In this version of the model conservativeliberal is removed due to high p value.
modelcnnnewsmessages <- glm(Answer.yesnobelief ~ totalyes, data = datanewscnn, family = "binomial")
summary(modelcnnnewsmessages)

exp(coef(modelcnnnewsmessages))

```

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```
# overwritten part datanews to dicotomie trust in climate scientist question. Low was no high was yes.
data3[,52]<-apply(data3[,52],function(x)ifelse(x>3,0,1))
modeltrustc = glm(Answer.yesnobelief~ Answer.conservativeliberal+Answer.S1, data=data3, family="binomial")
summary(modeltrustc)
exp(coef(modeltrustc))
```

```
#graphs
require(ggplot2)
require(stringr)
require(reshape2)
data3$Answer.Age=as.numeric(data3$Answer.Age)
agedata=mutate(data3, realage=2016-Answer.Age)
agedata=agedata[-31]
agedata=agedata %>% filter(realage!="NA")
agedata$realagegrp =cut(agedata$realage, breaks=c(0,30,40,50,60,70,'INF'))
# changes age into agegroup
agedata$realagegrp = str_replace(agedata$realagegrp, "\]","])
agedata$realagegrp = str_replace(agedata$realagegrp, "(?<=\[0-9])0","1,")
# gets rid of the bracket, and makes the categories not look like they overlap by changing 30-40 to 31-40.
counts <- table(agedata$realagegrp)
barplot(counts, main="Age Group Distribution", ylim=c(0,130))
# AGE DEMOGRAPH GRAPHIC

datademographic=data3
datademographic$Answer.conservativeliberal=cut(datademographic$Answer.conservativeliberal, breaks=c(0,2,4,'INF'), labels=c("Conservative","Neutral","Liberal"))
# changes political into a categorical variable with labels instead of a number
datapoliticalmeanstable(datademographic)%>%group_by(Answer.conservativeliberal)%>%summarise(count=n(),overallbelieflevel-mean(Answer.yesnobelief,na.rm=TRUE),naivefmean=mean(naivef),antisciencefmean=mean(antisciencef),sophisticatedfmean=mean(sophisticatedf),naturefmean=mean(naturef),actuallygoodfmean=mean(actuallygoodf),cyclefmean=mean(cyclef),na.rm=TRUE)
# breaks factor down by political group
datapoliticalmeanstable=as.data.frame(datapoliticalmeanstable)
datamelt=melt(datapoliticalmeanstable,id=1,c('naivefmean','antisciencefmean','sophisticatedfmean','naturefmean','actuallygoodfmean','cyclefmean'),variable.name="testvariablename")
# preps for graph
```
geom_bar(aes(fill=testvariablename), position = "dodge", stat="identity", col="Black")
#Graph of factor response averages by political affiliation

counts-table(datanews$Answer$conservativeliberal)
barplot(counts, main="Political Group Distribution", col=c("Red","Gray","Blue"), ylim=c(0,200))
#Political graph
datagender-data3
datagender$Answer$Gender-cut(datagender$Answer$Gender, breaks=c(0,1,2), labels=c("Male","Female"))
#Changes gender into a variable with labels.
counts-table(datagender$Answer$Gender)
barplot(counts,main="Gender", ylim=c(0, 250))
#Gender graph
datanews-data3
datanews$Answer$news-cut(datanews$Answer$news, breaks=c(0,1,2,3,4,5,6,7,8), labels=c("CNN","ABC","FOX","MSNBC","NPR","BBC","CBS","Other"))
#1=CNN 2=ABC 3=FOX 4=MSNBC 5=NPR 6=BBC 7=CBS 8=OTHERS
#Creates categorical variable
counts-table(datanews$Answer$news)
barplot(counts,main="News Source", ylim=c(0,90),names.arg=c("CNN","ABC","FOX","MSNBC","NPR","BBC","CBS","Other"))
help(barplot)

require(dplyr)
datanewsmeanstable-datanews%>%group_by(Answer$news)%>%summarise(count=n(), overallbelieflevel-mean(Answer$yesnobelief,na.rm=TRUE), naivefmean-mean(naivef), antisciencefmean-mean(antisciencef), sophisticatedfmean-mean(sophisticatedf), naturefmean-mean(naturef), actuallygoodfmean-mean(actuallygoodf), cyclefmean-mean(cyclef), na.rm=TRUE)
datanewsmeanstable2-as.data.frame(datanewsmeanstable)
damatmelt-melt(datanewsmeanstable2,id=1,c('naivefmean','antisciencefmean','sophisticatedfmean','naturefmean','actuallygoodfmean','cyclefmean'),variable.name="testvariablename")
ggplot(damatmelt, aes(x=Answer$news, y=value)) +
  geom_bar(aes(fill=testvariablename), position = "dodge", stat="identity", col="Black")

#Means for each type

#BELIEVERS VS NONBELIEVERS
databelieftable-data3%>%group_by(Answer$yesnobelief)%>%summarise(count=n(), naivefmean-mean(naivef), antisciencefmean-mean(antisciencef), sophisticatedfmean-mean(sophisticatedf), naturefmean-mean(naturef), actuallygoodfmean-mean(actuallygoodf), cyclefmean-mean(cyclef), na.rm=TRUE)
#Breaks factor down by political group
databelieftable-as.data.frame(databelieftable)
damatmelt-melt(databelieftable, id=1,c('naivefmean','antisciencefmean','sophisticatedfmean','nature fmean','actuallygoodfmean','cyclefmean'),variable.name="testvariablename")
#preps for graph
ggplot(damatmelt, aes(x=Answer$yesnobelief, y=value)) +
  geom_bar(aes(fill=testvariablename), position = "dodge", stat="identity", col="Black")
#Graph of factor response averages by political affiliation
C: R Code for Reproduction of (Hornsey et al., 2016)
---
title: "Bentley Dissertation R Code: Reproduction of other's predictors"
author: "Peter Eklund & Andrew Bentley"
date: "March 7 2017"
output: word_document
---

{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)

#This installs all the relevanat packages needed for this project
{r prep}
install.packages('readxl') #allows R to read into an excel file
install.packages('dplyr') #used to manipulate the data set, mutate, ect.
install.packages('ggplot2') #plotting functions, makes graphs
install.packages('lme4') #Logistic regression program
install.packages('car') #Regression algorythem, allows to test the reliability of modles
install.packages('VIF')
install.packages('powerMediation') #Power analysis function
install.packages('xtable')

#Keeps the program from continuing if the code from a pakage is not working
require(readxl)
require(dplyr)
require(ggplot2)
require(lme4)
require(car)
require(VIF)
require(powerMediation)
require(xtable)

#reads in the excel file
data = read_excel("C:/Users/andrewpbentley/Google Drive/Mallinson/A-DISSERTATION/R-SHit/Combined_data_sanitized_as_of_3-22-2017.xlsx")

#Tells us if there line, aka participant, has filled in datat for each variable
completeFun <- function(data, desiredCols) {
  completeVec <- complete.cases(data[, desiredCols])
  return(data[completeVec, ])
}

#Creating a vector of every row without missing values in the columns specified.

#the completefun function has now made data2 the data file, but removed participants who did not fill out columns 5 through 48 completely. These are the likert items
data2=completeFun(data, 5:48)

#Overwrite part data2 via a function that makes every value less than 3 a 1 for yes, and everything over 3 a 0 for no. This is done via a ifelse function
data2[,5:48]=sapply(data2[,5:48],function(x)ifelse(x>3,1,0))

#Make Data Binary For Questions. Oringinally I had it return a 1 or a 2 for no and yes. Now it is turned into 1 or 0 for the sake of consistency.
data2[,67]=sapply(data2[,67],function(x)ifelse(x>1,0,1))

#excel returned this column as a table instead of a vector, this fixes this issue.
data2$Answer.yesnobelief=as.vector(data2$Answer.yesnobelief)

#Makes gender female 0, male 1
data2[,50]=sapply(data2[,50],function(x)ifelse(x>1,0,1))
# Dicotomizes age. Younger than 40 is a 0, older is a 1
data2[,49] <- sapply(data2[,49], function(x) ifelse(x > 1977, 0, 1))

# Overwrite part data2 via a function that dicotomizes the values for the likert question about political ideology. Originally it was low for conservative (<3) and high for liberal. The code below makes liberals a 0 and conservatives a 1. This makes is so I can easily compare false knowledge to ideology.
data2[,57] <- sapply(data2[,57], function(x) ifelse(x > 3, 0, 1))
data2[,64] <- sapply(data2[,64], function(x) ifelse(x > 3, 0, 1))

modelpredictors <- glm(Answer.yesnobelief ~ Answer.Gender + Answer.Age + Answer.conservativeliberal + Answer.sciclass + Answer.school + Answer.income, data = data2, family = "binomial")
summary(modelpredictors)

exp(coef(modelpredictors))

install.packages("stargazer")
require(stargazer)

stargazer(modelpredictors, type = "html", report = "v", "c", "s", "t", "p", flip = TRUE, out = "testtest2.htm")
Date: March 18, 2015

To: Heather Petcovic, Principal Investigator
    Andrew Bentley, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 15-03-20

This letter will serve as confirmation that your research project titled “Anthropogenic Climate Change Message Inventory: Instrument Validation” has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may only be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., you must request a post approval change to enroll subjects beyond the number stated in your application under “Number of subjects you want to complete the study”). Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: March 17, 2016