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Evaluating Contradicting and Confirming Evidence: A Study on Beliefs and Motivated Reasoning

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EVALUATING CONTRADICTING AND CONFIRMING EVIDENCE: A STUDY ON BELIEFS AND MOTIVATED REASONING

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ABSTRACT

EVALUATING CONTRADICTING AND CONFIRMING EVIDENCE: A STUDY ON BELIEFS AND MOTIVATED REASONING

by Zachary A. Caddick

The purpose of this study is to examine ideological, psychological, and demographic predictors of motivated reasoning. Three-hundred and seventy-seven participants from Amazon's Mechanical Turk system completed written responses critically evaluating strengths and weaknesses in a vignette on the topic of anthropogenic climate change. The vignette has two fictional scientists present prototypical arguments for and against anthropogenic climate change that are constructed with equally flawed and conflicting reasoning from both view points. Written responses were coded by a team of trained and reliability assessed qualitative raters. Motivated reasoning is operationalized by providing supporting evidence for the congruent belief and counter evidence against the incongruent belief. We found higher levels of dogmatism and lower levels of neuroticism in those engaging in motivated reasoning. Participants who supported anthropogenic climate change had equal levels of need for cognition, adoption of scientific attitudes, and openness to experience to participants who did not accept anthropogenic climate change, but were less conservative and more neurotic. Participant reasoning was predominately assessed as encompassing valid statements, supporting the notion that reasoning about beliefs and corresponding evidence creates directional reasoning and not necessarily invalid reasoning.

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Introduction

Why do some people gravitate toward unscientific explanations of events and others toward scientific explanations? The tendency to explain natural phenomena with answers that are incongruent with known scientific understandings permeates many aspects of society. Beliefs stemming from pseudoscience, the supernatural and paranormal, conspiracy theories, magical thinking, and superstition all stand in defiance to scientific explanations about the material universe.

In the pursuit of understanding how beliefs that are incongruent with scientific understandings remain prominent in an increasingly scientifically advanced world, a number of psychological variables must be considered. One such psychological variable is motivated reasoning. Motivated reasoning is a type of bias in which one is motivated to reason differently about information that supports one's prior beliefs compared to information that is incongruent with one's prior beliefs (Kunda, 1990). Whenever individuals are subjected to new information related to a prior belief, motivated reasoning is a possible agent influencing the maintenance of a belief. In recent times, motivated reasoning can be seen in beliefs about anthropogenic climate change (i.e., human caused climate change) which have sparked considerable debate and controversy.

Anthropogenic climate change (ACC) is a topic that has been entrenched in the United States' political discourse with fevered debates from prominent figures on either side of the issue. Although political consensus surrounding ACC in the United States may be lacking, the scientific consensus is overwhelming. Cook et al. (2013) reviewed 11,944 scientific paper abstracts and found that of those that offered an opinion on ACC,

97.1% agreed that ACC is occurring. In a 2016 Gallup poll, 65% of Americans affirmed the belief that humans are responsible for Earth's rising temperatures--a 10-point increase from the previous year (Gallup, 2016). Although the acceptance of ACC may be increasing within the United States, a notable gap still exists between the public and scientific community.

The purpose of the present study is to examine predictors of motivated reasoning and test for detectable differences in one's critical thinking and reasoning when competing and supportive evidence were presented. In the effort to do so, psychological, ideological, and demographic variables will be evaluated in their relationship to a vignette written response task assessing strengths and weaknesses of beliefs about anthropogenic climate change.

Magical Thinking

Beliefs exist in a wide array of manifestations. A great many beliefs are referred to as magical thinking. Matute, Yarritu, and Vadillo (2011) reviewed research concerning the implementation of false causal inferences for magical thinking. The researchers explain that a false connection is drawn between two unrelated events and this is the reason why individuals hold beliefs for which there is minimal or even a complete absence of scientific validity. An example of magical thinking might be an individual who wears a new coat to work and is fired that day, now attributing the firing to the "unlucky" coat instead of a more probable answer, e.g., being late or poor prior work performance. This example is hardly the only instance in which magical or superstitious thinking occurs.

Magical and superstitious thinking greatly vary based on the content, affected

domains, and characteristics of individuals. Harris et al. (1991) found that children exhibited fear of a monster in a box that they themselves imagined.

Magical thinking is not limited to children, of course. Fifty-four percent of adults in the U.S believe in psychic healing and 36% in the existence of telepathy (Newport & Strausberg, 2001). Additionally, 65% of U.S. adults believe in Noah's flood, 52% believe in astrology, and 42% believe that people can talk to the dead (Shermer, 2002). A 2005 Gallup poll found that approximately three out of every four Americans admitted to believing in at least one paranormal belief (Moore, 2005). It is clear that magical thinking is a widespread phenomenon. Although these beliefs and explanations held by individuals may often seem innocent, the issue is much more multi-faceted than may first appear.

Research into magical thinking is often focused around "the illusion of control." The illusion of control is identified as a personal miscalculation of probability for success that stands in defiance of the true probability (Langer, 1975; Yarritu, Matute, & Vadillo, 2013). Langer found when situations based on chance were masqueraded as skill-based, participants felt they had more control over their environment than in actuality. To exemplify this point, participants were placed in either a choice or no-choice condition for receiving a lottery ticket. Despite the probability of winning being equal between the lottery tickets, participants placed more value on the lottery ticket that they chose in contrast to the participants who were not given a choice in the matter. The probability of winning was not affected by the decision making, but by simply making one's own selection, participants exuded a false illusion of control over the situation at-hand.

Magical thinking is pervasive in pseudoscience, for which there are five specific criteria: “it lacks the cumulative progress seen in science, disregards empirical or established facts or results and a contradiction of what is already known, limited amount of internal skepticism, presents only vague mechanisms of how conclusions are reached, and lacks both deductive and inductive logic” (Feist, 2006, p. 220-222). An example of the potential harm of pseudoscience can be seen in the Gerson Therapy. Gerson Therapy is an alternative medicine practice, referred to as "metabolic therapy," based on a dietary routine to treat cancer. This vegetarian diet emphasizes low fat, low salt, high potassium, and regular coffee enemas (Munshi et al., 2008). The American Cancer Society, supported by a panel of experts, has stated that the Gerson Therapy lacks scientific validity. Despite a lack of evidence in support of alternative therapies, one study found that over 80% of its sample of cancer patients had used at least one therapy without scientific support (Miller et al., 1998). The authors stated that such decisions bring with them financial cost and the possibility of interaction with supported treatments. It should also be stated that avoidance of validated medical treatment can lead to premature death, a fact underlying the significance of understanding beliefs that are not supported with evidence.

The study of pseudoscience, magical thinking, and other beliefs is important because of the gap in values and understandings between scientific and non-scientific beliefs. Mikulak (2011) reviewed the factors that contribute to the disconnect between scientists and the general public, citing communication break-downs and differing beliefs of how knowledge can be gained. Investigating how thinking may differ and how beliefs are

acquired within individuals who display pseudoscientific thinking is central to understanding how the divide between scientific and non-scientific beliefs can be bridged. Without this understanding, individuals will continue to be victims of false beliefs, with potentially dramatic consequences. The following subsections will cover constructs investigated in this study as they relate to beliefs that stand in defiance of scientific knowledge and explanations.

Motivated Reasoning

The essence of motivated reasoning is the idea that motivation influences cognitive processes in how we construct and evaluate beliefs. Motivated reasoning theory is a framework from which we can understand how individuals respond to information that either confirms or disconfirms prior belief. The motivation element refers to individual's preference for a general outcome in a reasoning situation as well as the preference to be correct (Kunda, 1990). Kunda (1990) distinguished between two types of motivated reasoning that seek conclusions based on either accuracy (i.e., the best available answer) or directionality (i.e., congruent to prior belief). However, even in the presence of accuracy goals, biases are not eliminated (Kunda, 1990).

Motivated reasoning is intrinsically related to, but distinct from, confirmation bias. Confirmation bias is viewed as the act of seeking evidence that confirms prior beliefs (Nickerson, 1998). Nickerson (1998) reviewed scientific literature on the topic of confirmation bias and stated that confirmation bias, in part, encompasses a lack of awareness towards alternative evidence, unfounded preference for confirming information, and a bias for positive sources versus negative sources of information (i.e.,

the addition of information instead of the absence). Confirmation bias can be viewed as half of the motivated reasoning machinery, the other half being the disconfirmation bias. As the name implies, disconfirmation bias is the preference for disconfirming certain sources of information. Taber and Lodge (2006) found that individuals' prior beliefs about gun control and affirmative action predicted devaluing incongruent arguments compared to arguments that were congruent, regardless of their quality. The confirmation and disconfirmation biases work in tandem to motivate an individual's reasoning to a specific conclusion.

Kunda (1990) also noted that cognitive dissonance is closely related to many studies on motivated reasoning biases. Cognitive dissonance occurs when an individual holds an idea that stands in contrast to presented information. Festinger, Riecken, and Schacter (1956) famously explored cognitive dissonance in the lives of cult members as they approached a prophecy doomed to fail. The beliefs were not based on any observations or scientific data points (i.e., the individuals' beliefs were *a priori* explanations, as to *a posteriori* in nature). The researchers investigated the hypothesis that individuals with strongly held convictions, when faced with a contradictory reality, will work to protect their beliefs by furthering the intensity of the belief. On the night of the cult leader's failed prediction for a great flood, an alleged secret message via automatic writing was received that stated the flood did not occur due to the great amount of faith the believers possessed, which convinced the believers who experienced the failed prophecy that the beliefs they held were correct.

Klaczynski (1997) examined biases in everyday reasoning in a sample of adolescents

by presenting them with information that was either congruent or incongruent to their personal beliefs. Klaczynski found that the best predictor for engaging in biased reasoning was personal belief (Klaczynski, 1997). People were also more likely to agree with deductive arguments if they agreed with the conclusion offered (Markovits & Nantel, 1989; Rips, 1990).

One explanation for why people exhibit motivated reasoning is ego protection (Klaczynski & Narasimham, 1998). "Many researchers agree that among the most important social motives are those to comprehend self and the world, to have a sense of control over outcomes, to belong, to find the world benevolent and to maintain one's self-esteem" (Lindeman, 1998, p. 285). Through this lens, it is understandable why so many individuals gravitate towards protecting their beliefs. In the pursuit of understanding a complex phenomenon like motivated reasoning, a number of perspectives and variables must be considered. The following sections will cover predictors as they relate to motivated reasoning: cognitive style, personality, conservatism, dogmatism, and birth order.

Cognitive Style/Need for Cognition

Cognitive style is, in part, characterized by an individual's disposition to engage in rational thinking (Stanovich & West, 1998). Cognitive style and propensity to engage in differential cognitive processes have been extensively studied, often with varying jargon about related ideas. Notably, Daniel Kahneman describes differences in what is referred to as System 1 and System 2 processes. System 1 is characterized as being automatic, associative, fast, and effortless; on the other hand, System 2 is characterized as being

controlled, deductive, slow, and effortful (Kahneman & Frederick, 2002). However, System 2 processing can become integrated into System 1 upon repeated activation and acquired ability (Kahneman & Frederick, 2002). It is also possible that some decisions based on heuristics and biases work in conjunction with System 2 and are not solely under the guidance of System 1 (Kahneman & Frederick, 2002). Similarly, Epstein (1994) distinguished between experiential and rational processing systems, noting that there exists empirical convergence on two prominent processing systems resulting from disparate research pursuits, one, abstract and analytical, the other, automatic and intuitive. A further overview of related theories about information processing and decision making can be seen in Epstein (1994).

Differences in cognitive style can be facilitated by individuals having additional internal rules that work as a kind of higher order heuristic. Examples of possible rules that individuals work through to aid in reasoning ability are "consider possible alternative explanations" or "don't stop looking for evidence" (Stanovich & West, 1998). The presence of easily retrievable rules allows for additional evaluation during reasoning.

An often studied aspect of cognitive style is need for cognition, which is defined as "an individual's inclination to pleasurably participate in thinking" (Cacioppo & Petty, 1982, p. 119). Need for cognition has been researched in numerous ways, including its relation to interest in science, beliefs, intelligence, personality, and religiosity (Feist, 2012; Kardash and Scholes, 1996; Pennycook et al., 2014; Sadowski & Cogburn, 1997; Woo, Harms, & Kuncel, 2007). The body of research on need for cognition lends credence to its ability to affect behavior.

For example, in a study of juror decision making, need for cognition was examined as it related to jurors' ability to evaluate information (McAuliff & Kovera, 2008). Participants were given transcripts to read that included an expert witness testimony in a trial on sexual harassment. It is worth noting that the participants were employees of the same industry from which the sexual harassment suit was derived. This design allowed for knowledge of the given scenario to be equally understood by all participants and to reduce added insight in individuals who may have resulted in more knowledgeable jurors. The transcripts given to participants featured varying levels of internally valid arguments presented in an expert eyewitness testimony. The jurors who scored higher in need for cognition rated the expert witnesses' evidence higher when presented with evidence that was internally valid. This capability was not found in jurors who scored low in need for cognition.

Prior research has demonstrated that individual's increased need for cognition is associated with higher levels of critical thinking. Kardash and Scholes (1996) presented undergraduate students with two separate pieces of texts that gave two conflicting arguments on whether or not AIDs came about from HIV. Participants then wrote a concluding paragraph to the texts. Results showed that those who scored higher in need for cognition were more likely to expand on the inconclusiveness of the varied evidence to which they were subjected.

Need for cognition shares a relationship with several personality traits. For instance, Sadowski and Cogburn (1997), in a sample of undergraduates, found that need for cognition was related to neuroticism, openness to experience, and conscientiousness.

Individuals who scored high in need for cognition were more likely to be high in conscientiousness and openness to experience and low in neuroticism (Sadowski & Cogburn, 1997).

Personality

The study of personality has often converged on the presence of five dominant personality traits, commonly known as the Five-Factor Model (FFM) or the "Big Five" (Digman & Inouye, 1986). The five traits are openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Beyond its' relationship with need for cognition, personality has been connected to a wide range of constructs, many of which are related to motivated reasoning.

In investigating how personality traits, as measured by the Big Five, relate to religious beliefs, Saroglou (2002) reported that low domain scores in Openness to Experience were the best predictors of religious fundamentalist beliefs (to clarify: fundamentalists are those who believe in the literal word of a holy book). In this meta-analysis of 13 studies, there was a relationship between low scores in openness to experience and high scores in religious fundamentalism (Saroglou, 2002). This means that those who tended to be higher in religious fundamentalism were lower in openness to experience personality characteristics. Neuroticism was also negatively related to religious fundamentalism, meaning that those who tended to have higher rates of religious fundamentalism also tended to score lower on neuroticism. Agreeableness however, increased with religious fundamentalism. In the same meta-analysis, openness to experience was related to general religiosity, but the best personality predictors were

extraversion, agreeableness, and conscientiousness. Openness to experience tended to decrease as individuals increased in religiosity, as was seen in religious fundamentalists. In contrast to openness to experience, as scores of religiosity increased so did scores of extraversion, agreeableness, and conscientiousness, all of which shared a positive relationship. It is important to note that the present study will use two Big Five personality traits: openness to experience and neuroticism.

Personality has also been studied in its relationship to typical intellectual engagement. Typical intellectual engagement is measured by individual's typical engagement in intellectual activities (e.g., reading books, learning about scientific discoveries; Ackerman & Heggestad, 1997; Goff & Ackerman, 1992). Goff and Ackerman (1992) found in their sample of undergraduates that individuals who scored higher in typical intellectual engagement tended to be lower in neuroticism and higher in openness to experience.

Ideological Beliefs: Conservatism and Dogmatism

Conservatism. The political ideology of conservatism has been studied in its relation to information processing, cognitive style, dogmatism, motivated reasoning, and problem-solving (Alker & Hermann, 1971; Jost et al., 2003; Pennycook et al., 2012). Conservatism has also been repeatedly found to be related to feelings of threat (Jost et. al., 2003). "Threat has generally been operationalized in terms of threatening societal periods, threats to the legitimacy or stability of the social system, the salience of terrorism, rising immigration, and a host of other threatening stimuli, including thoughts about one's mortality" (Thórisdóttir & Jost, 2011, p. 796).

Conservative political views have been linked to disbelief in anthropogenic climate change (Gallup, 2014; McCright, 2011). In general, self-identified liberals and Democrats are more likely to identify with pro-environmental views, than their more conservative counterparts (McCright, 2011). McCright and Dunlap (2011) examined a number of nationally representative samples from the years 2001-2010 and found that educational attainment and understanding of climate change beliefs are moderated by political beliefs. In this review, conservatism was weakly or negatively related to both educational attainment and understanding climate change (McCright & Dunlap, 2011).

Dogmatism. Dogmatism is defined by Altemeyer as "unjustified certainty" (1996, p. 201). Altemeyer reasoned that those who are high in dogmatism would be more likely to be driven by directional goals in reasoning than those who score lower in dogmatism. Prior researchers found that dogmatism was negatively related to need for cognition and rational engagement, but positively related to the following: experiential engagement, a personal need for structure, close mindedness, and right-wing authoritarianism (Crowson, DeBacker, & Davis, 2008). Not surprisingly, religious fundamentalism shares a strong relationship with dogmatism (Altemeyer, 1996).

Bettinghaus, Miller, and Steinfatt (1970) evaluated syllogistic reasoning ability in a high-dogmatism and a low-dogmatism sample. When neutral syllogisms were presented, no significant difference between the high and low dogmatism groups was found. However, those high in dogmatism scored significantly worse in syllogistic reasoning with positive and negative sources of information (i.e., information from individuals who were rated either positively or negatively). In scenarios with information presented from

positive sources but with invalid syllogisms, individuals low in dogmatism outperformed their more dogmatic counterparts in accurately judging the presented information.

Birth Order

The study of birth order has captured the attention of many psychologists including such notable figures as Francis Galton, Sigmund Freud, and Alfred Adler. The investigation of birth order has not gone without controversy and conflicting results (Ernst & Angst, 1983; Schooler, 1962; Sulloway, 1995). Sulloway argued that in order to understand birth order effects it is imperative that researchers statistically control for a number of variables which have been found to muddle results including the following: social economic status, number of siblings, gender, and age gap between siblings (see Sulloway, 1997).

Sulloway (1997) provided an empirical argument for the use of 'functional' rather than 'biological birth order'. This methodology makes the distinction between going through childhood with a closely aged sibling or a sibling that is considerably older. The age distance for classifying firstborns includes second born children who are 6 or more years apart from an elder sibling. Only children are also categorized as being firstborns.

Sulloway (1995) conducted a meta-analysis on the relationship between birth order and the Big Five personality dimensions and found converging evidence for birth order effects while seeking to diminish the “file drawer” problem (i.e., the non-reporting of non-significant findings) and poor methodological design. Sulloway (1995) found that birth order had the largest effect on openness to experience, with latterborns exhibiting more unconventional and rebellious personalities ($z = 13.19$). Firstborns and latterborns

have also been found to differ in levels of neuroticism ($z = 7.68$), with firstborns being characterized as more anxious, fearful, and less well-adjusted (Sulloway, 1995). Firstborns are also more conscientious ($z = 12.14$) and less agreeable ($z = 8.44$) than their latterborn counterparts (Sulloway, 1995). Though these results have not gone without controversy.

The study of birth order has a long and contentious history. Ernst and Angst (1983) provided evidence that there is not a meaningful difference in intelligence based on birth order. Kristensen and Bjerkedal (2007) however found a significant, but small, difference in IQ based on social rank within a family. Rohrer, Egloff, and Schmukle (2015) state that many of the findings around birth order may be more driven by methodology than reality, specifically, the study design differences inherent in within-family vs. between-family designs. The same researchers, in a multi-country sample of more than 20,000 individuals, found no evidence of personality difference based on birth order--furthering the conflicting evidence for birth order differences.

Sulloway (1997) provided a comprehensive overview on the role birth order plays in a wide variety of outcomes. The thesis of Sulloway's book describes how latterborns are less likely than firstborns to seek parental favor, as well as more likely to reject the status quo and to accept revolutionary ideas. In short, firstborns are more likely to conform and latterborns are more likely to rebel. Due to beliefs around climate change having a contentious history, we will evaluate differences in anthropogenic climate change belief based on functional birth order.

Hypotheses

Based on these findings, we predict that individuals who exhibit higher level of motivated reasoning will be lower in need for cognition, more dogmatic and conservative, less neurotic, and also be lower in openness to experience than those who score low in motivated reasoning. We also hypothesize that having higher levels of adoption of scientific attitudes will be associated with belief in anthropogenic climate change and a disbelief that addressing climate change would cause an unnecessary tax burden. The latter part addressing a tax burden was included in the present study in response to a prominence of complaints of the financial impact of addressing climate change found in readings of popular media sources by the author.

Methods

Participants and Design

Participants. Participants were collected from Amazon's Mechanical Turk (MTurk) system. MTurk is a crowdsourcing surveying system and has been found to offer a more representative sampling procedure than that of convenience samples (see Berinsky, Huber, & Lenz, 2012; Buhrmester, Kwang, & Gosling, 2011). MTurk respondents are "workers" who are reimbursed small amounts of money by the researchers for their participation. In this study, we reimbursed participants one dollar for their participation. Participants were limited to only those who lived in the United States, which was verified by IP address. All participants were 18 years old and above.

The total collected sample consisted of 477 participants. Thirty-one participants were removed from analysis for either not giving consent, missing at least one of the three

filter questions (e.g., "please select '4' for this answer"), or not completing the majority of the survey. One participant was removed for analysis for answering no to the last question of the survey, "Did you answer all of the previous questions honestly and to the best of your ability?" This reduced the number of participants to 446. An additional 69 participants (15.47%) were removed from the vignette ratings due to not answering the prompt (see Appendix A for vignettes and Appendix B for examples of responses that did not meet inclusion criteria). In all, 377 participants provided rated vignette responses. There were roughly equal exclusion rates for not submitting a ratable vignette response between those who did and did not believe in anthropogenic climate change (ACC; 16.15% & 13.71%, respectively).

Design. A mixed design was developed for this study. The between-subjects variable was participants' belief about whether or not climate change is primarily driven by human behavior. The primary within-subjects variable was congruence. The congruence variable had two levels based on whether participants were reasoning about congruent or incongruent information (in reference to their ACC belief) and was created from ratings of participants' written responses to a vignette assessing strengths and weaknesses of arguments for and against anthropogenic climate change. Additionally, participants completed measures of openness to experience, neuroticism, need for cognition, conservatism, dogmatism, adoption of scientific attitudes, birth order, as well as demographic variables.

Apparatus and Materials

In addition to the MTurk platform for data collection, we developed a survey using

the online survey software Qualtrics, which facilitates the creation of multiple choice questions as well as open-ended questions.

Measures

Need for Cognition. Cacioppo, Petty, and Kao's (1984) short form of the Need for Cognition Scale assessed need for cognition (see Appendix C), which is an 18 item, self-report Likert scale. The measure is revised from Cacioppo and Petty's "The Need for Cognition Scale" (1982). The two measures are correlated at .95 and the shorter scale has been found to be more efficient (Cacioppo, Petty, & Kao, 1984). The scales' responses range from 1-5, with: 1 = extremely uncharacteristic; 2 = somewhat uncharacteristic; 3 = uncertain; 4 = somewhat characteristic; 5 = extremely characteristic. Nine of the 18 items are reverse scored. Cacioppo et al. (1984) reported a Cronbach's alpha coefficient of .90. Additionally, other researchers have reported test-retest reliability of .88 (Sadowaki & Gulgoz, 1992). Sample items include the questions: "I would prefer complex to simple problems" and "The notion of thinking abstractly is appealing to me."

Personality. Two personality dimensions were measured using the Big Five Inventory (BFI): openness to experience and neuroticism (see Appendix D). The BFI measure consists of 18 items with a 5-point Likert scale. Sample items include: "I see myself as someone who is curious about many things" and "I see myself as someone who is relaxed, handles stress well." The five dimensions of the BFI have test-retest reliability coefficients of .80-.90 (John & Srivastava, 1999; John et al, 2008). Further evidence for the validity of the BFI can be found in John and Srivastava (1999).

Conservatism. The Authoritarian-Conservatism-Traditionalism (ACT) Scale measured conservatism, more specifically social conservatism (i.e., in contrast to economic conservatism; see Appendix E). The ACT Scale is a 36-item Likert response, ranging from -4 to +4 for levels of agreement. Example items include: "What our country needs most is discipline, with everyone following our leaders in unity" and "It is important that we preserve our traditional values and moral standards." Reliability coefficients for ACT ranged from .83-.94 in five separate samples (Duckitt et al., 2010).

Dogmatism. Dogmatism, defined as "unjustified certainty," was measured with the Dogmatism (DOG) Scale (Altemeyer, 1996, p. 201; see Appendix F). The DOG Scale is a 20 item measure with Likert scale responses ranging from -4 to +4, representing: "very strongly disagree" to "very strongly agree" (Altemeyer, 1996). Researchers have reported Cronbach's alpha coefficients between .90 and .93 in three samples (Crowson, DeBacker, & Davis, 2008). The DOG Scale has acceptable levels of both validity and reliability (Crowson, 2009). Items from the DOG Scale include: "I am so sure I am right about the important things in life, there is no evidence that could convince me otherwise" and "I am absolutely certain that my ideas about the fundamental issues in life are correct."

Adoption of Scientific Attitudes. One dimension of the Test of Science-Related Attitudes (TOSRA) scale was used: Adoption of Scientific Attitudes (ASA; see Appendix G). The ASA scale is a Likert response, ranging from strongly agree to strongly disagree, with 10 items being measured. Average reliability coefficient for TOSRA in four separate samples ranged from .80-.84 (Fraser, 1981). Example items include: "I enjoy

reading about things which disagree with my previous ideas" and "I am curious about the world in which we live."

Belief Questionnaire. Participants completed a short three-item questionnaire related to beliefs about climate change called the Brief Climate Change Belief Questionnaire (Caddick, 2015; see Appendix H). The three items are: "Do you believe that climate change (i.e., global warming) is occurring," "Do you believe that human activity is primarily causing climate change (i.e., global warming)," and "Do you believe that addressing climate change will cause an unnecessary tax burden." Responses to the second question about whether humans are causing climate change formed the participant's status on ACC. In reference to the third question about a tax burden, the use of the word 'unnecessary' was used not only capture those who view taxes as a burden (e.g., taxes used for building new roads may be viewed as burdensome to many, but not unnecessary) but as a tax that is viewed as unnecessary in its implementation.

Motivated Reasoning. Participants completed written responses critically evaluating a vignette on the topic of anthropogenic climate change (see Appendix A). The vignette introduces fictional scientists who speak as authorities on the issue of ACC, with one in support and one against ACC. The scientists were created to have comparable credentials and present similarly flawed reasoning in support of their belief. The vignette design was created across 5 separate pilot samples. Originally each stance on climate change was presented separately, but this was forgone for an integrated approach that allowed for counterbalancing of the information being presented. The piloting process aided in the creation of a vignette and allowed for both the elicited written responses from

participants and a rating system to be assessed and refined. The implemented vignette featured errors in reasoning, seen in two logical fallacies (red herring and appeal to authority), and poor research methodology. The scientists had equivalent types and numbers of logical reasoning errors used in support of their belief. The presentation order of the scientists and their arguments was counter-balanced between two otherwise identical vignettes. Participants were prompted to identify both strengths and weaknesses, if any, they found in the argument provided for each scientist. Responses were written in a separate text box for each scientist. An annotated version of the vignettes detailing argument structure and fallacies can be seen in Appendix I.

Participant vignette responses were coded by a team of trained raters. Statements within responses were categorized by whether they addressed a strength or a weakness in the argument and if the statement was valid or invalid (see Appendix B for examples of rated responses & Appendix J for Vignette Response Rating Manual used by raters). That is, some answers were deemed valid (e.g., "comparing temperature from two years is not enough evidence to solely support belief in anthropogenic climate change") and others invalid because they were not consistent with known evidence (e.g., "there is no way to measure past climates"). Raters added a value of one for every unique instance of strengths or weaknesses referenced in responses (i.e., expanding on a point did not result in an increase in score). Each participant had eight categories of points based on vignette responses; there were four for each scientist: valid strengths, invalid strengths, valid weakness, and invalid weakness.

Motivated reasoning was operationalized using scores from the eight categories of

participant's statements as well as participants measured belief in ACC (yes/no). View Table 1 for an overview of how the variables were created. Motivated reasoning was viewed as arguing for weaknesses in the information that was incongruent with the individuals' personal view, as well as arguing for the strengths in the information that was congruent with their own view.

Table 1
Motivated Reasoning Variable Derivation

Variable	Deriving Formula
Congruent Reasoning	$\text{Weaknesses}_{\text{incongruent view}} + \text{Strengths}_{\text{congruent view}}$
Incongruent Reasoning	$\text{Strengths}_{\text{incongruent view}} + \text{Weaknesses}_{\text{congruent view}}$
Motivated Reasoning	Incongruent Reasoning − Congruent Reasoning

Note. Congruent and incongruent view subscript denote alignment of scientists' view with participant's anthropogenic climate change belief (yes/no).

The rating system for participant responses, and the vignette itself, were developed and modified over the course of five separate pilot samples (see Vignette Ratings Scoring Manual in Appendix J). All raters were blind to participants' belief in ACC. Inter-rater reliability was assessed with Gwet's AC2 using a linear weight (see Gwet, 2008), due to the analysis' not having an assumption of independence among coders, the ordinal nature of the data, and the range of our ratings (0-4). All statistics were computed in *R* using the statistical package 'rel' (Riccardo, 2016).

After four individuals, author included, trained on pilot data and obtained reliability between .66 and .94 for all eight categories being rated, we were confident that all individuals understood the rating system (see Appendix K for complete inter-rater agreement overview). After initial inter-rater reliabilities had been established, the first 100 vignette responses (91 valid responses) in the presented data were rated

independently by raters who then met to collaboratively deliberate over any differences in ratings until 100% agreement was reached (agreement ranged from .66 to .95 before deliberation).

The remaining participants (n = 347; 283 valid responses) were divided between three of the raters, with one rater (the author) rating all remaining responses. Inter-rater reliability for these responses range from .74 to .96. The two raters' score for each of these three sections was averaged into a single score which was used for analysis along with the first collaboratively deliberated section. Although differing methodology for agreement was used within one dataset, results show a similar motivated reasoning trend across vignette ratings (see Appendix L for motivated reasoning scoring differences across raters). More precisely, the relative pattern for levels of motivated reasoning across ACC belief was maintained for all ratings.

Birth Order/Demographics. Birth order was assessed in functional terms with five items that inquired about number of siblings, son/daughter birth rank, and distance in years from next older and younger siblings (see Appendix M). Participants were coded as either a firstborn or latterborn. Firstborns were individuals with a birth rank of one, were six or more years younger than an older sibling, or were only children. Latterborns were individuals who had an elder sibling that was less than six years older. Additionally, a brief questionnaire inquired about participant: age, education, ethnicity, gender, income, religious belief, school major, and parental education (see Appendix N).

Procedure

The survey software Qualtrics was used for data collection in conjunction with

Amazon's Mechanical Turk (MTurk). All data were collected online. The participants completed an informed online consent form prior to starting the study by clicking a box that stated they had read and consented to participate. Participants then completed, at their own pace, written vignette responses, two scales from the Big Five Inventory (openness to experience and neuroticism), a need for cognition measure, a measure of dogmatism, conservatism measure, an adoption of scientific attitudes measure, and a demographic and belief questionnaire. The vignette writing task was always presented first. Next, all psychological and ideological measures as well as the belief questionnaire were randomly ordered in their presentation to participants. The demographic questionnaire was always presented after the above measures. Before completion, participants were asked a validity check question of "Did you answer all of the previous questions honestly and to the best of your ability?" Lastly, participants were debriefed and thanked for their participation as well as given a task completion code for payment on the MTurk system.

Results

Descriptive Statistics for Demographic Variables and ACC

Descriptive statistics for all the major demographic variables in the study are listed in Table 2. Climate change (CC) was accepted by 91.03% of participants and anthropogenic climate change (ACC) was accepted by 72.13%. The belief that addressing climate change would cause an unnecessary tax burden was agreed to by 30.04% of the sample. The average age of participants who accepted ACC was 35.71 years old (*SD* = 12.60) and 40.43 years old (*SD* = 12.97) for those who rejected ACC.

Sixty-five percent of individuals who endorsed ACC were female and those who did not believe in ACC were 62.10% female. The percentages of participants who had at least some college education for those who did and did not believe in ACC were 69.43% and 61.29%, respectively.

Table 2
Descriptive Statistics

	Accepts ACC		*Rejects ACC*	
Variable	*n*	*M* (*SD*) / *Pct*	*n*	*M* (*SD*) / *Pct*
Age	320	35.71 (12.60)	124	40.43 (12.97)
Birth Order				
Firstborns	222	69.59%	92	74.19%
Latterborns	97	30.41%	32	25.81%
College Education				
No	76	30.57%	48	38.71%
Yes	218	69.43%	76	61.29%
Gender				
Female	208	65.00%	77	62.10%
Male	110	34.38%	47	37.90%
Other / Prefer not to say	2	.63%	0	.00%
Ethnicity				
American Indian / Alaska Native	2	.63%	2	1.61%
Asian	15	4.69%	4	3.23%
Black / African American	18	5.63%	11	8.87%
Hispanic / Latino	25	7.81%	4	3.23%
Native Hawaiian / Other Pacific Islander	1	.31%	0	.00%
White	251	78.13%	101	81.45%
Other	9	2.81%	2	1.61%
Religious Affiliation				
Agnostic	72	22.57%	13	10.48%
Atheist	53	16.61%	8	6.45%
Buddhist	7	2.19%	0	0%
Christian	128	40.13%	83	66.94%
Hindu	2	.63%	0	0%
Jewish	6	1.88%	0	0%
Mormon	2	.63%	4	3.23%
Muslim	2	.63%	2	1.61%
Other	48	14.73%	14	11.29%

Note. ACC denotes anthropogenic climate change; $N = 445$.

Planned Analyses

Predictors of Motivated Reasoning. A hierarchical multiple regression analysis was run to test whether belief in anthropogenic climate change could be predicted by psychological and ideological variables beyond that of demographic variables for motivated reasoning. Demographic variables of age, birth order, college education, and gender were included in step 1. Step 2 consisted of ideological and psychological variables: ACT (composite score of: authoritarianism, conservatism, and traditionalism), dogmatism, need for cognition, neuroticism, and openness to experience. A zero-order correlation matrix is presented in Appendix O.

Demographic variables in step 1 were not significant predictors of motivated reasoning ($F(4, 364) = .03$ $p = 1.00$, $R^2 = .00$). When ideological and psychological variables were entered in step 2 there was a significant 6% increase in variance in motivated reasoning ($F(5, 359) = 4.34$, $p < .01$, $R^2_{change} = .06$). Additionally, there were two significant individual predictors in step 2, dogmatism and neuroticism. Participants were more likely to engage in motivated reasoning (not assessing whether the statements were valid or invalid) if they were more dogmatic ($sr^2 = .13$) and less neurotic ($sr^2 = -.14$). No other significant predictors were found, as can be seen in Table 3.

Table 3
Hierarchical MRC: Demographic, Ideological, and Psychological Predictors of Motivated Reasoning

Predictors	β	$sr^{2\,a}$	ΔR^2
Step 1: Demographic			.00
Age	-.01	-.01	
Birth order	.01	.01	
College Education	.01	.01	
Gender	.01	.01	
Step 2: Ideological and Psychological variables			.06
ACT	.12	.11	
Dogmatism	.13*	.12	
Need for Cognition	-.03	-.02	
Neuroticism	-.14*	-.12	
Openness to Experience	-.04	-.03	

Note. *$p < .05$; [a] sr^2 represents unique variance explained; $N = 369$. Gender coded: 1 = male, 2 = female; College education coded: 1 = some college; 2 = no college; Birth order coded: 1 = firstborn, 2 = latterborn.

Two 2x2 Yates Chi-Square tests were conducted to examine whether participants' belief that addressing climate change would cause an unnecessary tax burden (TB) was associated with belief in climate change (CC) and anthropogenic climate change (ACC). Endorsing the tax burden statements was negatively associated with believing that climate change is occurring ($\chi^2(1) = 49.59$, $p < .001$). Participants who believed in CC predominantly did not believe addressing climate change would cause an unnecessary tax burden (74.88%). The majority of individuals who did not believe in CC did believe TB (80.00%). Furthermore, belief in ACC predicted not believing that addressing climate change would be a tax burden ($\chi^2(1) = 139.05$, $p < .001$). Individuals who accepted ACC were more likely to believe addressing climate change would not cause an unnecessary tax burden (71.77%), while individuals who rejected ACC were more likely to believe it would be a tax burden (85.98%).

We also hypothesized that adopting scientific attitudes would be associated with believing that climate change was real and that humans were causing it. However, there was no difference found in adoption of scientific attitudes and belief in CC or ACC ($t(444)=1.21$, $p = .25$ & $t(443)=.72$, $p = .48$, respectively) . However, the belief that addressing climate change will cause an unnecessary tax burden and individual's adoption of scientific attitudes were found to significantly differ across belief, $t(444) = 3.71$, $p < .001$, $d = .35$. Individuals with lower levels of adoption of scientific attitudes were more likely to believe that addressing climate change would cause an unnecessary tax burden. No significant effects were found between birth order and belief in CC, ACC, or TB (Yates Chi-Square tests, p's $> .05$).

Differences in Motivated Reasoning by ACC Belief. A 2x2 mixed ANOVA was conducted to examine differences in ratings of participant's vignette responses assessing strengths and weaknesses in both congruent and incongruent evidence of anthropogenic climate change. The between-subjects factor was participants' belief in ACC (yes/no). The within-subjects variable was motivated reasoning (operationalized by differences in congruent and incongruent reasoning). Additionally, paired sample *t*-tests were used to further examine within-subjects effects of reasoning differences paired with Cohen's *d* for effect sizes. Recall that focusing on strengths for a congruent belief and weaknesses or an incongruent belief is congruent reasoning, whereas focusing on weaknesses for the congruent belief and strengths for the incongruent belief is incongruent reasoning.

Not taking into account whether a statement was deemed valid or invalid, differences in participant's reasoning was examined across ACC belief. There was a significant

within-subjects effect of reasoning, $F(1, 375) = 35.13$, $p < .001$, $\eta^2 = .09$. Participants who rejected ACC were more likely to engage in congruent reasoning ($M = 1.93$, $SD = .71$) than incongruent ($M = 1.10$, $SD = .87$), $t(106) = 8.93$, $p < .001$, $d = 1.05$. Participants who accepted ACC did not significantly differ in their congruent ($M = 1.66$, $SD = .81$) and incongruent reasoning ($M = 1.56$, $SD = .88$), $t(269) = 1.48$, $p = .14$. A between-subjects main effect between ACC belief was not found, $F(1, 375) = 1.58$, $p = .21$, $\eta^2 = .00$. There was, however, a significant interaction between reasoning and belief, ($F(1,375) = 57.27$, $p < .001$, $\eta^2 = .13$), such that participants who did not believe in ACC were more likely to exhibit congruent reasoning than incongruent reasoning, regardless of whether their statements were valid or not, while participants who accept ACC were equally likely to engage in incongruent or congruent reasoning. A visualization of the contrast within the belief by reasoning interaction can be seen in *Figure 1*.

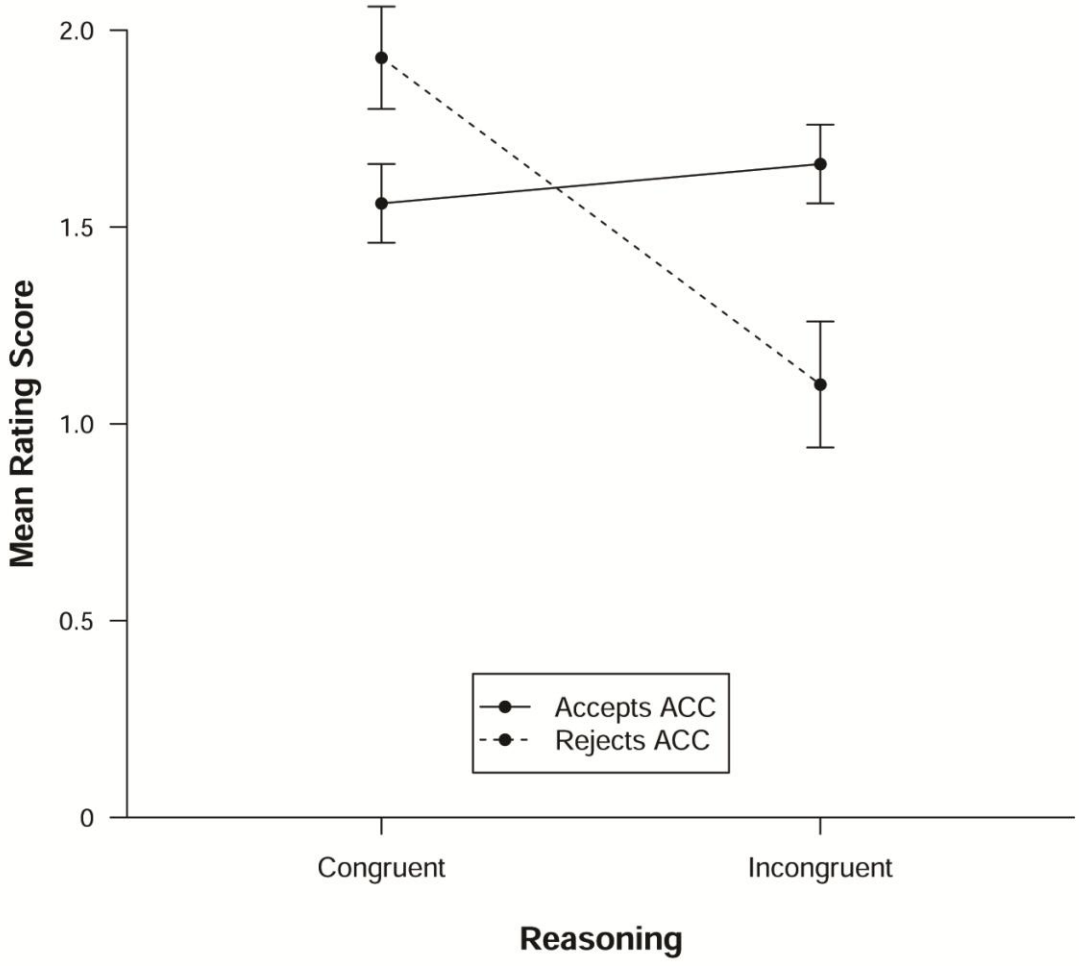


Figure 1. Motivated reasoning by anthropogenic climate change belief. Error bars represent 95% confidence interval.

Psychological and Ideological Group Differences by ACC Belief. Independent samples t-tests were run to test whether individuals significant differed in psychological and ideological measures based on ACC belief alignment (yes/no). The largest difference between those who accept ACC and those who do not is that individuals who rejected ACC were much more conservative (as measured by ACT) in their ideological preferences. This was true for each sub-measure of ACT: authoritarianism (d = .62),

conservatism (d = .37), and traditionalism (d = .92). Participants who accepted ACC scored higher in neuroticism (d = .28) or, inversely, individuals who did not believe in ACC were measured as having higher levels of emotional stability. There were no significant differences across ACC belief for adoption of scientific attitudes, dogmatism, need for cognition, or openness to experience. Mean and standard deviation values for the psychological and ideological variables are presented in Table 4.

Table 4
Group Differences by Anthropogenic Climate Change Belief

	Accepts ACC	Rejects ACC		
Psychological and Ideological	*M* (*SD*)	*M* (*SD*)	*t*	*Cohen's d*
ACT	3.94 (1.53)	5.20 (1.62)	7.66**	.73
Authoritarianism	4.32 (1.57)	5.44 (1.77)	6.52**	.62
Conservatism	4.02 (1.68)	4.74 (1.72)	4.03**	.38
Traditionalism	3.47 (1.81)	5.41 (2.07)	9.70**	.92
ASA	4.02 (.47)	3.99 (.47)	.72	.06
Dogmatism	4.88 (.34)	4.88 (.37)	.18	.02
Need for Cognition	3.67 (.81)	3.68 (.84)	-.22	.02
Neuroticism	2.74 (1.02)	2.42 (.95)	2.95*	.28
Openness to Experience	3.90 (.66)	3.84 (.72)	.91	.09

Note. N = 445. *p < .05; **p < .001; ASA denote Adoption of Scientific Attitudes.

Post-hoc Analyses

With a data set as rich as this one, there are always some unexpected and non-predicted findings. Due to the prominent representation of individuals who identified as "Christian" (47.52% of the sample), a Yates Chi-square analysis was conducted to test whether there was a difference in belief in ACC depending on whether or not a participant identified as Christian or non-Christian (i.e., all other religious affiliations, or lack thereof, were included as a group). Individuals who accepted ACC were less likely to identify as Christian (40%), while those who rejected ACC were more likely to

identify as Christian (66.94%), $\chi^2(1) = 24.93$, $p < .001$.

Differences in Reasoning by ACC Belief. Two separate mixed ANOVAs were used for different categorizations of participant statements (as assessed by raters) separating valid from invalid statements. Participants differed in their motivated reasoning scores based on their belief in ACC (yes/no) for responses deemed valid ($F(1, 375) = 29.23$, $p < .001$, $\eta^2 = .07$), such that participants who believed in ACC were more likely to engage in incongruent reasoning ($M = 1.35$ $SD = .75$) than congruent reasoning ($M = 1.09$, $SD = .69$), $t(269) = 5.22$, $p < .001$, $d = .36$. Participants who rejected ACC were more likely to engage in congruent reasoning ($M = 1.56$, $SD = .68$) than incongruent reasoning ($M = .79$, $SD = .74$; $t(106) = 9.48$, $p < .001$, $d = 1.08$). There was no significant between-subjects effect of ACC belief ($F(1, 375) = .43$, $p = .51$, $\eta^2 = .00$). There was a significant interaction, however between belief in ACC and reasoning in vignette responses ($F(1, 375) = 119.36$, $p < .001$, $\eta^2 = .24$). As Figure 2 shows, individuals who believe in ACC were more likely to engage in valid incongruent reasoning and individuals who reject ACC were more likely to exhibit congruent reasoning in their valid statements.

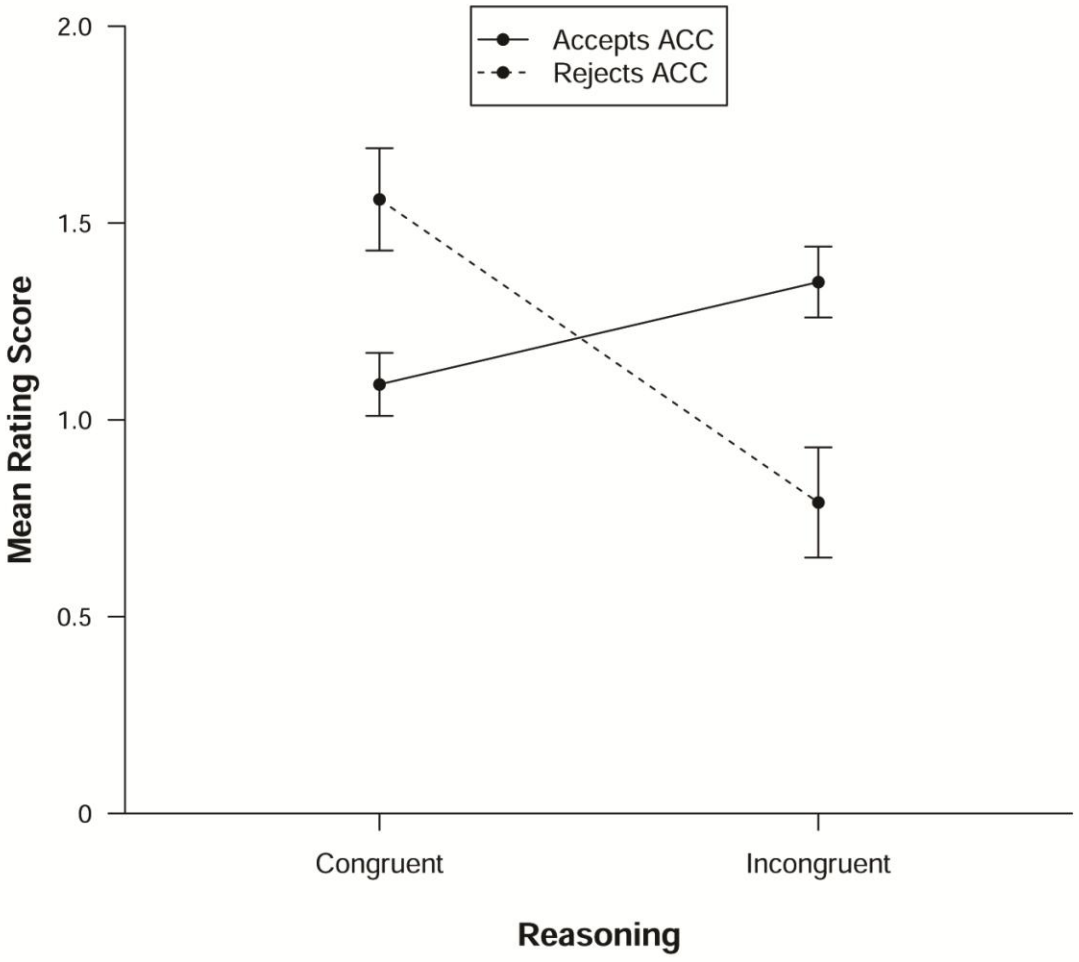


Figure 2. Reasoning differences for valid statements by anthropogenic climate change belief. Error bars represent 95% confidence interval.

Participants significantly differed in their levels of incongruent and congruent reasoning based on belief in ACC for statements rated as invalid. A significant within-subjects effect of reasoning was found, $F(1, 375) = 7.89$, $p < .01$, $\eta^2 = .02$. Participants who believed in ACC were more likely to engage in congruent reasoning ($M = .47$, $SD = .66$) then incongruent reasoning ($M = .31$, $SD = .45$) for invalid statements, $t(269) = 3.71$, $p < .001$, $d = .28$. Individuals who did not believe in ACC did not significantly differ in

their level of congruent (M = .37, SD = .48) and incongruent (M = .31, SD = .49) reasoning, $t(106) = .99$, $p = .32$. There was not a significant between-subjects effect with ACC belief, $F(1, 375) = .96$, $p = .33$, $\eta^2 = .00$. There was not a significant interaction between belief in ACC and levels of reasoning, $F(1, 375) = 1.55$, $p = .21$, $\eta^2 = .00$. Figure 3, presenting invalid reasoning scores, contrasts with Figure 2 as invalid statements were less frequent than valid statements.

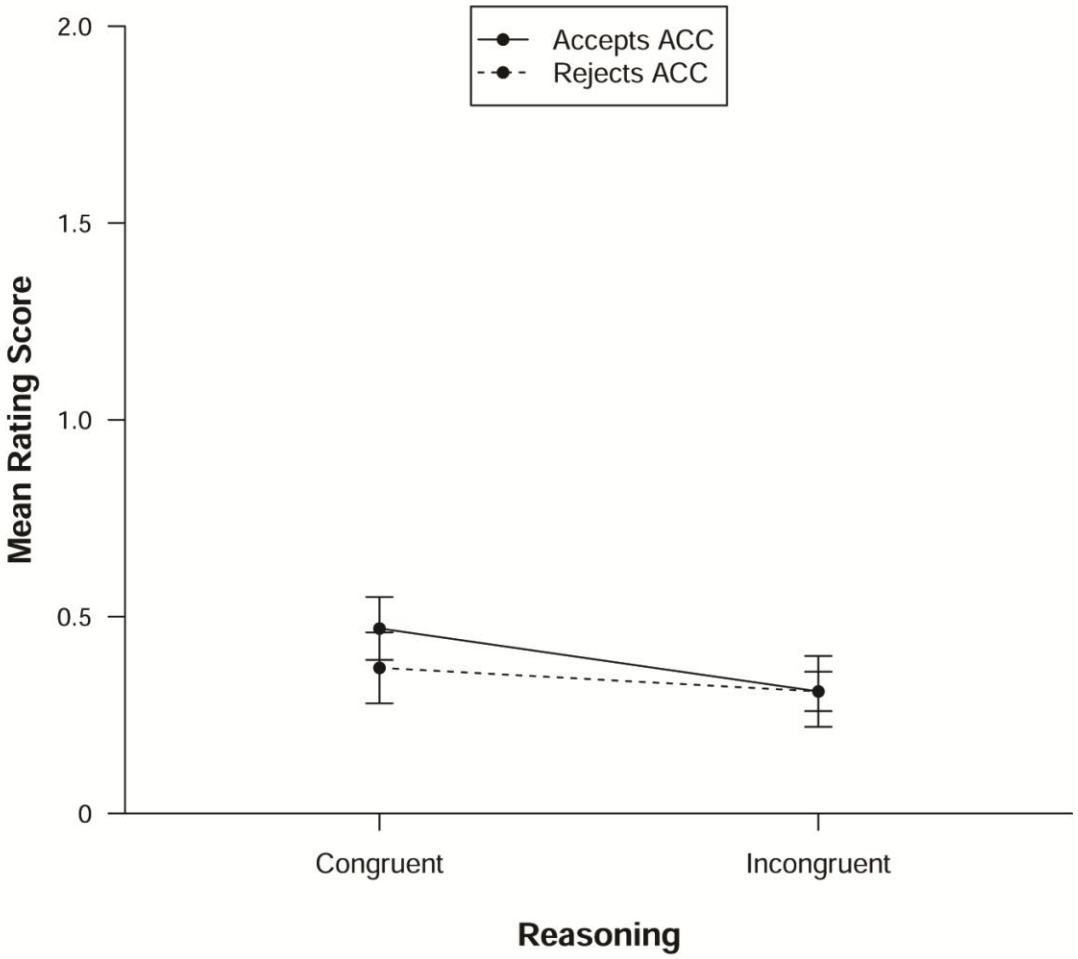


Figure 3. Reasoning differences for invalid statements by anthropogenic climate change belief. Error bars represent 95% confidence interval.

Predictors of Reasoning Sub-categories. The qualitative scoring of vignette responses resulted in 8 scored categories for each written response and was rich for further analysis beyond the main motivated reasoning variable. Four hierarchical multiple regression analyses were run to test whether belief in anthropogenic climate change could be predicted by psychological and ideological variables beyond that of demographic variables for both the valid and invalid components of motivated reasoning as well as both total valid and invalid reasoning (not taking into account congruence of argument).

Demographic variables in step 1 were not significant predictors of motivated reasoning assessing valid statements only, $F(4, 364) = .41$, $p = .80$, $R^2 = .01$. Step 2, with ideological and psychological variables, did not explain a significant increase in variance ($F(5, 359) = 4.07$, $p < .01$, $R^2_{change} = .05$). In step 2, Conservatism was found to be a significant predictor of motivated reasoning with valid statements. Participants higher in conservatism ($sr^2 = .16$) were more likely to engage in motivated reasoning with valid statements. Table 5 presents beta weights and unique variance explained for each predictor variable.

Table 5
Hierarchical MRC: Demographic, Ideological, and Psychological Predictors of Motivated Reasoning (Valid)

Predictors	β	$sr^{2\,a}$	ΔR^2
Step 1: Demographic			.01
Age	.05	.05	
Birth order	-.03	-.03	
College Education	.00	.00	
Gender	.04	.04	
Step 2: Ideological and Psychological variables			.06
ACT	.17**	.16	
Dogmatism	.08	.08	
Need for Cognition	.03	.03	
Neuroticism	-.10	-.09	
Openness to Experience	.00	.00	

Note. *$p < .05$; [a] sr^2 represents unique variance explained; $N = 369$. Gender coded: 1 = male, 2 = female; College education coded: 1 = some college; 2 = no college; Birth order coded: 1 = firstborn, 2 = latterborn.

Motivated reasoning was also analyzed for invalid statements made by participants. Demographic variables in step 1 were not a significant predictor of motivated reasoning in invalid statements ($F(4, 364) = .92$ $p = .45$, $R^2 = .01$). Ideological and psychological variables were not significant predictors of motivated reasoning in invalid statements ($F(9, 359) = 1.78$ $p = .07$, $R^2 = .04$). In fact, no significant predictors were found as can be seen in Table 6.

Table 6
Hierarchical MRC: Demographic, Ideological, and Psychological Predictors of Motivated Reasoning (Invalid)

Predictors	β	$sr^{2\,a}$	ΔR^2
Step 1: Demographic			.01
Age	-.08	-.08	
Birth order	.06	.06	
College Education	.01	.01	
Gender	-.03	-.03	
Step 2: Ideological and Psychological variables			.04
ACT	-.05	-.05	
Dogmatism	.10	.10	
Need for Cognition	-.11	-.08	
Neuroticism	-.08	-.08	
Openness to Experience	-.07	-.05	

Note. $*p < .05$; [a] sr^2 represents unique variance explained; $N = 369$. Gender coded: 1 = male, 2 = female; College education coded: 1 = some college; 2 = no college; Birth order coded: 1 = firstborn, 2 = latterborn.

Two post-hoc hierarchical multiple regression correlation analyses were conducted to test whether belief in anthropogenic climate change could be predicted by psychological and ideological variables beyond that of demographic variables for the total of valid reasoning by participants (i.e., regardless if the focal point of the statement was a strength or weakness for a congruent or incongruent view) as well as the total invalid reasoning.

We found that total valid motivated reasoning was not predicted by demographic variables ($F(4, 364) = 1.28$, $p = .28$, $R^2 = .01$). However, college education ($sr^2 = -.11$) by itself predicted total valid reasoning. Participants with at least some college were more likely to identify strengths and weaknesses that were valid than those with no college education. Ideological and psychological variables were a significant predictor of valid motivated reasoning ($F(9, 359) = 2.30$, $p = .02$, $R^2 = .06$). There was a significant change from Step 1 to Step 2, $F(5, 359) = 3.09$, $p = .01$, $R^2_{change} = .04$. Conservatism

(measured by ACT) and need for cognition were found to be significant predictors in step 2. The more conservative a participant the less likely they were to identify strengths and weaknesses that were valid (sr^2 = -10). Participants were more likely to identify strengths and weaknesses that were valid if they were higher in need for cognition (sr^2 = .12). Table 7 contrast from Tables 5 and 6 due to not focusing on the congruence of the arguments with prior belief but instead on the total valid reasoning by a participant.

Table 7
Hierarchical MRC: Demographic and Ideological and Psychological Predictors of Total Valid Reasoning

Predictors	β	$sr^{2\,a}$	ΔR^2
Step 1: Demographic			.01
Age	.02	.02	
Birth order	-.03	-.03	
College Education	-.11*	-.11	
Gender	.02	.02	
Step 2: Ideological and Psychological variables			.06
ACT	-.11*	-.10	
Dogmatism	.03	.03	
Need for Cognition	.17*	.12	
Neuroticism	.09	.08	
Openness to Experience	-.05	-.03	

Note. *$p < .05$; [a] sr^2 represents unique variance explained; N = 369. Gender coded: 1 = male, 2 = female; College education coded: 1 = some college; 2 = no college; Birth order coded: 1 = firstborn, 2 = latterborn.

We also examined whether invalid statements could be predicted by ideological and psychological variables. Demographic variables were not significant predictors of total invalid reasoning ($F(4, 364) = .50$ $p = .73$, $R^2 = .01$). Nor were ideological and psychological variables ($F(9, 359) = .61$ $p = .79$, $R^2 = .02$). The inability to identify predictors of invalid reasoning, regardless of congruence with prior belief, is presented in Table 8.

Table 8
Hierarchical MRC: Demographic and Ideological and Psychological Predictors of Total Invalid Reasoning

Predictors	β	$sr^{2\,a}$	ΔR^2
Step 1: Demographic			.01
Age	-.03	-.03	
Birth order	.03	.03	
College Education	-.07	-.07	
Gender	.01	.01	
Step 2: Ideological and Psychological variables			.02
ACT	-.04	-.04	
Dogmatism	-.01	-.01	
Need for cognition	-.11	-.08	
Neuroticism	.01	.01	
Openness to Experience	.04	.03	

Note. $*p < .05$; $**p < .01$; [a] sr^2 represents unique variance explained; $N = 369$. Gender coded: 1 = male, 2 = female; College education coded: 1 = some college; 2 = no college; Birth order coded: 1 = firstborn, 2 = latterborn.

Discussion

We predicted that individuals who scored higher in motivated reasoning would be lower in need for cognition, neuroticism, and openness to experience, and more dogmatic and conservative than those who scored low in motivated reasoning. However, we only found evidence for neuroticism and dogmatism predicting motivated reasoning. Motivated reasoning was marked by increased levels of dogmatism and emotional stability (i.e., low levels of neuroticism). We found support for the hypothesis that climate change beliefs are related to the belief that addressing climate change would cause an unnecessary tax burden. Those who believed in climate change and those who believed in anthropogenic climate change predominately disagreed with the view that addressing the issue would cause an unnecessary tax burden; in contrast, those who did not believe in climate change or those who did not believe in anthropogenic climate

change predominately thought that addressing climate change would cause an unnecessary tax burden. We predicted that higher levels of adoption of scientific attitudes would be associated with belief in anthropogenic climate change, but this was not supported. Support was found, however, for our prediction that greater adoption of scientific attitudes would be related to believing that addressing climate change would not cause an unnecessary tax burden.

Group differences in belief in anthropogenic climate change were investigated for a number of psychological and ideological variables. The largest contributor to one's beliefs about ACC was ideological in nature. Those who rejected ACC had higher levels of authoritarianism, conservatism, and traditionalism. Additionally, these individuals had higher levels of emotional stability (a personality trait which is a polar opposite of neuroticism). Notably, the split in belief in ACC was not associated in differences in adoption of scientific attitudes, dogmatism, need for cognition, nor openness to experience. However, we found that those who did not believe in anthropogenic climate change were more likely to engage in motivated reasoning than those who did. Individuals who reject ACC were more likely to provide evidence to support their belief and less likely to provide countering evidence to their view. However, individuals who accepted ACC provided equal reasoning for and against their prior view.

Beyond the primary results, a number of secondary and tertiary examinations were undertaken. After investigating the study's hypotheses, additional analyses were conducted to examine a subset of our motivated reasoning measure that teased apart the contributions of valid and invalid reasoning. Interestingly, individuals who believed in

ACC were more likely to support incongruent evidence than congruent evidence in their valid statements (i.e., ignoring the invalid statements). In contrast, those who did not believe in ACC disproportionately focused in support of congruent evidence, compared to incongruent evidence for valid responses. However, in examining responses deemed invalid, those who believe in ACC were more likely to write invalid statements for the congruent view than the incongruent view (though the effect was considerably smaller than the effect for motivated reasoning in valid statements). Individuals who did not believe in ACC were equally likely to make invalid statements in reference to both congruent and incongruent evidence.

Predictors of the additional motivated reasoning sub-category variables were also analyzed. Individuals were more likely to contribute to the valid components of motivated reasoning if they were conservative and emotionally stable. Our psychological, ideological, and demographic variables did not consistently predict the invalid aspects of motivated reasoning. When not taking into account the direction of reasoning (i.e., for or against anthropogenic climate change) but examining the total of statements deemed valid, individuals who had at least some college, were more liberal, and had a higher need for cognition, were more likely to make valid statements in their reasoning. None of the variables investigated were able to predict total invalid reasoning.

Implications of the Findings

The present study supported the notion that motivated reasoning is a bipartisan endeavor. Although the primary divider between belief in anthropogenic climate change was political orientation, the best indicator of motivated reasoning was not one's political

beliefs, but rather higher levels of dogmatism and emotional stability. However, conservatism was the best predictor of the valid subset of motivated reasoning. This supported the idea that beliefs create a filter through which we process information. It was not that those who rejected anthropogenic climate change were unable to reason effectively. In fact, these individuals in many cases were making valid points to support their belief. Instead, their prior beliefs biased their ability to focus on both congruent and incongruent information in equal terms. There is an impediment to recognizing flaws related to evaluating one's own beliefs, even if he or she can readily find errors in someone else's belief.

Holding a belief congruent with scientific consensus does not bar one from also engaging in biased reasoning. Indeed, there is evidence that many individuals who claim to be scientific and objective in their views also hold beliefs that stand in conflict with empirically gained knowledge. The topic presented in the present work is an issue that largely affects individuals on the conservative side of the political spectrum, but politically left individuals are not free from such biases as motivated reasoning.

As is often true in science, issues are not simply studied and presented. Instead, proposed solutions are attached to the findings. Correspondingly, the present work found a relationship between the view that humans are not primarily causing climate change and believing that addressing climate change will cause an unnecessary tax burden. In regards to climate change, government organizations are often most notably the bodies seen addressing (or at least formally discussing) climate change (e.g., intergovernmental climate change summits, United Nations meeting, etc.). Due to the linking of scientific

knowledge with proposed actions, individuals may reject scientific findings as a function of their dislike for a proposed action (e.g., limiting carbon emissions).

The present finding of conservatism being related to disbelief in anthropogenic climate change is supported by McCright and Dunlap (2011). They found robust evidence for differences in anthropogenic climate change belief based on levels of conservatism in 10 separate nationally representative polls. Notably, evidence for one side of ACC belief having greater scientific literacy or knowledge, as measured by adoption of scientific attitudes, or related constructs like need for cognition and openness to experience, was not supported here. This is congruent with earlier research that did not find a difference in the levels of concern for climate change based on either technical reasoning capacity or science literacy (Kahan et al. 2012).

The relationships between dogmatism, neuroticism, and motivated reasoning are noteworthy. One reason dogmatism continues to be a robust predictor of denial of ACC, may be in part due to its' relationship with emotional stability. Beliefs can be comforting to individuals. Gray and Gallo (2016) found individuals who believed in psychics had higher levels of life satisfaction than those who did not. This has been discussed in terms of extrinsic religiosity as well. Individuals with extrinsic reasons (e.g., seeking comfort, security, and social connections) or intrinsic reasons (e.g., trying to live by a holy book) have been distinguished in their religious orientation (Allport & Ross, 1967). Additionally, people may find comfort in not challenging their views. Engaging in challenging our own beliefs can result in uncomfortable or unpleasant feelings as we wrestle with uncertainty.

Limitations

As is true of all studies, this one has its limitations. Participant responses were completed over the internet and although steps were taken to maintain the integrity of the collected data, accuracy of provided information cannot be guaranteed. Due to the reliance on Amazon's Mechanical Turk system for participants, it is likely that the collected sample is not entirely representative of the larger nation. The creation of two new measures (ACC vignettes and Brief Climate Change Belief Questionnaire) had not been validated prior to the study. Some vignette responses appeared to be driven by motivated reasoning: however, they were removed due to not meeting the inclusion criteria of assessing strengths and weaknesses in the submitted vignette responses. Due to this standard, motivated reasoning was not captured in all of its forms. Additionally, although the ratings were made blind to the participants' belief, it is still possible that the raters' own biases influenced participant scores. The use of two separate rating systems within a single study may have influenced outcome variables used in analysis as well. Birth order was measured by grouping only children with firstborns who have siblings, which could have altered the outcome for this variable.

Future Directions and Concluding Points.

The present research examined motivated reasoning in an issue that has strong political polarization. An obvious direction for future research could be a similarly designed study that primarily drives those on the political left to hold a view incongruent with current scientific understandings. However, an issue where there is roughly equivalent division across the political spectrum may be more fruitful. An example that

may fit this criterion is the debate around genetically modified foods (GMOs). Although this topic is popularly viewed as an issue where liberals tend to be incongruent with science (see Azarian, 2015), recent research suggests that GMOs are actually not polarizing (Kahan, 2015). That is not to say that misinformation is not widely present, however. A recent Pew Research Center poll found that 88% of American Association for the Advancement of Science scientists say that genetically modified foods are generally safe, a fact that contrasts with the 57% of the public who feel that genetically modified foods are unsafe (Pew, 2015). The staggering 45-point difference in opinions between scientists and the general public on this issue highlight the need for more effective transfer of scientific knowledge.

The vignettes used in the present study were purposely written to be structurally similar to how information might be delivered on a television news show (conflict oriented vs. clarity). Two authority-like figures are presented on either side of the issue along with their credentials, followed by the individuals offering reasoning behind their belief. Evidence was introduced based on a study, but was presented in a shallow manner and not scrutinized. As the present study shows, this format is ripe for motivated reasoning to occur within an individual receiving the information. Such a finding is congruent with a prior finding that controversy in presented news information creates more uncertainty in the receiver (Corbett & Durfee, 2004).

In a recent study, evidence suggested that it is possible to reduce incorrect beliefs about climate change through educational information (Ranney & Clark, 2016). By describing the process through which ultraviolet light turns into infrared energy and

creates heat, individuals were able to reduce their level of disbelief in climate change. It is important to expand our understanding of how we can find the 'most distilled representation of an idea' or 'most potent argument' and combine it with an effective presentation in both space and time.

There is concern that individuals are increasingly living in echo chambers. The ability to filter and customize one's media to only include information from sources already approved of and endorsed has never been easier. An individual can easily foster and reinforce an unwillingness to engage with contradicting information by selectively choosing their own news sources. News coverage has been identified as creating a platform for misinformation (e.g., MMR vaccination; see Speers and Lewis, 2004). Although social media is no exception to spreading misinformation, it also has the potential to remedy it. Bode and Vraga (2015) found that by presenting correct information in an adjacent visual space ('related stories'), misperceptions can be reduced. Admittedly, finding successful strategies for getting individuals the right information can be challenging--though the importance should not be understated.

Climate change as a topic was chosen partly because in the 21st century we have the ability to utterly transform Earth's landscape. The abilities to create, alter, and destroy have never been so great in their magnitude nor ease. Given the potential for greater consequences, there is greater importance upon our decision-making and reasoning about issues in relatively objective and less biased ways. Recognizing that motivated reasoning is a widespread phenomenon, information generation should be artful in its dissemination. The ability to make good decisions depends on good information, or more

specifically, on well understood and well-reasoned-about information—especially when that information may contradict our already held beliefs.

References

Aghababaei, N. (2012). Religious, honest and humble: Looking for the religious person within the HEXACO model of personality structure. *Personality and Individual Differences*, *53*, 880–883.

Alker, H. A., & Hermann, M. (1971). Are bayesian decisions artificially intelligent? The effect of task and personality on conservatism in processing information. *Journal of Personality and Social Psychology*, *19*, 31–41.

Allport, G. W., & Ross, J. M. (1967). Personal religious orientation and prejudice. *Journal of Personality and Social Psychology*, *5*, 432–443.

Altemeyer, B. (1996). Dogmatism. In B. Altemeyer, The authoritarian specter. Cambridge, MA: Harvard University Press.

Azarian, B. (2015, February 25). Spreading Pseudoscience: 5 reasons why some liberals are as bad as conservatives | Huffington Post. Retrieved September 18, 2016, from http://www.huffingtonpost.com/bobby-azarian/spreading-pseudoscience-5-reasons-liberals_b_6694374.html

Berinsky, A. J., Huber, G. A., & Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon.com's mechanical turk. *Political Analysis*, *20*, 351–368.

Bettinghaus, E., Miller, G., & Steinfatt, T. (1970). Source evaluation, syllogistic content, and judgments of logical validity by high- and low-dogmatic persons. *Journal of Personality and Social Psychology*, *16*, 238–244.

Bode, L., & Vraga, E. K. (2015). In related news, that was wrong: The correction of misinformation through related stories functionality in social media. *Journal of Communication*, *65*, 619–638.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's mechanical turk: A new source of inexpensive, yet high quality, data? *Perspectives on Psychological Science*, *6*, 3–5.

Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology*, *42*, 116–131.

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment*, *48*, 306–307.

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., …

Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*, 024024

Corbett, J. B., & Durfee, J. L. (2004). Testing public (un)certainty of science: Media representations of global warming. *Science Communication*, *26*, 129–151.

Crowson, H. M., DeBacker, T. K., & Davis, K. A. (2008). The DOG Scale: A valid measure of dogmatism? *Journal of Individual Differences*, *29*, 17-24.

Crowson, H. M. (2009). Does the DOG scale measure dogmatism? Another look at construct validity. *The Journal of Social Psychology*, *149*, 365–383.

Digman, J. M., & Inouye, J. (1986). Further specification of the five robust factors of personality. *Journal of Personality and Social Psychology*, *50*, 116–123.

Donahue, M. J. (1985). Intrinsic and extrinsic religiousness: Review and meta-analysis. *Journal of Personality and Social Psychology*, *48*, 400–419.

Duckitt, J., Bizumic, B., Krauss, S. W., & Heled, E. (2010). A tripartite approach to right-wing authoritarianism: The authoritarianism-conservatism-traditionalism model. *Political Psychology*, *31*, 685–715.

Ekehammar, B. O., Akrami, N., Gylje, M., & Zakrisson, I. (2004). What matters most to prejudice: Big five personality, social dominance orientation, or right-wing authoritarianism? *European Journal of Personality*, *18*, 463–482.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *The American Psychologist*, *49*, 709–724.

Ernst, C., & Angst, J. (1983). Birth order: Its influence on personality. Berlin and New York: Springer-Verlag.

Feist, G. J. (2006). *The psychology of science and the origins of the scientific mind*. New Haven, Conn: Yale University Press.

Feist, G. J. (2012). Predicting interest in and attitudes toward science from personality and need for cognition. *Personality and Individual Differences*, *52*, 771–775.

Festinger, L., Riecken, H. W., & Schacter, S. (1956). When prophecy fails. In E. E. Maccoby, T. M. Newcomb & E. L. Hartley (Eds.), *Readings in Social Psychology* (3rd Edition, p. 156 – 163).

Fraser, Barry J. *Test of science related attitudes*. Educational Testing Service, 1981.

Gallup. (2014, April 22). One in four in U.S. are solidly skeptical of global warming. Retrieved from http://www.gallup.com/poll/168620/one-four-solidly-skeptical-global-warming.aspx

Gallup. (2016, March 16). U.S. concern about global warming at eight-year high. Retrieved August 20, 2016, from http://www.gallup.com/poll/190010/concern-global-warming-eight-year-high.aspx

Gauthier, K. J., Christopher, A. N., Walter, M. I., Mourad, R., & Marek, P. (2006). Religiosity, religious doubt, and the need for cognition: Their interactive relationship with life satisfaction. *Journal of Happiness Studies*, *7*, 139–154.

Goff, M., & Ackerman, P. L. (1992). Personality-intelligence relations: Assessment of typical intellectual engagement. *Journal of Educational Psychology*, *84*, 537–552.

Goldberg, L. R. (1999). A broad-bandwidth, public-domain, personality inventory measuring the lower-level facets of several five-factor models. *Personality Psychology in Europe*, *7*, 7–28.

Gray, S. J., & Gallo, D. A. (2015). Paranormal psychic believers and skeptics: a large-scale test of the cognitive differences hypothesis. *Memory & Cognition*, (2016), 242–261.

Gwet, K. L. (2008). Computing inter-rater reliability and its variance in the presence of high agreement. *British Journal of Mathematical and Statistical Psychology*, *61*, 29–48.

Harris, P.L., Brown, E., Marriott, C., Whittall, S., & Harmer, S. (1991). Monsters, ghosts and witches: Testing the limits of the fantasy-reality distinction in young children. *British Journal of Developmental Psychology*, *9*, 105–123.

Henningsgaard, J. M., & Arnau, R. C. (2008). Relationships between religiosity, spirituality, and personality: A multivariate analysis. *Personality and Individual Differences*, *45*, 703–708.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative Big Five Trait taxonomy: History, measurement, and conceptual issues. In R. J. Sternberg (Ed.), Handbook of creativity (3rd ed., pp. 114–158). Cambridge, England: Cambridge University Press. New York, NY: Guilford Press.

John, O. P.,&Srivastava, S. (1999). The Big Five Trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John (Eds.), Handbook of personality: Theory and research (2nd ed., pp. 102–138).

Jost, J. T., Glaser, J., Kruglanski, A. W., & Sulloway, F. J. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin, 129*, 339–375.

Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*, 732–735.

Kahan, D. M. (2015). Climate-science communication and the measurement problem. *Political Psychology*, *36*, 1-43.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. *The Psychology of Intuitive Judgment*, *49*, 49–81.

Kahoe, R. D. (1974). Personality and achievement correlates of intrinsic and extrinsic religious orientations. *Journal of Personality and Social Psychology*, *29*, 812–818.

Kardash, C. M., & Scholes, R. J. (1996). Effects of preexisting beliefs, epistemological beliefs, and need for cognition on interpretation of controversial issues. *Journal of Educational Psychology*, *88*, 260–271.

Klaczynski, P. A. (1997). Bias in adolescents' everyday reasoning and its relationship with intellectual ability, personal theories, and self-serving motivation. *Developmental Psychology, 33*, 273–283.

Klaczynski, P. A., & Narasimham, G. (1998). Development of scientific reasoning biases: Cognitive versus ego-protective explanations. *Developmental Psychology, 34*, 175–87.

Klaczynski, P. A., & Robinson, B. (2000). Personal theories, intellectual ability, and epistemological beliefs: Adult age differences in everyday reasoning biases. *Psychology and Aging*, *15*, 400–416.

Kunda, Z. (1990). The case for motivated reasoning. *Psychological bulletin, 108*, 480.

Langer, E.J. (1975). The illusion of control. *Journal of Personality and Social Psychology*, *32*, 311–328.

Lindeman, M. (1998). Motivation, cognition and pseudoscience. *Scandinavian Journal of Psychology*, *39*, 257–265.

Markovits, H., & Nantel, G. (1989). The belief-bias effect in the production and evaluation of logical conclusions. *Memory & Cognition*, *17*, 11–17.

Matute, H., Yarritu, I., & Vadillo, M. a. (2011). Illusions of causality at the heart of pseudoscience. *British Journal of Psychology*, *102*, 392–405.

McAuliff, B. D., & Kovera, M. B. (2008). Juror need for cognition and sensitivity to methodological flaws in expert evidence. *Journal of Applied Social Psychology*, *38*, 385–408.

McCright, A. M. (2011). Political orientation moderates Americans' beliefs and concern about climate change. *Climatic Change*, *104*, 243–253.

Mccright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001-2010. *Sociological Quarterly*, *52*, 155–194.

Mikulak, A. (2011). Mismatches between "scientific" and "non-scientific" ways of knowing and their contributions to public understanding of science. *Integrative Psychological & Behavioral Science*, *45*, 201–215.

Miller, M., Boyer, M. J., Butow, P. N., Gattellari, M., Dunn, S. M., & Childs, A. (1998). The use of unproven methods of treatment by cancer patients. Frequency, expectations and cost. *Supportive Care in Cancer*, *6*, 337–347.

Newport, F., & Strausberg, M. (2001, June 8). *Americans' belief in psychic and paranormal phenomena is up over last decade*. Retrieved April 19, 2014, from http://www.gallup.com/poll/4483/americans-belief-psychic-paranormal-phenomena-over-last-decade.aspx

Moore, D.W. (2005) *Three in four Americans believe in paranormal*. Retrieved November 15, 2013, from http://www.gallup.com/poll/16915/three-four-americans-believe-paranormal.aspx?version=print

Munshi, A., Ni, L. H., & Tiwana, M. S. (2008). Complementary and alternative medicine in present day oncology care: Promises and pitfalls. *Japanese Journal of Clinical Oncology*, *38*, 512–520.

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*, 175–220.

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. a. (2014). Cognitive style and religiosity: The role of conflict detection. *Memory & Cognition*, *42*, 1–10.

Peterman, A. H., Fitchett, G., Brady, M. J., Hernandez, L., & Cella, D. (2002). Measuring

spiritual well-being in people with cancer: The functional assessment of chronic illness therapy--spiritual well-being scale (FACIT-Sp). *Annals of Behavioral Medicine*, *24*, 49–58.

Pew Research Center. (2015, January 29). What Americans and scientists think about science. Retrieved from http://www.pewresearch.org/fact-tank/2015/01/29/5-key-findings-science/

Ranney, M. A., & Clark, D. (2016). Climate change conceptual change: scientific information can transform attitudes. *Topics in cognitive science, 8*, 49-75.

Riccardo Lo Martire (2016). rel: Reliability Coefficients. R package version 1.1.0. http://CRAN.R-project.org/package=rel

Rips, L. J. (1990). Reasoning. *Annual Review of Psychology*, *41*, 321–353.

Rohrer, J. M., Egloff, B., & Schmukle, S. C. (2015). Examining the effects of birth order on personality. *Proceedings of the National Academy of Sciences*, *112*, 14224-14229.

Sadowski, C. J., & Cogburn, H. E. (1997). Need for cognition in the big-five factor structure. *The Journal of Psychology*, *131*, 307–312.

Saroglou, V. (2002). Religion and the five factors of personality: A meta-analytic review. *Personality and Individual Differences*, *32*, 15–25.

Schooler, C. (1962). Birth order effects: Not here, not now! *Psychological Bulletin*, *59*, 257–272.

Shermer, M. (2002). *Why people believe weird things: Pseudoscience, superstition, and other confusions of our time*. New York: A.W.H. Freeman/Owl Book.

Speers, T., & Lewis, J. (2004). Journalists and jabs: Media coverage of the MMR vaccine. *Communication & Medicine*, *1*, 171-181.

Stanovich, K. E., & West, R. F. (1998). Individual differences in rational thought. *Journal of Experimental Psychology: General*, *127*, 161–188.

Sulloway, F. J. (1995). Birth order and evolutionary psychology: A meta-analytic overview. *Psychological Inquiry*, *6*, 75–80.

Sulloway, F. J. (1997). *Born to rebel: Birth order, family dynamics, and creative lives*. New York: Vintage Books.

Thórisdóttir, H., & Jost, J. T. (2011). Motivated closed-mindedness mediates the effect of threat on political conservatism. *Political Psychology*, *32*, 785–811.

Ventis, W. L. (1995). The relationships between religion and mental health. *Journal of Social Issues*, *51*, 33–48.

Wang, Y. J., Hernandez, M. D., Minor, M. S., & Wei, J. (2012). Superstitious beliefs in consumer evaluation of brand logos: Implications for corporate branding strategy. *European Journal of Marketing*, *46*, 712–732.

Woo, S. E., Harms, P. D., & Kuncel, N. R. (2007). Integrating personality and intelligence: Typical intellectual engagement and need for cognition. *Personality and Individual Differences*, *43*, 1635–1639.

Yarritu, I., Matute, H., & Vadillo, M. A. (2013). Illusion of control: The role of personal involvement. *Experimental Psychology*, *61*, 1–10.

Appendix A
Anthropogenic Climate Change Vignettes

Note. Text within brackets is for descriptive purposes and did not appear in the survey. Participants received either vignette #1 or #2, which offer counterbalanced presentation of viewpoints/scientists.

[First page]
On the following page, you will be asked to read and evaluate an excerpt from a debate on causes of climate change. Both sides of the debate are presented along with some evidence. We want you to carefully read and evaluate both sides of the argument and discuss any strengths and/or weaknesses you see in either side. List as many strengths and/or weaknesses as you can think of for BOTH positions. Your thoughts are important to us, so be sure to express them clearly. You may take as long as you wish.

Did you fully read the instructions above? (Please do so if you have not) [yes/no]

[Second page]
Instructions: Read the following short passage and identify strengths AND weakness, if any, you see in the argument or evidence presented. Please fully explain your response in the boxes below. Write your answers in full, complete sentences. Try to write at least a couple of sentences per answer.

#1 An issue that has received considerable public attention is that of climate change. Climate change has inspired a great deal of debate and has prominent individuals on all sides of the issue. The biggest disagreement arises not so much about whether climate change exists, but rather whether the current period of change is caused by humans or is just in a natural cycle. Dr. Helmholtz and Dr. Freedlander are both scientists who study climate change. Dr. Helmholtz, a member of the American Meteorological Society, does not believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. He conducted a study that found that climate has varied throughout its history and cites this as his primary reason for his belief. Dr. Freedlander, however, a member of the World Meteorological Organization, does believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. He primarily believes this due to a study he conducted that found that 2014 was hotter than 1990.

#2 An issue that has received considerable public attention is that of climate change. Climate change has inspired a great deal of debate and has prominent individuals on all sides of the issue. The biggest disagreement arises not so much about whether climate change exists, but rather whether the current period of change is caused by humans or is just in a natural cycle. Dr. Freedlander and Dr. Helmholtz are both scientists who study climate change. Dr. Freedlander, a member of the World Meteorological Organization, believes that humans' contribution to rising CO_2 levels is primarily driving global climate change. He conducted a study that found that 2014 was hotter than 1990 and cites this as

his primary reason for his belief. Dr. Helmholtz, however, a member of the American Meteorological Society, does not believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. He primarily believes this due to a study he conducted that found that climate has varied throughout its history and cites this as his primary reason for his belief.

Appendix B
Examples of Vignette Responses

Note. An ampersand in-between quotations denotes both responses from a single participant. Typos were cleaned up to improve readability in some of the provided responses.

Examples of Appeal to Authority fallacies:

"The only strength behind Dr. Freedlander is that he is a member of the world meteorological origination, which seems like a fairly exclusive group. I would think you would need good credentials to get into it."

"Dr. Freedlander is a member of the World Meteorological Organization meaning he is looking to see how climate change effects the entire world not just one country, that is a strength."

"Dr. Helmholtz is from the American Meteorological Organization meaning that he primarily looks out for the best interest of his country (America), this may be considered a weakness"

Examples of participants using reasoning error of saying a particular stance is "common sense/intuitive/logical":

"Dr. Helmholtz did not cite any studies in support of his view. Also, his view does not make common sense." & "I personally do believe that climate change is happening and it's a matter of common sense. Dr. Freedlander's view is in accordance with mine, although for different reasons. A strength is that he have a scientific study he can cite in support of his belief. I don't, but again, I feel it's a matter of common sense. Another strength is that he happens to be correct."

"The strength of his argument is that it is simple and intuitive."

"Dr. Helmholtz did not cite any studies in support of his view. Also, his view does not make common sense."

"Helmholtz weaknesses: Yes, climate change has varied, but to what degree? He doesn't address any specifics, and he doesn't address the current acceleration. Strength: I guess that his belief makes logical sense."

Motivated Reasoning Examples:

"The Strength for Dr. Freedlander is the comparative analysis of temperatures between 2014 and 1990. This data lends credence to his theories." & "Dr. Helmholtz weakness in his argument is a lack of empirical data to support his claim. Anyone can say something is true based on history or observation, but unless there is data to back it up you can't believe them."

"Dr. Freedlander to me doesn't have any strengths, his weakness is that he doesn't have much evidence of study or findings for his beliefs." & "Dr.Helmholtz strength of argument, I believe, is that climate temperatures have varied throughout history. I don't really see any weaknesses here."

Examples of equivalent reasoning:

"Dr Freedlander's argument simply looks at a point in time in the past, and notices that it is hotter now. therefore, he concludes, humans are responsible. this fails to take into consideration other factors, or even natural variation in the climate system." & "Dr Helmholtz's argument, that climate has always fluctuated and this is the reason for global warming, is also unsophisticated and limited. He fails to take into consideration factors like C02 that might be driving current climate change."

"Just comparing two arbitrary dates whether it was hotter or not is not enough convince most people in my opinion. It would be better to show a comparison of many dates to show a trend of rising temperatures." & "I think it is obvious that climate has varied throughout history but can his study show that climate has changed as drastically as it right now in another point in history?"

Example of off topic discussion:

"Dr. Freedlander is either an idiot or a puppet for the elites. That's a huge weakness. The biggest factor of climate change is the sun.. always has been and always will be. So, now humans must be exterminated because we exhale CO2? WHAT?" & "Dr. Helmholtz is reasonable, that is his strength."

Examples of items deemed not to address the prompt of assessing strengths and weaknesses in the respective scientists' arguments:

"Climate change is happening and I don't care what anyone says."

"The earth was all mostly ice once during the Ice Age, so what's to say there isn't going to be a "Hot Age"?"

"Very smart" [referencing Freedlander] & "Seems ignorant of evidence" [referencing Helmholtz]

"Humans may have some to do with change but it will still happen no matter if humans are here are not so it doesn't matter when it comes down to it. "

"He is quick to go to the crowd" [referencing Freedlander] & "Dr. Helmholtz seems to be argumentative"

"Believe that climate change contributed by humans' " & "doesn't believe that humans' contributing to global climate change"

Examples of unrated participant responses due to solely copying vignette text as their responses:

"Dr. Freedlander believes that humans are contributing to climate change through rising CO2 levels. His study found that 2014 is hotter than 1990."

"... Dr. Helmholtz says he found through a study that climate has varied throughout all of history and does not think it is humans that are causing it. "

"Dr. Freedlander conducted a study that found that 2014 was hotter than 1990 and cites this as his primary reason for his belief. Dr. Freedlander is a member of the World Meteorological Organization." & "Dr. Helmholtz is a member of the American Meteorological Society. He conducted a study that found that climate has varied throughout its history and cites"

Appendix C
Short Form of the Need for Cognition Scale

Instructions: For each of the statements below, please indicate to what extent the statement is characteristic of you. If the statement is extremely uncharacteristic of you (not at all like you) please write a "1" to the left of the question; if the statement is extremely characteristic of you (very much like you) please write a "5" next to the question. Of course, a statement may be neither extremely uncharacteristic nor extremely characteristic of you; if so, please use the number in the middle of the scale that describes the best fit. Please keep the following scale in mind as you rate each of the statements below: 1 = extremely uncharacteristic; 2 = somewhat uncharacteristic; 3 = uncertain; 4 = somewhat characteristic; 5 = extremely characteristic.

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.*
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.*
5. I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.*
6. I find satisfaction in deliberating hard and for long hours.
7. I only think as hard as I have to.*
8. I prefer to think about small, daily projects to long-term ones.*
9. I like tasks that require little thought once I've learned them.*
10. The idea of relying on thought to make my way to the top appeals to me.
11. I really enjoy a task that involves coming up with new solutions to problems.
12. Learning new ways to think doesn't excite me very much.*
13. I prefer my life to be filled with puzzles that I must solve.
14. The notion of thinking abstractly is appealing to me.
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.*
17. It's enough for me that something gets the job done; I don't care how or why it works.*
18. I usually end up deliberating about issues even when they do not affect me personally.

Note. * Denotes reverse scoring.

Appendix D
Openness to Experience & Neuroticism

Instructions: For each of the statements below, please indicate to what extent you agree with the statement.

1. I see myself as someone who... is original, comes up with ideas
2. I see myself as someone who... is depressed, blue
3. I see myself as someone who... is curious about many things
4. I see myself as someone who... is relaxed, handles stress well*
5. I see myself as someone who... is ingenious, a deep thinker
6. I see myself as someone who... can be tense
7. I see myself as someone who... has an active imagination
8. I see myself as someone who... worries a lot
9. I see myself as someone who... is inventive
10. I see myself as someone who... is emotionally stable, not easily upset*
11. I see myself as someone who... values artistic, aesthetic experiences
12. I see myself as someone who... can be moody
13. I see myself as someone who... prefers work that is routine*
14. I see myself as someone who... remains calm in tense situations*
15. I see myself as someone who... likes to reflect, play with ideas
16. I see myself as someone who... gets nervous easily
17. I see myself as someone who... has few artistic interests*
18. I see myself as someone who... is sophisticated in art, music, or literature

Note. * Denotes reverse scoring. A 5-point Likert scale was used. Openness to Experience & Neuroticism are sub-scales from the Big Five Inventory (BFI). Openness to Experience items: 1, 3, 5, 7, 9, 11, 13, 15, 17. Neuroticism items: 2, 4, 6, 8, 10, 12, 14, 16, 18.

Appendix E
Authoritarian-Conservatism-Traditionalism (ACT) Scale

Instructions: The following statements express social attitudes and opinions with which people may disagree or agree. Please indicate to what extent you personally disagree or agree with each statement by circling the number (ranging from -4 to +4) that best reflects your degree of disagreement or agreement with that statement.

1. Strong, tough government will harm not help our country.*
2. It's great that many young people today are prepared to defy authority.*
3. Nobody should stick to the "straight and narrow." Instead people should break loose and try out lots of different ideas and experiences.*
4. Being kind to loafers or criminals will only encourage them to take advantage of your weakness, so it's best to use a firm, tough hand when dealing with them.
5. What our country <u>needs</u> most is discipline, with everyone following our leaders in unity.
6. The "old-fashioned ways" and "old-fashioned values" still show the best way to live.
7. Our society does NOT need tougher government and stricter laws.*
8. Students at high schools and at university must be encouraged to challenge, criticize, and confront established authorities.*
9. God's laws about abortion, pornography, and marriage must be strictly followed before it is too late.
10. The facts on crime and the recent public disorders show we have to crack down harder on troublemakers, if we are going preserve law and order.
11. Obedience and respect for authority are the most important virtues children should learn.
12. There is absolutely nothing wrong with nudist camps.*
13. Our prisons are a shocking disgrace. Criminals are unfortunate people who deserve much better care, instead of so much punishment.*
14. Our country will be great if we show respect for authority and obey our leaders.
15. This country will flourish if young people stop experimenting with drugs, alcohol, and sex, and pay more attention to family values.
16. The way things are going in this country, it's going to take a lot of "strong medicine" to straighten out the troublemakers, criminals, and perverts.
17. People should be ready to protest against and challenge laws they don't agree with.*
18. There is nothing wrong with premarital sexual intercourse.
19. We should smash all the negative elements that are causing trouble in our society.
20. People should be allowed to make speeches and write books urging the overthrow of the government.*
21. Traditional values, customs, and morality have a lot <u>wrong</u> with them.*
22. The situation in our country is getting so serious, the strongest methods would be justified if they eliminated the troublemakers and got us back to our true path.

23. The more people there are that are prepared to criticize the authorities, challenge and protest against the government, the better it is for society.*
24. Everyone should have their own lifestyle, religious beliefs, and sexual preferences, even if it makes them different from everyone else.*
25. People who say our laws should be enforced more strictly and harshly are wrong. We need greater tolerance and more lenient treatment for lawbreakers.*
26. People should stop teaching children to obey authority.*
27. The radical and sinful new ways of living and behaving of many young people may one day destroy our society.
28. The courts are right in being easy on drug offenders. Punishment would not do any good in cases like these.*
29. The real keys to the "good life" are respect for authority and obedience to those who are in charge.
30. Trashy magazines and radical literature in our communities are poisoning the minds of our young people.
31. What our country really needs is a tough, harsh dose of law and order.
32. The authorities should be obeyed because they are in the best position to know what is good for our country.
33. It is important that we preserve our traditional values and moral standards.
34. Capital punishment is barbaric and never justified.*
35. Our leaders should be obeyed without question.
36. People should pay less attention to the bible and the other old-fashioned forms of religious guidance, and instead develop their own personal standards of what is moral and immoral.*

Note. * Denotes reverse scoring. Authoritarianism items: 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34. Conservatism items: 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35. Traditionalism items: 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36.

Appendix F
The DOG Scale

Instructions: For each of the statements below, please indicate to what extent you agree with the statement. If you completely agree with the statement, select "4." If you completely disagree with the statement, select "-4." Of course, you may be uncertain of your agreement with a statement, if so, please select "0."

X. I may be wrong about some of the little things in life, but I am quite certain I am right about all the BIG issues.
Y. Someday I will probably think that many of my present ideas were wrong.
1. Anyone who is honestly and truly seeking the truth will end up believing what I believe.
2. There are so many things we have not discovered yet, nobody should be absolutely certain his beliefs are right.*
3. The things I believe in are so completely true, I could never doubt them.
4. I have never discovered a system of beliefs that explains everything to my satisfaction.
5. It is best to be open to all possibilities and ready to reevaluate all your beliefs.*
6. My opinions are right and will stand the test of time.
7. Flexibility is a real virtue in thinking, since you may well be wrong.*
8. My opinions and beliefs fit together perfectly to make a crystal-clear "picture" of things.
9. There are no discoveries or facts that could possibly make me change my mind about the things that matter most in life.*
10. I am a long way from reaching final conclusions about the central issues in life.*
11. The person who is absolutely certain she has the truth will probably never find it.
12. I am absolutely certain that my ideas about the fundamental issues in life are correct.*
13. The people who disagree with me may well turn out to be right.*
14. I am so sure I am right about the important things in life, there is no evidence that could convince me otherwise.
15. If you are "open-minded" about the most important things in life, you will probably reach the wrong conclusions.*
16. Twenty years from now, some of my opinions about the important things in life will probably have changed.
17. "Flexibility in thinking" is another name for being "wishy-washy."*
18. No one knows all the essential truths about the central issues in life.
19. Someday I will probably realize my present ideas about the BIG issues are wrong.
20. People who disagree with me are just plain wrong and often evil as well.

Note. * Denotes reverse scoring. Questions X & Y will not be used during data analysis. They are only present to familiarize participants with the type of questions the scale seeks

to have answered.

Appendix G
Adoption of Scientific Attitudes

Instructions: For each of the statements below, please indicate to what extent you agree with the statement. (1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4 = Agree, 5 = Strongly agree)

1. I enjoy reading about things which disagree with my previous ideas.
2. I dislike repeating experiments to check that I get the same results.*
3. I am curious about the world in which we live.
4. Finding out about new things is unimportant.*
5. I like to listen to people whose opinions are different from mine.
6. I find it boring to hear about new ideas.*
7. In science experiments, I like to use new methods which I have not used before.
8. I am unwilling to change my ideas when evidence shows that the ideas are poor.*
9. In science experiments, I report unexpected results as well as expected ones.
10. I dislike listening to other people's opinions.*

Note. * Denotes reverse scoring. Adoption of Scientific Attitudes is a sub-scale of the Test of Science-Related Attitudes (TOSRA).

Appendix H
Brief Climate Change Belief Questionnaire (BCCBQ)

1. Do you believe that climate change (i.e., global warming) is occurring?
    A. Yes
    B. No
2. Do you believe that human activity is primarily causing climate change (i.e., global warming)?
    A. Yes
    B. No
3. Do you believe that addressing climate change will cause an unnecessary tax burden?
    A. Yes
    B. No

Appendix I
Vignette Argument Structure Annotations

#1

An issue that has received considerable public attention is that of climate change. [*Introduce topic*] Climate change has inspired a great deal of debate and has prominent individuals on all sides of the issue. [*Introduce disagreement*] The biggest disagreement arises not so much about whether climate change exists, but rather whether the current period of change is caused by humans or is just in a natural cycle. [*Framing issue*] Dr. Helmholtz and Dr. Freedlander are both scientists who study climate change. [*Introduce individuals*] Dr. Helmholtz, a member of the American Meteorological Society, does not believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. [*Identify stance & appeal to authority*] He conducted a study that found that climate has varied throughout its history and cites this as his primary reason for his belief. [*Methodological reasoning error & red herring*] Dr. Freedlander, however, a member of the World Meteorological Organization, does believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. [*Identify stance & appeal to authority*] He primarily believes this due to a study he conducted that found that 2014 was hotter than 1990. [*Methodological reasoning error & red herring*]

#2

An issue that has received considerable public attention is that of climate change. [*Introduce topic*] Climate change has inspired a great deal of debate and has prominent individuals on all sides of the issue. [*Introduce disagreement*] The biggest disagreement arises not so much about whether climate change exists, but rather whether the current period of change is caused by humans or is just in a natural cycle. [*Framing issue*] Dr. Freedlander and Dr. Helmholtz are both scientists who study climate change. [*Introduce individuals*] Dr. Freedlander, a member of the World Meteorological Organization, believes that humans' contribution to rising CO_2 levels is primarily driving global climate change. [*Identify stance & appeal to authority*] He conducted a study that found that 2014 was hotter than 1990 and cites this as his primary reason for his belief. [*Methodological reasoning error & red herring*] Dr. Helmholtz, however, a member of the American Meteorological Society, does not believe that humans' contribution to rising CO_2 levels is primarily driving global climate change. [*Identify stance & appeal to authority*] He primarily believes this due to a study he conducted that found that climate has varied throughout its history and cites this as his primary reason for his belief. [*Methodological reasoning error & red herring*]

Note. Annotations in brackets are of the preceding sentence.

Appendix J
Vignette Response Rating Manual

Each scientists' position (both Freedlander [for human caused climate change] and Helmholtz [against human caused climate change]) will be rated on four dimensions: two weakness (valid and invalid) and two strengths (valid and invalid). Each box (8 altogether for each participant) will have either a 0 or 1 in it depending on whether it is present or absent.

Coding System

- 0 = not present (weakness or strength) per weakness/strength (i.e., one box can get a score > 1)
- 1 = present (weakness or strength) per weakness/strength (i.e., one box can get a score > 1)

Weaknesses

Valid: legitimate logical or methodological flaws are correctly identified
Invalid: misinterpreted or misunderstood flaw (e.g., they think something is a flaw but it is not)

Strengths

Valid: legitimate logical or methodological strengths are correctly identified
if the person simply describes the position in the vignettes without describing it as a strength or a weakness, then it gets a 0
Invalid: misinterpretations or misunderstood strength (e.g., think something is a strength that is not)

Coding Rules

- If redundant with another answer count as only 1
- If someone misinterprets a weakness point (e.g., they argue the opposite of what the Dr. was saying), then mark 1 for invalid weakness; if they misinterpret a strength point, then mark 1 for invalid strength
- If irrelevant, mark a zero
- If someone says the method of collecting data over time is a strength, that is valid but if they use that to draw a conclusion about human caused change that is invalid
- If someone says one argument is more valid than another that is invalid (b/c they are equally flawed) strength or weakness depending on context
- If blank/nothing written, give zero
- If someone argues for one vignette in the context of the other vignette, still rate the first vignette on its own (as if it were in the correct box)
- If someone confuses one scientists for the other but it's clear they are discussing one vignette but labeled it with the other name, then rate the vignette not the name

- If people agree with a stance but give no reasoning give it a zero
- If the person merely describes a point in the vignette, count that as a 0; but if they label it as a strength or weakness and it is such, then rate 1 point:
- If the reason is vague (eg., "he doesn't have enough proof") then count as a 0
- Rate each response after taking overall content of both boxes (F & H) into account (i.e., sometimes what they say in one box affects how you rate what they say in another box)
- If they argue that this one study is the main or sufficient evidence then rate that as a invalid strength (by itself one study can't be sufficient evidence)
- If the person makes an inference that goes beyond the vignette (e.g., "A weakness is that CO2 increase could be caused by cattle rather than humans") and it is valid, then rate it as such (1); if it is invalid, rate it as such (0)
- If the person says doing a study is a strength, then rate that a valid strength

Partial List of Valid Weaknesses

- No details of how studies were conducted; too small of a time frame (1990-2014; Freedlander)
- Freedlander believes humans are causing climate change
- Draws overall conclusions from just one study
- No evidence of how reliable and valid the assessments were.
- No evidence presented that directly implicates humans or natural cycles; differences (over time) don't identify cause of difference; no evidence of cause
- Both ignore the real evidence of looking at pre and post Industrial Revolution changes (when humans really started to use carbon based machines and engines)
- No evidence of the overall scientific literature (what do most studies show?); only one study presented
- Ignores evidence that modern CO_2 levels are higher than ever
- Argument is mostly just opinion
- Helmholtz doesn't compare CO_2 levels over time, just states they are changing
- Helmholtz: time points are not clear
- If they point out that these studies are not sufficient to draw conclusions from

Partial List of Invalid Weaknesses

- Scientist defends his study
- It may be biased
- Can be attributed to cattle (because cattle contribute to methane not CO_2)
- Helmholtz: believes we are not responsible when we are at least a bit
- Only climatologists can make scientific statements about climate
- One person did the study
- If someone argues that the article/paper was not peer reviewed and therefore is a weakness, we will rate that as invalid weakness
- Study is not logical/makes sense/intuitive/common sense

Partial List of Valid Strengths:

- Conducted an (empirical/scientific) study
- Measured temperature over time (Freedlander's increases and Helmholtz varied temperature)
- Has data on temperature increase
- Helmholtz: studies temperature over a long(er) period of time
- If they state the person was a scientist and that the person conducted a study
- The studies presented say nothing about other sources of climate change such as methane (produced by cattle)

Partial List of Invalid Strengths:

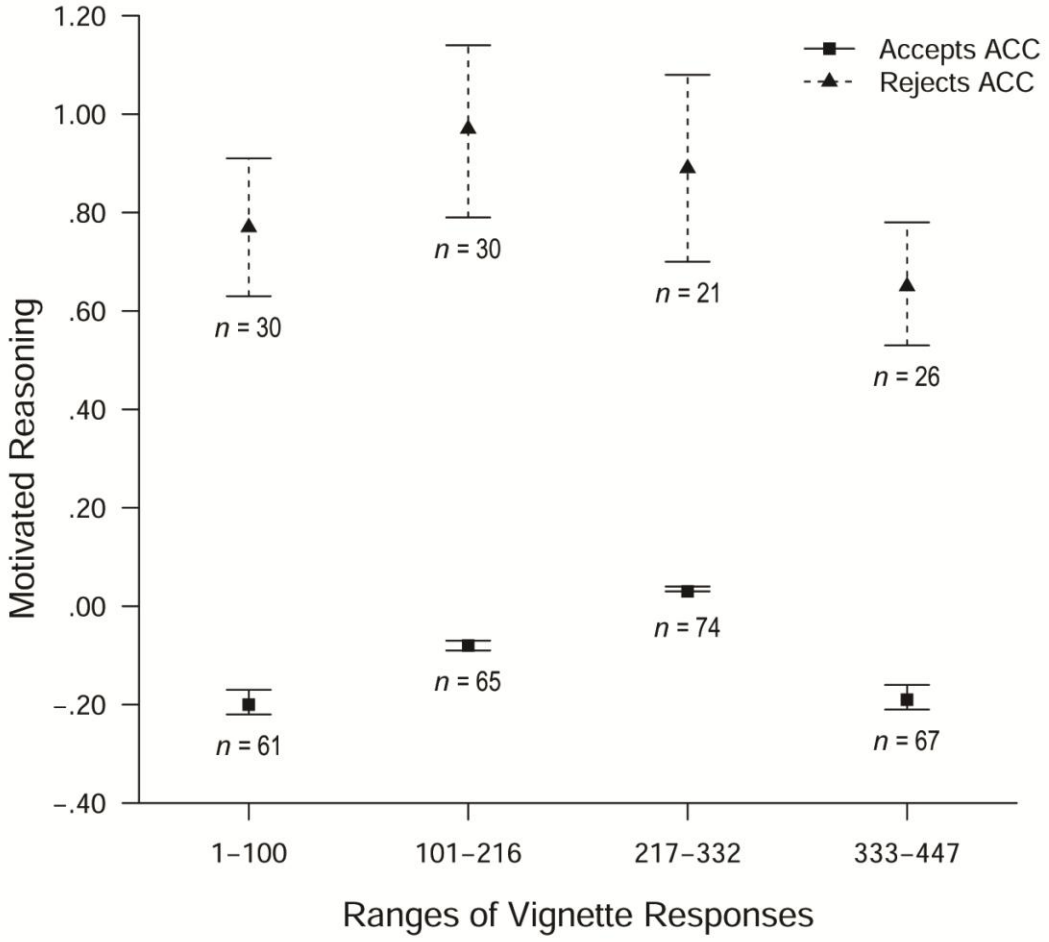
- Members of scientific organizations
- Someone believes or doesn't believe humans are causing it based on this one study
- He has studied this question
- If they only state the person was a scientist and that is all
- If they argue that two time points are enough to draw a valid conclusion
- Study is logical/makes sense/intuitive/common sense

Appendix K
Gwet AC2 Inter-rater Agreement Results

	# of Ratings	*For VS*	*For IS*	*For VW*	*For IW*	*Against VS*	*Against IS*	*Against VW*	*Against IW*	*# of Raters*
Pilot (1-50)										
Rater 1	42	.81	74	.82	.93	.79	.66	.94	.93	2
Rater 2	42	.85	.79	.72	.89	.77	.77	.71	.68	2
Rater 3	42	.91	.71	.81	.89	.86	.71	.76	.75	2
Thesis (1-100)										
Rater 1	91	.84	.86	.91	.94	.73	.81	.81	.95	2
Rater 2	91	.84	.82	.90	.86	.67	.73	.82	.88	2
Rater 3	91	.82	.88	.88	.90	.66	.85	.81	.90	2
Thesis (101-447)										
Rater 1 (101-116)	95	.85	.73	.85	.97	.75	.85	.88	.89	2
Rater 2 (217-332)	95	.54	.80	.61	.89	.83	.79	.80	.87	2
Rater 3 (333-447)	93	.78	.83	.79	.91	.65	.79	.84	.96	2
All Raters (101-447)	283	.88	.89	.87	.96	.74	.83	.85	.95	4

Note. "For" denotes belief in ACC & "Against" denotes disbelief in ACC; VS = Valid Strength; IS = Invalid Strength; VW = Valid Weakness; IW = Invalid Weakness; All raters were compared to author's ratings for inter-rater assessment. 'Pilot' denotes earlier data used for rater training purposes only; 'Thesis' denotes data used in the present study. Numbers in parentheses denote ranges of participant responses with '# of Ratings' detailing responses that were deemed ratable.

Appendix L
Motivated Reasoning Scoring Differences Across Raters



Note. ACC denotes Anthropogenic Climate Change belief. Ranges represent slices of the vignette responses dataset. Responses 1-100 were scored by four raters before the responses were deliberated and 100% agreement was reached; Responses 101-216, 217,332, and 333-447 were scored by separate raters in addition to the author, who scored all responses, before the two ratings were averaged into a composite score.

Appendix M
Birth Order

1. How many siblings do you have? (i.e brothers and sisters)
    - Choices: 0-9
2. In your family, what is your birth ranking? (i.e., were you born 1st, 2nd, 3rd, etc.). For example: If you are the eldest or an only child, select 1; if you have one older sibling, select 2.
    - Choices: 1-9
3. What is your son/daughter birth ranking? (i.e., were you the first born son? Or the second born daughter?). For example: you might have been born second, but the first son/daughter. Select the number corresponding to your birth ranking among same-gender siblings.
    - Choices: 1-9
4. What is the age gap between you and your next younger sibling in years? (i.e., the sibling born after you, but not necessarily the youngest in the family) If you do not have an younger sibling select "NA."
    - Choices: NA, 0-Twins, 0-Triplets, 1-20, 20+
5. What is the gender of your next younger sibling? (i.e., the sibling born after you, but not necessarily the youngest in the family) If you do not have an younger sibling select "NA."
    - Choices: NA, male, female
6. What is the age gap between you and your next older sibling in years? (i.e., the sibling born before you, but not necessarily the eldest in the family) If you do not have an older sibling select "NA."
    - Choices: NA, 0-Twins, 0-Triplets, 1-20, 20+
7. What is the gender of your next older sibling? (i.e., the sibling born before you, but not necessarily the oldest in the family) If you do not have an older sibling select "NA."
    - Choices: NA, male, female

Appendix N
Demographic Questionnaire

1. What is your age?
2. What is your gender?
    a. Male
    b. Female
    c. Prefer not to say
3. What is your major in school? (write "NA" if not applicable).
4. What ethnicity do you consider yourself to be?
    a. American Indian / Alaska Native
    b. Asian
    c. Black / African American
    d. Hispanic / Latino
    e. Native Hawaiian / Other Pacific Islander
    f. White
    g. Other
5. Do you live in the United States of America?
6. Which of the following do you identify as?
    a. Christian
    b. Jewish
    c. Mormon
    d. Muslim
    e. Hindu
    f. Buddhist
    g. Agnostic
    h. Atheist
    i. Other
7. What is the highest level of education attained by your mother or female guardian?
    a. Not applicable/I don’t know
    b. She did not attend high school
    c. She did not complete high school
    d. She completed high school or got her G.E.D.
    e. She completed some college classes but did not receive a degree
    f. She received an associate's degree
    g. She received bachelor’s degree
    h. She attended graduate school but did not receive a degree
    i. She received a graduate degree (master's, MBA, Ph.D., etc)
8. What is the highest level of education attained by your father or male guardian?
    a. Not applicable/I don’t know
    b. He did not attend high school
    c. He did not complete high school

d. He completed high school or got her G.E.D.
e. He completed some college classes but did not receive a degree
f. He received an associate's degree
g. He received bachelor's degree
h. He attended graduate school but did not receive a degree
i. He received a graduate degree (master's, MBA, Ph.D., etc)

9. What was your total family income last year (from all sources, before taxes)? This refers to the combined incomes of all individuals living in your home. (Please select one.)
    a. Less than 15,999
    b. $15,999 to $19,999
    c. $20,000 to $29,999
    d. $30,000 to $39,999
    e. $40,000 to $49,999
    f. $50,000 to $59,999
    g. $60,000 to $69,999
    h. $70,000 to $79,999
    i. $80,000 to $89,999
    j. $90,000 or more
10. What was your personal income last year? This refers only to your personal income, and does NOT include the income of others living in your home. (Please select one.)
    a. Less than 15,999
    b. $15,999 to $19,999
    c. $20,000 to $29,999
    d. $30,000 to $39,999
    e. $40,000 to $49,999
    f. $50,000 to $59,999
    g. $60,000 to $69,999
    h. $70,000 to $79,999
    i. $80,000 to $89,999
    j. $90,000 or more

Appendix O
Zero-Order Correlations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1. ACC	--	-.34**	-.17**	.03	-.30**	.05	.51**	-.19**	.01	.03	-.36**	-.49**	.06	.14**	-.01	.04	-.56**	.05	.04	-.42**
2. ACT		--	.11*	-.32**	.91**	-.06	-.30**	.90**	.08	.12*	.15**	.18**	.00	-.12*	-.23**	-.26**	.33**	-.03	-.15**	.90**
3. Age			--	.04	.07	.10*	-.13**	.06	.01	.05	.07	.12*	-.05	-.29**	.06	.10*	.09	-.03	-.05	.15**
4. ASA				--	-.31**	-.05	.06	-.28**	-.17**	.05	-.08	-.02	-.10*	-.16**	.56**	.49**	-.17**	-.09	.12*	-.28**
5. Authoritarianism					--	-.07	-.27**	.77**	.93*	.09	.13*	.14**	.04	-.11*	-.22**	-.27**	.30**	-.03	-.15**	.71**
6. Birth Order						--	.03	-.06	-.11*	.00	.02	-.03	.07	.00	.00	.10*	-.02	.02	-.03	-.04
7. CC							--	-.19**	-.03	.01	-.21**	-.26**	.00	.11*	.00	.07	-.34**	.04	.03	-.33**
8. Conservatism								--	.06	.12*	.09	.10*	.01	-.10*	-.21**	-.22**	.20**	.00	-.17**	.69**
9. DOG									--	-.05	.12*	.09	.09	-.05	-.06	-.01	.09	.00	-.03	.07
10. Gender										--	.01	.04	-.03	.15**	-.09	-.02	-.06	.02	.02	.12*
11. MR											--	.80**	.58**	-.15**	-.04	-.04	.24**	.15**	-.13*	.17**
12. MR Valid												--	-.02	-.14**	.03	.00	.30**	-.03	-.10	.24**
13. MR Invalid													--	-.06	-.10	-.08	-.01	.28**	-.08	-.04
14. Neuroticism														--	-.28**	-.22**	-.07	.03	.04	-.11*
15. NFC															--	.65**	-.11*	-.08	.15**	-.19**
16. Openness																--	-.11*	-.04	.08	-.22**
17. TB																	--	-.01	-.11*	.39**
18. TIR																		--	-.25**	-.04
19. TVR																			--	-.10*
20. Traditionalism																				--

Note. Significance levels: * < .05; ** < .01; ACC = Belief in Anthropogenic Climate Change (0=No, 1=Yes); ACT = Authoritarianism, Conservatism, and Traditionalism composite score; ASA denotes Adoption of Scientific Attitudes; CC= Belief in Climate Change (0=No, 1=Yes); Birth Order coded 1=firstborn, 2=latterborn; Gender coded 0=Male, 1=Female; MR denotes motivated reasoning; TB = Belief addressing CC will cause unnecessary tax burden (0=No, 1=Yes); TIR=Total Invalid Reasoning; TVR=Total Valid Reasoning; Openness denotes Openness to Experience;