Cultural or Scientific Consensus? Cultural Cognition, Climate Science Knowledge, and Policy Preferences

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Abstract

The disconnect between climate scientists and the public regarding climate change is well documented. Many have proposed that educating the public about climate science and/or the scientific consensus concerning climate change can be an effective measure to close the gap. Some evidence has suggested that those that know more about climate change or view a consensus among scientists are more supportive of policies to address climate change. However, other work has noted that views about scientific consensus are influenced by congruence with values based in cultural cognition. In addition, it is not clear that those in the public claiming to agree with the scientific consensus on climate change know the basis of scientific agreement. Using survey data from South Carolina's eight coastal counties, this paper explores cultural cognition; knowledge regarding climate science and the scientific consensus; and support for policies to address climate change. We find that individualists are less likely to believe a scientific consensus exists, however cultural cognition is note predictive of climate science knowledge. In addition, knowledge of the scientific consensus is not related to climate science knowledge. We also find that policy preferences are related to beliefs about the consensus, not climate science knowledge. Finally, increased development of renewable energy, followed by geo-engineering had the highest average support and were less polarized than other policy options. We conclude with a discussion of shifting the focus from climate change knowledge to climate change solutions that are amiable to multiple cultural orientations.

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1 Introduction

Scientists across the globe have reached a consensus that trends in consumption, pollution, and population growth are contributing to worldwide climate change. But, like many of the policy issues faced by modern democracies, global climate change is scientifically complex and

contains multiple social and political dimensions. Collective action on these types of issues is difficult because they require collaboration among multiple policy actors such as scientists, policymakers, and the public. In addition, collaboration requires some consensus on both a) the problem that needs attention and b) how that problem can best be addressed. Finally, in democratic societies policymaking institutions are built on a foundation of public support, therefore large-scale policy responses require a certain degree of public acceptance. However, the mass public often forms views about scientific and technical issues that diverge sharply from the views of scientists and other experts (Pidgeon and Fischhoff 2011; Sunstein 2007). This is certainly the case with climate change where despite the growing scientific consensus on the causes, impacts, and potential risks of climate change, public perceptions remain largely divided.

One potential explanation for the disconnect between scientists and the public is that the public simply doesn't know what scientists know about climate change. Therefore, the public needs to be properly educated to reduce these knowledge asymmetries, which in turn will increase public concern for climate change. Indeed, evidence suggests that the public holds misconceptions about climate change that might impede the development of adequate policy responses by democratically elected governments (Reynolds et al. 2010). A focus on the knowledge deficit has led to concerns about how to properly communicate science so that the problem of climate change can be clearly defined for the public.

Apart from knowledge, another explanation for the disconnect between scientists and the public is the politicized nature of the debate about climate change, particularly in the United States. As a consequence of the politicization of climate change, the public is likely to view the issue through the lens of their own social and political values (see McCright and Dunlap 2011). Once the climate change debate became entangled in values and social identities, the consensus needed for policy change became harder to achieve. This entanglement likely resulted from debates over policies to address climate change, such as the Kyoto Protocol (Krosnick, Holbrook, and Visser 2000). Political divisions over climate change grew through the ways in which potential solutions were defined, largely with solutions that involved government regulation of economic activity which are likely not acceptable to conservatives or individualists.

Both knowledge and values have been demonstrated to be important predictors of views

about climate change. A central assumption regarding the importance of knowledge is that shared knowledge can lead to agreement about problem definitions and the need for policy action. However, it is not clear what "knowledge", if any, can move those predisposed to reject climate change as a problem to being supportive of policies to address climate change. This is particularly important given that climate change policy solutions have likely exacerbated value-based conflicts. Therefore, increased understanding regarding the ways that knowledge and values work to define policy *solutions* may help break the gridlock surrounding climate change policy.

In this paper, we examine the role of core values and knowledge in influencing support for multiple possible climate change policy solutions. We draw on a sample of residents from the eight coastal counties of South Carolina, one of the fastest growing areas of the country, to explore the impacts of values and knowledge on public opinion concerning support for various federal policies aimed at mitigating climate change. Many areas will experience the impact of climate change, but recent literature focuses on coastal locations, which are often referred to as being the "front lines" of climate change. This focus is attributed to predictions of increased sea level rise and storm activity that may directly affect property, infrastructure, social and economic activity, and wildlife habitats of these coastal areas (Leichenko and Thomas 2012). The potential impact of climate change on the coasts, as well as their growing populations, make these areas vital to debates over how to address climate change. Indeed, those that live near the coasts are more likely to perceive the potential risks of climate change as greater (Brody et al. 2008), therefore coastal residents are an ideal demographic with which to use to understand climate views. Overall, we find that values, as opposed to knowledge, hold a prominent role in determining support for climate change policy options. We conclude with a discussion of policies options that find support across value types.

2 Knowledge, Values, and Support for Climate Change Policy

The "knowledge deficit" approach posits that divisions between scientists and the public regarding climate change can be bridged the more the public knows about climate change (Stoutenborough and Vedlitz 2014). What the public might need to "know" about climate change has been measured in a few ways, including through a *fact-based* approach that uses series of questions

about climate science and a *heuristic-based* approach where respondents are asked about their knowledge regarding the scientific consensus.[1] For the fact-based approached knowledge is defined by knowing bits of factual information, and with the heuristic-based approach knowledge is defined by knowing that there is a scientific consensus regarding climate change, which acts as a shortcut to knowing more specific facts.

Fact-based climate change knowledge is typically measured through a serious of questions, usually with true/false answers, based on scientific understandings of climate change. For example, measuring knowledge of the science regarding the causes of climate change (e.g., pollution/emissions from business and industry, use of coal and oil by utilities or electric companies, destruction of tropical forests) O'Connor, Bord, and Fisher (1999) found that knowledge was a significant predictor of willingness to change behavior to address climate change (also see Bord, O'Connor, and Fisher 2000; and O'Connor et al. 2002). Additional work by Wood and Vedlitz (2007) found that a higher "global warming IQ", based on correct answers to three questions, was associated with an increase in concern about the impacts of global warming. Finally, based a serious of six questions Stoutenborough and Vedlitz (2014) found that increased climate change knowledge was associated with increased climate change concern. With the fact-based approach, the assumption is that the more the knowledge (i.e., basic facts about climate science) gap between the scientists and the public shrinks, the more likely the public is to support policies aimed at mitigating climate change.

Heuristic-based knowledge examines the influence of whether respondents know that a consensus exists among climate scientists that the average temperature of the earth is increasing through anthropogenic forcing (Bolsen, Druckman, and Cook 2015; Farnsworth and Lichter 2012). Studies have shown that knowledge about the science consensus is associated with increased support for policies to address climate change.[2] The impact of belief about the scientific consensus is present even when considering potential mediating beliefs about climate change (e.g., human-caused, extent of harm)(Ding et al. 2011). In addition, McCright, Dunlap, and Xiao (2013) found that perceived scientific agreement influenced both climate views

[1] A third measure of climate change knowledge based on a self-report or self-assessment has also been used (e.g., how much do you know about climate change?) (see Kellstedt, Zahran, and Vedlitz 2008). However, that measure of knowledge has been shown to not be associated with knowledge assessed through questions based on climate science (Stoutenborough and Vedlitz 2014), and self-reported knowledge is likely to interact with political values (Hamilton 2011; Malka, Krosnick, and Langer 2009).

[2] Many of the studies measuring the impact of the scientific consensus term it a "belief", for our purposes we use the term belief and knowledge interchangeably.

and support for policy options, even when controlling for ideology and partisanship. Similarly, (Lewandowsky, Gignac, and Vaughan 2013) found that respondents in an experimental condition that informed them of the consensus surrounding climate science were more likely than those in the control condition to attribute climate change to human activity. van der Linden et al. (2015), using a within-subject pre-and-post design, find that after being provided with information about the scientific consensus regarding climate change respondents were more likely than before to believe that climate change is happening, human-caused, worrisome, and respondents were also more likely to support action on climate change. The heuristic-based approach assumes that if respondents know that the overwhelming majority of climate scientists agree about the causes of climate change, then respondents are more likely to support various climate policy proposals. Therefore, respondents don't need to possess more sophisticated knowledge, as with the fact-based questions, but only need to know that there is a consensus among scientists that climate change presents significant risks in order to support climate policies.

Given the ways that knowledge has been measured, an additional question is whether there is a relationship between the different types of knowledge. Do those that "know" about the scientific consensus also know the various facts about which scientists agree? We might expect that those that know a scientific consensus exists regarding climate change are also more likely to have fact-based knowledge.

Apart from climate knowledge, social and political values are a key driver of opinions about climate change. Indeed, core values are likely the leading predictor of climate change opinions, as evidenced by a recent meta-analysis of climate opinion studies (Hornsey et al. 2016). In particular, core values such as political ideology and cultural worldview are likely to play a pivotal role. Core values "include fundamental normative and ontological assumptions about human nature and the relative priority of values such as liberty, security, and equality" (Ripberger et al. 2014, 509). By their nature, core values span multiple policy issues and constrain preferences associated with those issues. Using ideology and/ partisanship as core values, several studies have shown that they play a large role in determining views about climate change (Borick and Rabe 2010; Dunlap and McCright 2008; McCright 2011).

In addition to political values, cultural worldview, based on Cultural Theory (CT), can also serve as a core value when determining policy preferences across a variety of policy domains

(Ripberger et al. 2014). According to CT, society is organized into four different ways of life based on two cross-cutting dimensions, group and grid (Thompson, Ellis, and Wildavsky 1990). The group dimension refers to the extent to which individuals are committed to social group solidarity and the tendency to value the advancement of society as a whole. Individuals that have a "weak" or low-group way of life tend to believe that individuals should rise or fall on their own merit, without the constraints or assistance of others. The grid dimension refers to the extent to which individuals recognize classification and authority. Individuals that apply rigid levels of classification or authority to society, often based on gender, economic status or race, have a high-grid way of life. Individuals that view society as being more equal have a low-grid way of life. More simply, the group dimension focused on "who" an individual associates, and the grid dimension focuses on "how" that individual interacts with them.

Depending on an individual's orientation toward group and grid, they fall into one of four different ways of life including individualism with low group and low grid; egalitarianism with high group and low grid; hierarchy with high grid and high group; and fatalism with low group and high grid (Thompson, Ellis, and Wildavsky 1990). In general, those with an egalitarian worldview are more likely to be concerned about environmental risks, and climate change in particular, than the other worldviews (Goebbert et al. 2012; Jones 2011; Leiserowitz 2006; Tansey and O'Riordan 1999).

Drawing on CT, cultural cognition posits that "individuals, as a result of a complex of psychological mechanisms, tend to form perceptions of societal risks that cohere with values characteristic of groups with which they identify" (Kahan et al. 2012, 732). At its center, cultural cognition recognizes the importance of underlying values and cultural characteristics and how they influence an individual's risk perception and policy beliefs, which are often associated with relevant science. Two characteristics differentiate cultural cognition from CT: a) the way in which it measures worldviews and ways of life, and b) the emphasis placed on social and psychological mechanisms that prescribe perceptions of risk (Kahan 2012).

As opposed to designing questions to measure the four various ways of life, cultural cognition measures worldviews across two continuous scales. One measures worldviews along the scale of "hierarchy and egalitarianism", corresponding to grid. The other measures worldviews along the scale of "individualism and communitarianism", corresponding to group. By using these

continuous scales, cultural cognition can measure an individual's worldviews along the entire spectrum of group or grid resulting in one conclusive orientation with regard to both dimensions. This differs from other approaches where the four potential worldviews are measured separately, which could result in an individual's belonging toward two conflicting ways of life (e.g., being both hierarchical and egalitarian) (Kahan 2012). An individual's worldview is determined by a survey consisting of two sets of agree-disagree items, one set for hierarchy-egalitarianism and one for individualism-communitarianism.

According to cultural cognition, individuals form perceptions of risk which are distinct to their way of life. Several social and psychological mechanisms through which cultural cognition influences individuals to form different perceptions of risk have been identified however, we focus on two; identity-protective cognition and biased information assimilation (Kahan 2012). Identity-protective cognition refers to individuals matching their views to those shared by other members of their cultural affinity group. Evidence for this can be seen in the role partisanship can play in forming political opinions (Cohen 2003), the matching of social identities to political partisanship (Green, Palmquist, and Schickler 2002), and the "white-male effect" where white-males tend to more accepting of environmental risk (Kahan et al. 2007). Biased assimilation, or motivated-reasoning, results when individuals attend to information that reinforces previous value-based beliefs. As a result of biased information processing, simply increasing policy-relevant knowledge may not be sufficient to reduce differences in opinion surrounding controversial issues. In fact, knowledge may lead to *more* rather than less polarization. Kahan et al. (2012) found that increased numeracy and science literacy was associated with an increase in polarization regarding climate change risks between cultural types. Increased polarization based on numeracy and science literacy is likely seen because those measures act as proxies for sophisticated reasoning abilities, and such reasoning ability allows individuals to better match information with their values-based orientations.

The potential for knowledge to overcome value based differences in views of climate change is likely weakened by the polarized nature of the climate change debate, which exacerbates the tendencies of biased information processing. As the politicization of climate change has increased, so has the tendency for what individuals "know" about climate change to become a function of their core values. Given the connection between values and climate change opinion and the

tendency toward identity-protection and biased information assimilation, it is likely difficult to "disentangle" what respondents know about climate change from their values (Kahan 2015). For example, conservatives tend to perform worse on fact-based climate science knowledge questions than liberals (Stoutenborough and Vedlitz 2014). In addition, using heuristic-based knowledge regarding whether or not a scientific consensus exists McCright, Dunlap, and Xiao (2013) found that conservatives, Republicans, and those less concerned about the environment were less likely to think a consensus among scientists exists regarding climate change. In a similar vein, Kahan, Jenkins-Smith, and Braman (2011) found that core values, measured by cultural cognition, were a significant predictor of thinking an expert consensus exists regarding climate change, gun control, and nuclear waste. Also, core values might influence whom one sees as a qualifying expert. Using an experimental design, the Kahan, Jenkins-Smith, and Braman (2011) study also found that whether respondents considered someone an expert was a function of whether they agreed with that experts conclusions.

The ultimate goal of overcoming the divisions in public opinion concerning climate change is to break the political gridlock associated with the development of policies to mitigate climate change. However, the debate over solutions to climate change was likely a major cause of value-based polarization. Solution based polarization, termed "solution aversion" (Campbell and Kay 2014), occurs when solutions to problems rather than the problems themselves form the basis for political divisions. For example, the debate over the Kyoto Protocol in 1997 seemed to solidify views about climate change among partisans (Krosnick, Holbrook, and Visser 2000). Therefore, conservatives and Republicans don't necessary reject climate science *per se*, but rather reject policies that would involve government regulation to address climate change. Therefore, one way to break the gridlock over climate change might be to focus on policy solutions that could receive majority support.

Much of the work on climate change opinions have focused on questions about concern or the risks associated with climate change, and less on the policy options to address climate change. Some of the studies that have focused on specific policy options have found support for policy proposals to be driven by the same value distinctions as other climate change opinions (Leiserowitz 2006; Stoutenborough, Bromley-Trujillo, and Vedlitz 2014). However, a large amount of variation exists in support of particular policy options. For example, support for

emission reductions (Leiserowitz 2006) and renewable energy (Jones 2011; Stoutenborough, Liu, and Vedlitz 2014) are typically supported by large majorities of respondents. In addition, differences in policy support exist across cultural types. Jones (2011) found that individualists were supportive of nuclear energy as a way to address climate change. In another example, presenting information about geoengineering as a solution to climate change worked to shift the views of hierarchical-individualist about the risks posed by climate change (Kahan et al. 2015).

2.1 Climate Change Policy Preferences

Previous research suggests that values and knowledge are major predictors of climate change opinion. We expand on these findings by testing hypotheses about the role of both values and two types of knowledge in determining policy preferences for addressing climate change. Drawing on cultural cognition, we test hypotheses about biased information processing and knowledge about climate change, as well as the influence of cultural worldview on climate change policy preferences. Also, we test the knowledge deficit model by examining the influence of knowledge on climate change policy preferences.

The knowledge deficit model posits that disagreements about climate change result from information asymmetries between experts and the public. Therefore, to lessen the divide, public knowledge about climate change needs to be increased. Knowledge is based on both heuristic knowledge of the scientific consensus and fact knowledge of climate science. We posit the following hypotheses:

> H1a: *As heuristic knowledge about climate change increases so does support for policies to mitigate climate change*

> H1b: *As fact-based knowledge about climate change increases so does support for policies to mitigate climate change*

In addition, we expect the types of knowledge to be related:

> H2: *Respondents that know about the scientific consensus regarding climate change are more likely to know basic climate science*

Cultural cognition posits that individuals engage in biased information processing, so we

expect both heuristic and fact-based knowledge to be a function of core values. Therefore, we posit the following hypotheses:

> H3a: Heuristic knowledge: *As respondents become more hierarchical / individualist (less egalitarian / communitarian) they are less (more) likely to agree that there is scientific consensus about climate change*

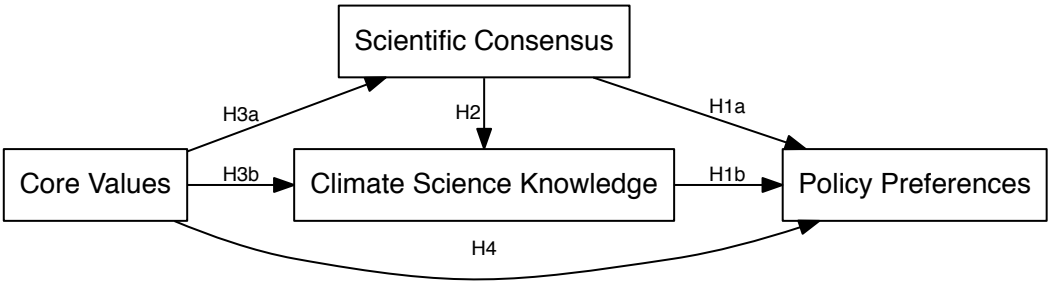
> H3b: Fact-based knowledge: *As respondents become more hierarchical / individualist (less egalitarian / communitarian) they are less (more) likely to correctly answer fact-based questions about climate change*

Cultural cognition also argues that because of identify-protection individuals tend to align their views with those that share their group affinities, as a result, we expect core values to influence policy preferences. Therefore, we posit the following hypothesis

> H4: *As respondents become more hierarch / individualist (less egalitarian / communitarian) they are less (more) likely to support policies that mitigate climate change*

Figure 1 illustrates the full model and hypotheses that we will test.

Figure 1: Climate Policy Preferences Model



The analysis will precede in two stages. First, we examine the relationship between core values and both types knowledge–heuristic and fact-based–(H3a and H3b), as well as the relationship between heuristic and fact-based knowledge (H2). Next, we examine the relationship

between knowledge and policy preferences (H1a and H1b) as well as between core values and policy preferences (H4).

3 Data and Analysis

The data for this study was drawn from a sample of residents living in the eight coastal counties in South Carolina including Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper.[3] Samples of residents in each county were obtained from Survey Sampling International, and the surveys were administered online from August 18th to August 29th 2015 with a completion rate of 79%.[4] The surveys measured social and political values, climate change knowledge, climate change policy preferences, and demographics.

The social and political values examined include political ideology, as well as cultural cognition. Ideology was based on a self–reported scale that asked respondents to rate themselves on a one to seven scale, with one indicated strongly liberal, four middle of the road, and seven strongly conservative. Cultural cognition was measured using the same series of questions as previous studies (Kahan, Jenkins-Smith, and Braman 2011; see Kahan et al. 2012), with six items that measure a participant's orientations to hierarchy-egalitarianism, with three items representing a hierarchical orientation and three representing egalitarianism, and six items that address a participant's orientation to individualism-communitarianism, with three items for each orientation. Participants were asked to what extent they agree or disagree with the statements, on a scale from one to seven, with one meaning strongly disagree and seven meaning strongly agree. Agreement with a statement indicated orientation toward the worldview it represented. For example, agreement with a statement representing individualism indicated orientation toward individualism. Likewise, disagreeing with a statement indicated orientation toward to opposite worldview; disagreeing with an individualism statement indicated orientation toward communitarianism. The hierarchy-egalitarianism scale has a Cronbach α of 0.866 and the individualism-communitarianism scale has an α of 0.775. The scales were reverse coded and averaged into a hierarch scale and an individualism scale that ranges from 1 to 7.[5]

The demographic variables included are age, education (with one as some high school to

[3] A map of South Carolina highlighting the eight counties is in the appendix.
[4] Completion rates reflect the percentage of respondents that complete the survey once they begin.
[5] Full question wording for cultural cognition measures are in the appendix.

seven Doctorate), income (in increments of $20,000), a dummy variable for white (vs. non-white), and a dummy variable for male. Table 1 presents the descriptive statistics for each of the independent variables.

Table 1: Descriptive Statistics

Independent Variable	N	Mean	St. Dev.	Min	Max
Hierarchical	352	3.871	1.590	1	7
Individualism	361	4.655	1.217	1	7
Ideology	302	4.205	1.648	1	7
Age	302	49.629	15.516	19	86
Education	302	4.156	1.366	1	7
Income	302	4.119	1.684	1	7
White	302	0.854	0.353	0	1
Male	302	0.434	0.496	0	1

3.1 Climate Science Knowledge

Heuristic climate change knowledge was accessed by asking respondents if they believe that "most scientists think climate change is happening." Yes responses were coded as 1 and disagreement among scientists and no consensus were coded as 0. The mean for the scientific consensus question was 0.495, indicating that about 50 of respondents believe there is a consensus among scientists about climate change.

Fact-based measures of climate change knowledge are typically based on a serious of "quiz" questions that are used to assess a respondents level of knowledge about the science surrounding climate change. Using such measures, many studies find a relationship between knowledge and other views about climate change (e.g., Stoutenborough and Vedlitz 2014). However, depending on the question it might not reflect what respondents know, but rather more general opinions regarding climate change. In an attempt to "disentangle" climate change knowledge from other climate change views, we draw on a serious of nine questions, used in Kahan (2015), that are designed not to reflect other climate change opinions. In addition, each question includes the phrase "climate scientists believe" to further avoid answers that reflect the respondents opinion rather than what they know about climate science. Questions purposely designed to not be reflective of other climate change options present a difficult test of our hypothesis regarding core values and fact-based climate change knowledge (H3b). Eight of the questions were true/false

and one question (*What gas do most scientists believe causes temperatures in the atmosphere to rise*) was multiple choice. All correct answers were coded as 1. Table 2 shows the question, as well as the mean and standard deviation of correct answers.

Table 2: Climate Science Knowledge Questions

Question (**Correct Answer**)	Mean Correct	sd
Climate scientists believe that if the North Pole ice cap melted as a result of human-caused global warming, global sea levels would rise (**FALSE**)	0.089	0.286
Climate scientists have concluded that globally averaged surface air temperatures were higher for the first decade of the twenty-first century (2000-2009) than for the last decade of the twentieth century (1990-1999) (**TRUE**)	0.836	0.314
Climate scientists believe that human-caused global warming will result in flooding of many coastal regions (**TRUE**)	0.890	0.314
Climate scientists believe that human-caused global warming has increased the number and severity of hurricanes around the world in recent decades (**FALSE**)	0.202	0.402
Climate scientists believe that nuclear power generation contributes to global warming (**FALSE**)	0.458	0.499
Climate scientists believe that human-caused global warming will increase the risk of skin cancer in human beings (**FALSE**)	0.226	0.419
Climate scientists and economists predict there will be positive as well as negative effects from human-caused global warming (**TRUE**)	0.476	0.500
Climate scientists believe that the increase of atmospheric carbon dioxide associated with the burning of fossil fuels will reduce photosynthesis by plants (**FALSE**)	0.247	0.432
What gas do most scientists believe causes temperatures in the atmosphere to rise (**carbon dioxide**)	0.902	0.298
Total Correct (0-9)	**4.33**	**1.184**

As can be seen, a large majority of respondents, $< 83\%$, know that the last decade was warmer than the previous one, climate change will result in coastal flooding, and that CO_2 causes rising temperatures. Just under half of respondents, 48%, correctly indicated that scientists and economists predict both positive and negative effects from climate change and slightly less, 46%, of respondents believe nuclear energy to be a significant cause of climate change. Large majorities of respondents over-estimated what scientists see as the harmful consequences of climate change such as hurricanes, skin cancer, and reduced photosynthesis by plants. Finally, only 9% of respondents knew that the melting of the North Pole ice cap would *not* increase sea

level rise, since the ice cap is sea ice and not land ice.[6]

Next, we test our hypotheses regarding core values and knowledge (H3a, H3b) as well our hypothesis about the relationship between the two types of knowledge (H2). The results are shown in Table 3.

Table 3: Logit and OLS Analysis of Climate Change Knowledge

	Dependent variable:	
	Scientific Consensus	Science Questions
	logistic	*OLS*
	(1)	(2)
Hierarchical	−0.139	0.077
	(0.120)	(0.063)
Individualism	−0.279*	0.114
	(0.125)	(0.064)
Ideology	−0.231*	−0.049
	(0.110)	(0.057)
Age	−0.012	0.005
	(0.009)	(0.005)
Education	−0.118	0.092
	(0.102)	(0.052)
Income	0.104	−0.035
	(0.084)	(0.043)
White	0.324	0.342
	(0.376)	(0.196)
Male	−0.510	0.221
	(0.273)	(0.145)
Scientific Consensus		−0.027
		(0.142)
Constant	3.433***	2.824***
	(0.816)	(0.440)
Observations	302	302
Adjusted R^2		0.049
Akaike Inf. Crit.	384.695	
Note:		*p<0.05; **p<0.01; ***p<0.001

H3a posited that core values would influence heuristic knowledge about climate change. As shown, as individualism increases (and communitarianism decreases) respondents become significantly less likely to believe there is a scientific consensus. In addition, as respondents become more conservative they are also less likely to believe a consensus exists among scientists. However, no significant differences exist for the hierarchical-egalitarianism scale.

Next, we examine the influence of core values and scientific consensus views of the level of climate science knowledge. As stated in H3b, we expect core values to be associated with

[6]These results are consistent with those in Kahan (2015).

increased knowledge. In addition, we expect knowledge about the scientific consensus to be associated with climate science knowledge (H2). However, we found no relationship between core values or consensus beliefs and climate science knowledge. Also, we found no significance among the control variables. A lack of a relationship between cultural cognition and ideology is evidence of the effectiveness of the fact-based questions at disentangling knowledge from other climate change views.[7]

3.2 Policy Preferences

We next examine support for various policies designed to address climate change. Respondents were given the following prompt prior to the policy options questions:

> Various policy solutions have been proposed as ways for the federal government in the United States to deal with climate change. Using a one to seven scale where one is *strongly oppose* and seven is *strongly support*, please indicate your support for each of the following policy proposals.

Table 4 presents the questions, the mean level of support for each of the policy options as well as an averaged aggregate measure, and the standard deviations.

Note that the policy preferences in Table 4 are presented in descending order. As shown in other studies (Krosnick and MacInnis 2013; Stoutenborough, Liu, and Vedlitz 2014), renewable energy is a popular option to address climate change with a mean of 5.772 on the 1 to 7 scale. Geoengineering has the next highest mean with 5.155. A potential carbon tax has the lowest mean at 4.066, which is at about the midpoint of the scale. Next, we test our hypotheses about the role of values and knowledge in predicting climate change policy preferences, and the results are shown in Table 5.

H4 posited that core values would be predictive of support for various climate change policy options. As shown, as respondents become more hierarchical (less egalitarian) they become less likely to support all polices to address climate change except nuclear energy. In addition, increased individualism (decreased communitarism) is associated with decreased support for

[7] Also note that there is wide variation in the percent of correct responses, providing further evidence that the measures are measuring something other than views about climate change. For comparison, the correct percent of responses exceeded 50% of all fact-based questions in other studies, such as Stoutenborough and Vedlitz (2014), that found a relationship between values and knowledge.

Table 4: Mean Support for Climate Change Policy Options

Policy Option	Mean Support	sd
Encourage research and development of renewable energy sources like solar or wind power	5.772	1.432
Encourage development of "geoengineering" technology such as filters that remove excess cardon dioxide from the air and high altitude orbiting reflectors to reduce solar heating	5.155	1.499
Environmental Protection Agency regulations that limit the amount of carbon dioxide and other greenhouse gases that power plants can emit	4.759	1.914
Accept internationally established limits on U.S. production of carbon dioxide and other greenhouse gases thought to cause climate change	4.484	1.903
Expand the use of nuclear energy	4.377	1.689
A cap and trade program that sets an overall cap on emissions through allowances that can be bought, sold, or saved for future use	4.108	1.904
A carbon tax that imposes a charge on coal, oil, and natural gas in proportion to the carbon they contain	4.066	1.990
Aggregate Policy Support	**4.675**	**1.211**

international agreements, cap and trade, a carbon tax, and the aggregate measure of policies to address climate change. Finally, increased conservatism is associated with *increased* support for renewable energy. Overall, this pattern of results lends support to H4.

For the knowledge measures, fact-based knowledge is associated with *decreased* support for EPA regulations, whereas heuristic knowledge is predictive of increased support for EPA regulations, international agreement, a carbon tax and the aggregate measure of policy support. These results support H1a, but not for H1b. Overall, heuristic knowledge about the scientific consensus is a predictor of policy support for several measures, but fact-based knowledge is not related to increased policy support.

To examine the differential impacts of cultural cognition and heuristic knowledge, we performed a path analysis.[8] The results are shown in Figure 2.

Figure 2 presents the standardized OLS coefficients illustrating the effects of hierarchical and individualism orientations, as well as knowledge about the scientific consensus on aggregate policy support, holding all other variables constant.[9] As shown, being more hierarchical (less

[8]Path analysis is a special case of structural equation modeling that include only observed, no latent, values. For purposes of this analysis the hierarchical and individualism scales are treated as observed.

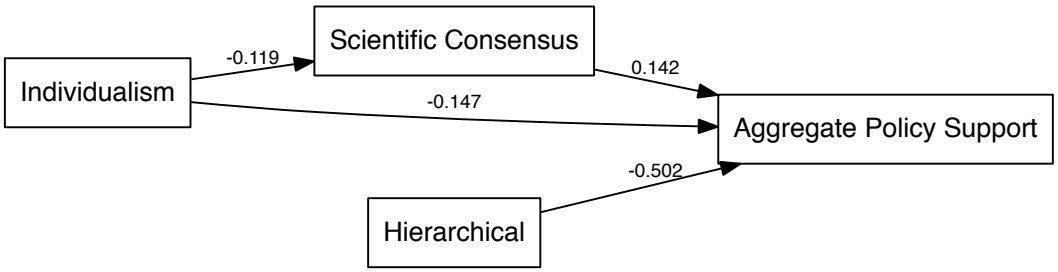
[9]For the path analysis with performed an OLS regression on the heuristic knowledge measure. It was recoded

Table 5: OLS Results for Climate Change Policy Preferences

	Dependent variable:							
	Renewables	Geoengine	EPA	Int. Agree	Nuclear	Cap and Trade	Carbon Tax	Aggregate Policy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hierarchical	−0.438***	−0.272***	−0.563***	−0.509***	0.105	−0.414***	−0.550***	−0.377***
	(0.073)	(0.080)	(0.081)	(0.082)	(0.088)	(0.090)	(0.086)	(0.053)
Individualism	−0.009	−0.022	−0.147	−0.309***	0.052	−0.252**	−0.286**	−0.139*
	(0.075)	(0.082)	(0.082)	(0.083)	(0.090)	(0.092)	(0.088)	(0.054)
Ideology	0.168*	0.040	0.009	−0.014	−0.030	−0.031	−0.003	0.020
	(0.066)	(0.073)	(0.073)	(0.074)	(0.080)	(0.082)	(0.078)	(0.048)
Sci. Knowledge	0.012	−0.144	−0.155*	0.049	0.046	−0.110	−0.076	−0.054
	(0.068)	(0.074)	(0.075)	(0.076)	(0.081)	(0.083)	(0.080)	(0.049)
Sci. Consensus	0.254	0.271	0.719***	0.626***	−0.189	0.284	0.764***	0.390**
	(0.164)	(0.180)	(0.181)	(0.184)	(0.198)	(0.202)	(0.194)	(0.119)
Age	−0.005	−0.007	0.003	−0.001	0.013*	0.001	0.005	0.001
	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.004)
Education	−0.001	0.010	−0.048	−0.065	0.200**	−0.062	−0.076	−0.006
	(0.061)	(0.066)	(0.067)	(0.068)	(0.073)	(0.075)	(0.072)	(0.044)
Income	0.030	−0.0004	−0.104	−0.029	0.071	−0.089	−0.046	−0.024
	(0.049)	(0.054)	(0.055)	(0.055)	(0.059)	(0.061)	(0.058)	(0.036)
White	0.956***	0.671**	0.663**	0.355	−0.070	0.330	0.403	0.473**
	(0.228)	(0.250)	(0.251)	(0.255)	(0.274)	(0.280)	(0.269)	(0.165)
Male	0.062	0.148	−0.483**	−0.224	0.757***	−0.276	0.022	0.001
	(0.169)	(0.185)	(0.186)	(0.188)	(0.203)	(0.207)	(0.199)	(0.122)
Constant	5.898***	6.280***	7.955***	7.594***	1.724**	7.753***	7.354***	6.365***
	(0.543)	(0.594)	(0.598)	(0.606)	(0.653)	(0.667)	(0.641)	(0.394)
Observations	302	302	302	302	302	302	302	302
Adjusted R^2	0.165	0.098	0.445	0.411	0.140	0.286	0.399	0.393

Note: *p<0.05; **p<0.01; ***p<0.001

Figure 2: Climate Policy Preferences Path Analysis



egalitarian) strongly outweighs the impact of heuristic knowledge for policy support, -0.502 vs. 0.142. The impact of individualism and heuristic knowledge is roughly equivalent, -0.147 vs. 0.142. In addition, being more individualist is also associated with a decreased likelihood of thinking a scientific consensus exists. Overall, being more individualist has a total effect of -0.1399.[10] The results presented Figure 2 illustrate the difficultly of increasing knowledge as a strategy to overcome value-based opposition to climate change policies.

4 Discussion

Agreeing that a scientific consensus exists has been termed a "gateway" belief (van der Linden et al. 2015), suggesting that convincing those skeptical of climate change just need be convinced that a majority of scientists agree in order to support actions to address climate change. The findings here suggests that support for some policy proposals increase as a result of knowledge about the scientific consensus, *when core value measures are held at their mean.* However, for consensus knowledge to shift value based differences it would need to have an impact on those prone to the hierarchical and individualist cultural orientations. Based on these results, it is not likely that a problem definition approach to increasing climate change knowledge is an effective way to bridge the political divides.

If a problem definition approach is not likely to be an effective strategy, what could work in its place? Kahan and Braman (2006) suggest using "identity affirmation" as a remedy for

as -1 = no consensus, 0 = disagreement among scientists, and 1 = consensus among scientists.

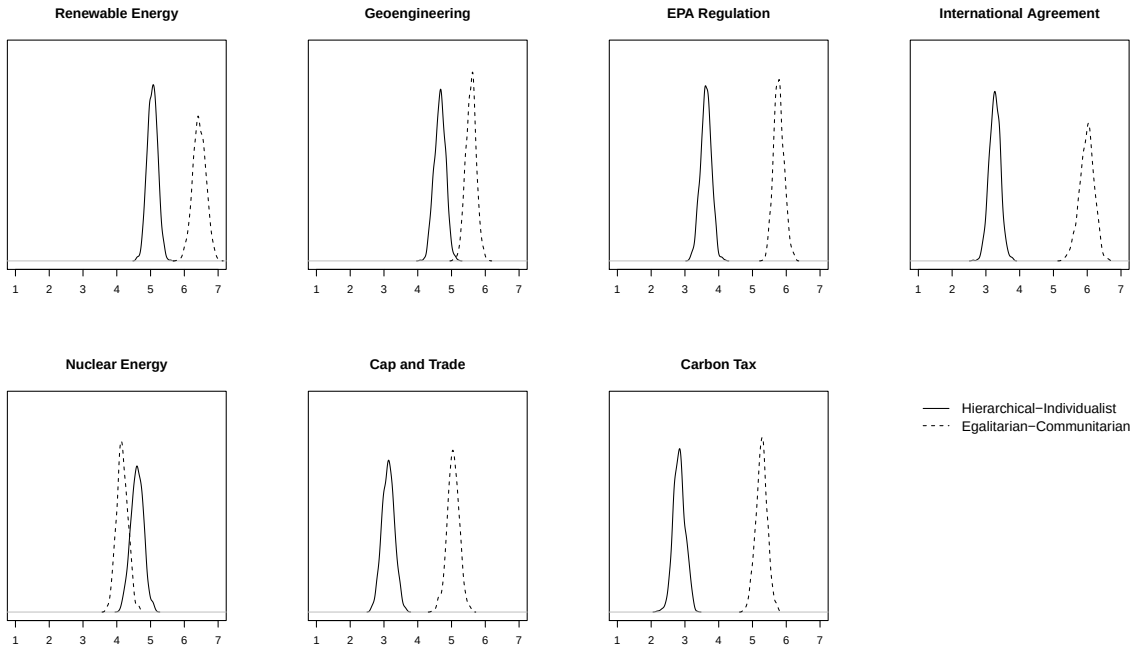
[10]This is calculated by adding the direct effect of the individualism scale on policy support, -0.147, to the indirect effect, $-0.147 * 0.142$ = -0.020874.

such conflicting viewpoints. Identity affirmation suggest policies that affirms a group's way of life, rather than those that might be an affront to some cultural orientations. Therefore, emphasizing various policies that are less likely to be polarizing may be a way to address climate change regardless of the political disagreements over how it is defined. For example, Kahan et al. (2015) found that geoengineering as a proposed approach to climate change lessened polarization. Likewise, Jones (2011) suggests that moving from the one-dimensional, liberal-conservative approach to values to the two-dimensional approach of CT offers avenues for potential compromise among policy solutions (e.g., nuclear energy). Next, we use our results to examine polarization among the various policy solutions.

To illustrate the results from the models in Table 5, we ran 1,000 simulations and manipulated the values of the cultural cognition scales to illustrate the estimated support for the various climate proposals. The simulations estimate various β's to illustrate model uncertainty. We estimate the models for hierarchical-individualist and for egalitarian-communitarian, because eesearch using cultural cognition generally focuses on how perceptions differ between those two groups. To obtain the X values of the cultural cognition measures, we used the mean score on each of the scales ± one standard deviation. For hierarchy we took the mean value of the hierarchical-egalitarian scale 3.871 and added one standard deviation 1.59 so the X value for hierarchy is 5.461. To calculate the egalitarian score we subtracted one standard deviation from the scale, so the egalitarian X values is 2.281. We repeated the process for individualists and communitarians using the individualist scale. Then to illustrate the estimate of the impacts of hierarchical-individualist on policy support we included the X value for hierarchy, 5.461, and the X value for individualist, 5.872 in the each of policy options models. We used the same process for egalitarian-communitarians. All of the other variables were held constant at their mean. The results of the simulations are shown in Figure 3.

The simulations clearly illustrate the differences in support for policies between the cultural types, particularly concerning EPA regulations, international agreements, cap and trade, and the carbon tax. Each of those four policy options are clearly polarized along cultural orientation lines. Renewable energy, geoengineering, and nuclear energy appear much less polarized, with renewable energy and geoengineering favored by both cultural types. Nuclear energy is roughly near the midpoint for both cultural groups.

Figure 3: Policy Preferences and Cultural Cognition Model Simulations



5 Conclusion

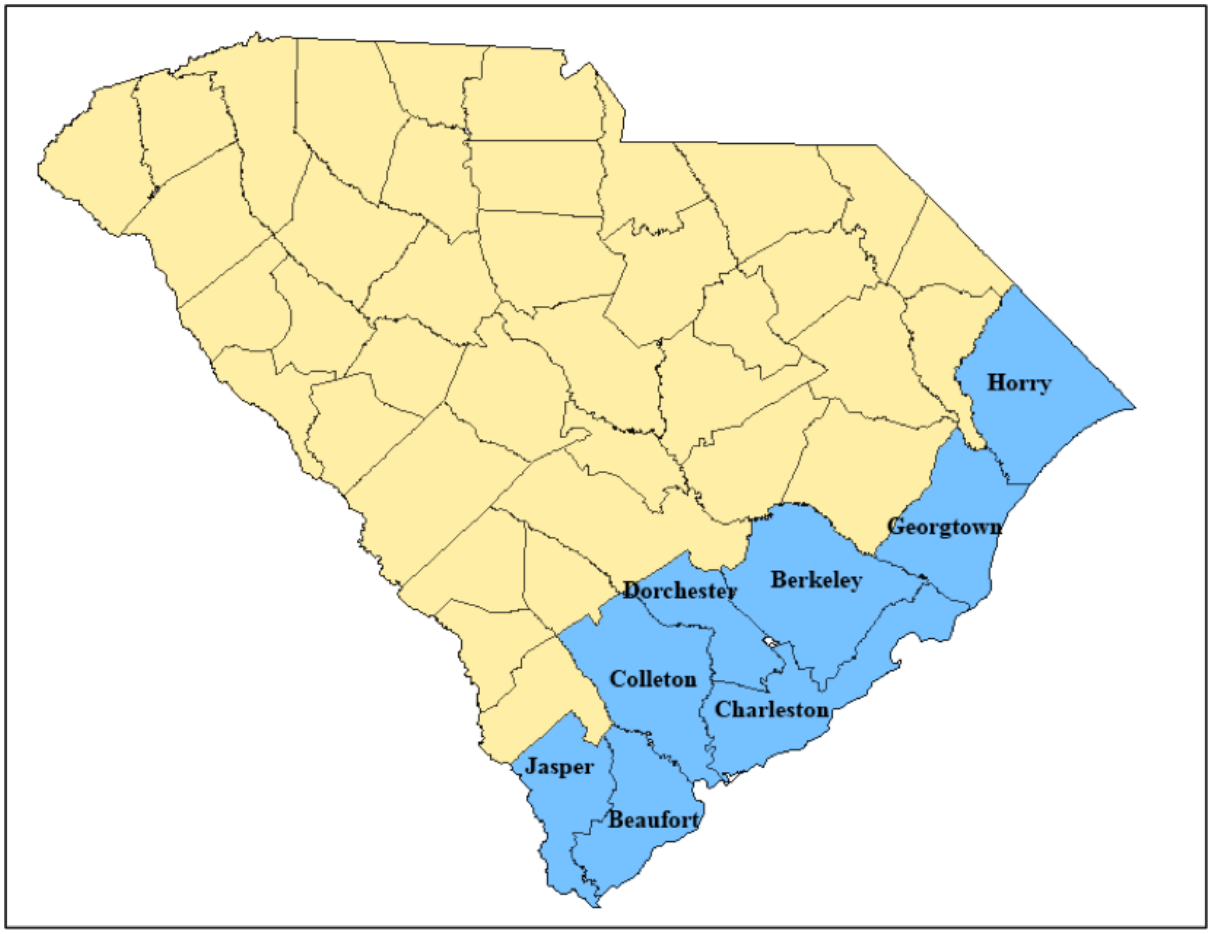
The focus of a large body of research regarding climate change opinion is on how the public understands, or defines, the *problem* of climate change. Much of this work focuses on what role knowledge can play in bridging the divides that exist in the public over how climate change is understood as a political issue. Some of the work in this vein has shown that increased knowledge, in terms of both climate "facts" as well as knowledge about the scientific consensus, leads to an increase in concern about climate change as well as support for various policy options (Ding et al. 2011; Lewandowsky, Gignac, and Vaughan 2013; O'Connor, Bord, and Fisher 1999; Stoutenborough and Vedlitz 2014; Wood and Vedlitz 2007). However, another set of studies, largely using cultural cognition, have found that values tied to social groups influence climate change views, including what counts as fact in the climate change debate (Kahan, Jenkins-Smith, and Braman 2011; Kahan et al. 2015, 2012). We build on both sets of literature to examine how knowledge and cultural cognition work to shape climate change opinion.

Our findings point to influence of core values, rather than knowledge, on support for climate change policy options. However, we also find that some solutions are less polarized than others. For example, renewable energy, geoengineering, and nuclear energy were far less polarized than

the other potential policy options. Therefore, a focus on defining *solutions* rather than problems might be an effective way to break the gridlock over climate change. Additional research is needed on ways to define solutions in a way that is acceptable to multiple value systems.

Appendix

Figure A1: South Carolina's Eight Coastal Counties



Cultural Cognition Questions

Hierarchy-Egalitarian Scale

Egalitarian questions (E) were reversed coded and question order was rotated.

- (H) We have gone too far in pushing equal rights in this country.
- (H) It seems like blacks, women, gays and other minorities don't want equal rights; they want special rights just for them.
- (H) Society as a whole has become way too soft and feminine.
- (E) Our society would be better off if the distribution of wealth was more equal.

- (E) We need to dramatically reduce the inequalities between the rich and the poor, whites and people of color, and men and women.
- (E) Discrimination against minorities is still a very serious problem.

Individualism-Communitarianism Scale

Communitarianism questions (C) were reversed coded and question order was rotated.

- (I) The government interferes far too much in our everyday lives.
- (I) It's not the government's business to try to protect people from hurting themselves.
- (I) The government should stop telling people how to live their lives.
- (C) Sometimes the government needs to make laws that keep people from hurting themselves.
- (C) The government should do more to advance society's goals, even if that means limiting the freedom and choices of others.
- (C) Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

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