

Evaluating the effects of ideology on public understanding of climate change science: How to improve communication across ideological divides?

Asim Zia and Anne Marie Todd

While ideology can have a strong effect on citizen understanding of science, it is unclear how ideology interacts with other complicating factors, such as college education, which influence citizens' comprehension of information. We focus on public understanding of climate change science and test the hypotheses: [H₁] as citizens' ideology shifts from liberal to conservative, concern for global warming decreases; [H₂] citizens with college education and higher general science literacy tend to have higher concern for global warming; and [H₃] college education does not increase global warming concern for conservative ideologues. We implemented a survey instrument in California's San Francisco Bay Area, and employed regression models to test the effects of ideology and other socio-demographic variables on citizen concern about global warming, terrorism, the economy, health care and poverty. We are able to confirm H₁ and H₃, but reject H₂. Various strategies are discussed to improve the communication of climate change science across ideological divides.

Keywords: agenda setting, climate change, cultural models, environmental communication, framing risk, risk communication, science communication

1. Introduction

Improvability of the public understanding of climate change science

Human induced climate change is arguably one of today's most important scientific and social challenges (McCarthy et al., 2001). To effectively address the challenge of global climate change, some scholars argue that it is "imperative to have an accurately and completely informed public" (Trumbo, 1996: 281) and that improvements in public understanding are urgently needed (see Moser and Dilling, 2007; NSF, 1999). The US government asserts that a public that can "accurately interpret complex scientific information" will make informed decisions about how to reduce the risk of climate change (US Department of State, 2002: 149).

Internationally, it has been argued that public knowledge of climate change is critical to public interest, and translating concern for climate change into action requires public knowledge (see Stern, 2008: 33; Bord et al., 2000: 205). It has been suggested that public knowledge of climate change science is critical to developing public health policy (Frumkin et al., 2008), and to shape public understanding of economic analysis (Stern, 2008: 1). Some researchers assert that public understanding of climate change science is “the most powerful predictor of both stated intentions to take voluntary actions and to vote on hypothetical referenda to enact new government policies to reduce greenhouse gas emissions” (Bord et al., 2000: 205). Furthermore, such proponents argue, mitigation policies require public acceptance for effective implementation and therefore must take public values into account in order to induce highest levels of public participation: “If a problem and the actions people can take to help solve it are framed in ways that resonate with cultural values and beliefs, people are more likely to take the action than if they are not” (Moser and Dilling, 2004: 41).

Such arguments for improving public understanding of climate change science are built on the premise that if the public have accurate scientific knowledge then they will make public policy decisions that fit in with the scientific normative view. This premise leads numerous scholars to conclude that “the scientific community should devote greater resources to developing public understanding of these principles to provide a sound basis for assessment of climate policy proposals” (Sterman and Sweeney, 2007: 229).

If public understanding of climate science influences public acceptance of climate policy, then empirical studies of factors that influence public interpretation of science can assist in developing effective risk communication strategies, which in turn can influence the development of effective mitigation and adaptation policies. Toward this end, Bostrom et al. (1994) deployed a mental modeling approach to assess public understanding of climate change science. They found that respondents’ “explanations of the physical mechanisms underlying global climate change were inconsistent and incomplete.” Many respondents were found to hold other fundamental misconceptions and more subtle misperceptions (p. 968). The authors concluded that the respondents’ “flawed mental models restricted their ability to distinguish between effective and ineffective strategies. One particular concern is that laypeople may waste their energies on ineffective actions, such as conscientiously refusing to use spray cans, while neglecting such critical strategies as energy conservation” (p. 969). These findings, and others (Kempton, 1991, 1997), suggest that “correcting” mental and/or cultural models about climate change science is a necessary step for developing effective mitigation and adaptation strategies.

This conclusion about the need to correct mental and/or cultural models of public knowledge of climate change science, however, poses daunting problems for research on public understanding of science. These include the problems of “cognitive dissonance” (Stoll-Kleemann et al., 2001), the “trust-gap” hypothesis (Priest et al., 2003) and ideology (Carvalho, 2007; Wood and Vedlitz, 2007). All seem to suggest that flaws in the mental or cultural models of climate change may not be as easy to “correct” by educating the public, as argued by the proponents of the seamless improvability of public understanding of climate change science (Bostrom et al., 1994; Trumbo, 1996; US Department of State, 2002; Sterman and Sweeney, 2007).

Stoll-Kleemann et al. (2001: 111) evaluate schematic patterns in social psychology to understand “cognitive dissonance,” which explains, “both the encoding and the retrieval of information are often guided by personal desire to maintain cognitive consistency. The lack of consistency is the state of the *dissonance*. In general, individuals experiencing dissonance seek to resolve it, deny it, or displace it” (see also Taylor and Fisk, 1981). Their research demonstrates that, “for the most part, denial or displacement act powerfully to maintain the gap between attitude and behavior with regard to climate change norms.” They conclude that there

is “both a coherence and a rationality to dissonance and denial that will not make it easy for democracies to gain early consent for tough climate change mitigation measures” (Stoll-Kleemann et al., 2001: 115). Cognitive dissonance, or the psychology of denial presents difficulties to shifting mental or cultural models through mere infusion of climate change science.

Similar arguments have been made about the lack of trust in the government and the trust gap between environmentalists and industrialists in the context of biotechnology policy development (Priest et al., 2003). The trust-gap hypothesis can also be extended to climate change policy development in the sense that the public may perceive that climate change knowledge is politicized before its infusion in public minds. Vast uncertainties about climate change impacts make it even likelier that climate change science is politicized, trusted by one social group and distrusted by another social group. The lack of trust in the climate change scientific knowledge may make it difficult to establish the “norm” for correcting the mental or cultural models of the public.

Current discussions of public understanding of science suggest that factors such as cognitive dissonance and the trust-gap hypothesis pose challenges in communicating science to public audiences. These findings suggest we must take into account public attitudes to understand how citizens will interpret scientific data. In this paper we evaluate how and to what extent ideological beliefs influence public understanding of and concern for climate change in the hope of gaining a greater understanding of the underlying cultural models of this globally significant issue.

Ideology and climate change science

Ideology influences the interpretation and eventually the understanding of scientific predictions such as climate change forecasts. “Ideology works as a powerful selection device in deciding what is scientific news, i.e. what the relevant ‘facts’ are, and who are the authorized ‘agents of definition’ of science matters” (Carvalho, 2007: 223). While there are multiple definitions of ideology (e.g. Eagleton, 1991), we treat ideology, proposed by Carvalho (2007: 225), “as a system of values, norms and political preferences, linked to a program of action vis-à-vis a given social and political order. People relate to each other and to the world on the basis of value judgments, ideas about how things should be, and preferred forms of governance of the world. In other words, ideologies are axiological, normative and political.” Value judgments and social norms constitute ideological preferences that influence individual actions in response to the social and political order.

Fundamentally, ideology influences knowledge. Wood and Vedlitz (2007), for example, demonstrated in a nation-wide survey ($N = 1093$) of US citizens that political ideology systematically influenced the concern of citizens along the lines of the much acclaimed “guns versus butter” political agenda theory (Mintz and Huang, 1991; Antonakis, 1999; Clark, 2001; Carrubba and Singh, 2004). Early studies (Russett, 1969, 1970; Hartman, 1973; Wilensky, 1975) of the guns versus butter trade-off postulated that government spending in defense and security (guns issues) detracts from the spending in education, health and social welfare (butter issues). Some of the later studies (Caputo, 1975; Clayton, 1976; Peroff and Podolak-Warren, 1979) found no direct evidence for this trade-off, while others (Mintz and Huang, 1991) found indirect evidence, i.e. increased levels of military expenditures dampen investment, which reduces growth, thereby reducing the ability of governments to allocate more funds to social welfare programs. This macro-economic theory of guns versus butter trade-offs was extended to studying the effects of ideology on public opinion formation (Carrubba and Singh, 2004) and political agenda formation (Wood and Vedlitz, 2007). The extended guns versus butter analogy postulates that citizens with a liberal political ideology

tend to be more concerned about “butter” issues; while citizens with a conservative political ideology tend to be more concerned about “guns” issues. This analogy is useful to understand public perceptions of climate change, which is typically framed as a “butter” issue, because of its domestic effects on the economy and environment.

In their study of public attitudes toward “guns” and “butter” issues, Wood and Vedlitz (2007) used linear regression models to test the effects of various independent variables such as the political ideology, religious identity, party affiliation, socio-demographic background, income, age, and gender on the concern of citizens regarding five important public policy “guns” and “butter” issues: terrorism, the economy, health care, poverty and global warming.¹ They found that the concern of citizens for these five issues is significantly affected by political ideology, as predicted by the “guns versus butter” theory. They also found the effects of party affiliation, religious identity, race, gender, college education, general science literacy, and self-reported knowledge of the issue to be significant; while income, age, number of children and number of information sources had no generally significant effect on citizen concern for these five issues. As a butter issue, one that is not explicitly linked to national defense, global warming was found to be of higher concern for citizens with liberal ideologies while conservatives ranked guns issues, such as terrorism, as having greater importance. This raises the question of how reframing climate change as a “guns” issue might broaden public concern for the issue.

A closer look at Wood and Vedlitz’s (2007: 558–61) results reveals an underlying pattern of conflicting effects on citizen concern for global warming. While conservative political ideology has a negative effect on citizen concern for global warming, factors such as college education, global warming literacy, personal experience with global warming, attention to global warming and social network concern about global warming have either insignificant or positive effects on citizen concern for global warming. In this study, we build on Wood and Vedlitz’s model and investigate the interplay of positive and negative effects of political ideology and other socio-demographic and economic variables on citizen concern for global warming.

We postulate in this study that ideology has a significant effect on public understanding of climate change science. We test the proposition that even college education does not trump the significant effect of political ideology on citizen understanding of and concern for the climate change problem. If our proposition tests positive, it will imply that enhanced educational opportunities, such as media sources, may improve communication of climate change, but improved education of citizens alone will not reduce misunderstanding of climate change science caused by ideological preferences. We use a mental and cultural models approach to demonstrate the effects of ideology vis-à-vis college education on public understanding of climate change science. Section 2 lays out our theoretical approach and hypotheses. Methodology and empirical results are presented in Section 3. On the basis of our empirical findings, in Section 4 we discuss different strategies for improving climate change science communication across ideological divides.

2. Theoretical approach and hypotheses

Risk communication, cultural models and ideology

Our cultural models are influenced by the complexities of climate change as a scientific and more importantly political issue. Scientific pronouncements on issues that concern the health and safety of the general public have high news value. Media coverage can attract public attention (Weingart et al., 2000: 280) and can alter public perceptions of risk. “The degree

of importance and concern attributed to climate change does indeed fluctuate in relation to other events and newsworthy items” (Lorenzoni and Pidgeon, 2006: 75). Public perceptions of environmental issues are influenced by scientific and technical knowledge as well as a variety of social factors including values and worldviews (see Leiserowitz, 2006; Slovic, 2000). For these reasons, social acceptance of climate policy depends on ideology, as individuals and groups make decisions on adaptation strategies based on political beliefs and socio-cultural experience.

Citizen concern about different political, economic and social issues can lead to the formulation and development of public policies. The effectiveness of climate change adaptation policies depends on “social acceptability of options for adaptation, the institutional constraints on adaptation” (Adger, 2003: 388). Public beliefs about the science of climate change constrain government implementation of “policies consistent with the best available scientific knowledge” (Sterman and Sweeney, 2007: 230). Reducing greenhouse gas emissions to levels needed to mitigate future climate change requires “changes in technology, energy prices, business practices, consumer behavior, and other activities affecting people’s daily lives” (Sterman and Sweeney, 2007: 233). For effective levels of participation in mitigation practices, people must understand the scientific basis for proposed policies: when “the best available science” conflicts with existing mental models that form the basis for common sense approaches, people are “unlikely to adopt appropriate policies or generate political support for legislation to implement them” (Sterman and Sweeney, 2007: 233).

Effective policy thus requires understanding what influences public perception of climate change science and public assessment of responsibility. Representation of science to the public, such as in media and government outlets, is important for “assessing the responsibility of both governments and the public in addressing climate change” (Carvalho, 2007: 223). Public opinion polls highlight a sense of urgency associated with climate change as an environmental issue, but not necessarily as a domestic issue (Lorenzoni and Pidgeon, 2006: 80). Thus, US citizens may not feel a sense of responsibility to take action on a global issue. Public attitudes toward climate change are complex: individuals characterize climate change in multiple terms “related to their everyday experiences and locality, distinguishing effects on different scales in space and time” (Lorenzoni and Pidgeon, 2006: 80). Widespread public “buy in” requires communication built on existing mental models that citizens already use to make decisions about participating in public policy. This calls for further study of communication of science in the context of existing mental models, such as those that construct political ideological frameworks.

Mental models can be represented as complex networks of beliefs that are dynamically contingent upon the place and time of a citizen (Axelrod, 1976; Kosko, 1986; Zaltman, 1997; Morgan et al., 2002). Concept mapping techniques can be used to represent mental models and, furthermore, shared mental models, i.e. cultural models, can be elicited by tracking the shared patterns of belief networks (Christensen and Olson, 2002). Our study builds upon this mental/cultural modeling research and postulates that public understanding of science is a function of such models, which are dynamically evolving belief networks about ideology, religious identity and other socio-demographic and economic factors.

More specifically, we hypothesize that citizens adhere to cultural models that exhibit patterns of belief networks that systematically differ across various gradations of political ideology, religious identity, socio-demographic background, income and sources of public/media information. Further, we postulate that citizens, for a given place and time, exhibit mental models with patterns of belief networks that can be differentiated across a series of ideological preferences.

Hypotheses

Based upon our arguments above, we test the following three specific hypotheses in this study:²

[H₁] Ideology has a significant effect on citizen concern for global warming. As citizens' ideology shifts from liberal to conservative, concern for global warming decreases.

[H₂] Citizens with college education and higher general science literacy tend to have higher concern for global warming.

[H₃] College education does not increase global warming concern for ideologically predisposed conservatives. In other words, the effect of ideology trumps the effect of college education when it comes to being concerned about global warming.

3. Methodology and results

Survey data

To explore the proposed ideologically driven cultural models and test the corresponding hypotheses, we replicated the survey questionnaire of Wood and Vedlitz (2007) on a local scale by surveying residents of California's San Francisco Bay Area in spring 2008. The survey questionnaire, available either from the online archive for this journal or directly from the corresponding author, shows descriptive statistics (*N*, mean, standard deviation and frequencies) of the survey respondents, as well as the coding scheme for the variables used in the regression analysis.

We interviewed 655 San Francisco Bay Area adult residents to represent the population of ~6.9 million in that area.³ The generalizations from our study results need to be interpreted cautiously because our study did not follow the standard telephone directory-based randomization strategy used to select study respondents. Instead, the sample in this study was collected by 70 students in an upper-division university course on Global Climate Change, with students each collecting ~8–10 responses from their representative communities in the San Francisco Bay Area. Owing to this sampling limitation, we cannot report response rate. Further, we caution our study results must be strictly interpreted at the sample level, and not the population level, of Bay Area residents.

Variables about present and future concern regarding five issues—terrorism, health care, the economy, global warming and poverty—are measured on a scale from 0 (no concern) to 10 (maximum concern). These variables about the citizen concern are used as dependent variables in the regression models. Political ideology is measured on a seven-point scale from strongly liberal (1) to strongly conservative (7).⁴ Figure 1(a) shows the variation in the citizen concern about the five most important present issues by three gradations of political ideology: liberal, moderate and conservative. The liberals are less concerned about terrorism (a guns issue), while conservatives are less concerned about global warming (a butter issue). Similar patterns emerged for issues of future concern, as shown in Figure 1(b).

Responses reveal 14% of the sample affiliates with the Republican Party. The average annual household income of the sample is ~\$60K (below the Bay Area's median household income of ~\$76K), and the average age is ~32 years (below the Bay Area's median age of ~38 years). Approximately 64% of respondents in the sample identified as white, which is slightly higher than the Bay Area's estimated 57% white population in 2008. The sample has 47% females, which is ~2.9% less than the Bay Area's estimated female proportion in 2008. About 34% of sample respondents report having one or more children. Conservatives represent 15% of the sample. There are ~40% college graduates in the sample. This mirrors the rate of the area's population, 41% of those 25 years or older have a bachelor's degree or higher. Figure 2 shows the variation by educational

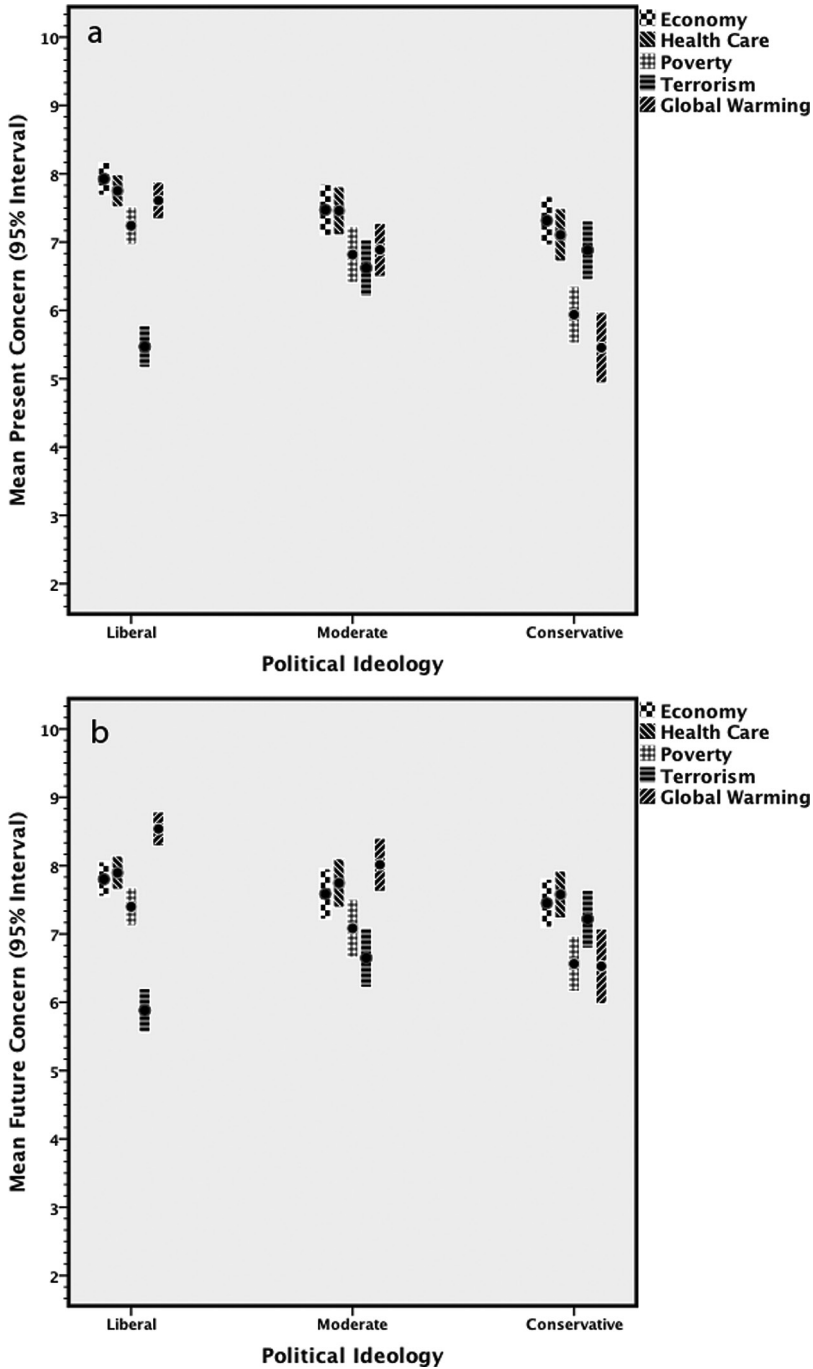


Figure 1. (a) Present and (b) future concern about the economy, health care, poverty, terrorism and global warming distributed by political ideology of the respondents.

background of respondents with their reported present concern about the five most important issues. Respondents with college education (tertiary category in Figure 2) are less concerned about terrorism, while those with primary school education only are less concerned about global warming.

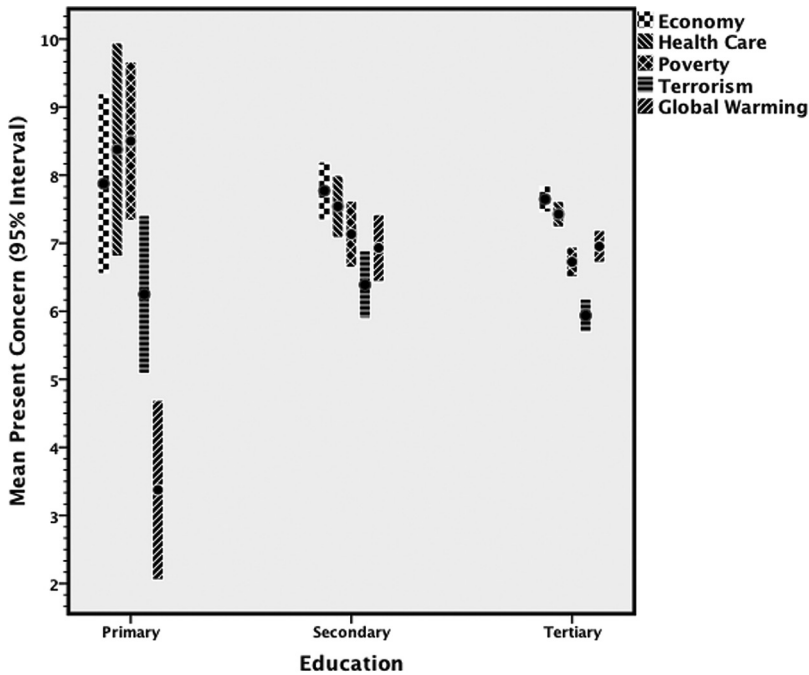


Figure 2. Present concern about the economy, health care, poverty, terrorism and global warming distributed by educational qualification of the respondents.

Questions 9–12 measure General Science literacy. These four questions are selected from a larger set of questions that have been typically asked to respondents in Eurobarometer and other similar projects for measuring their scientific literacy (Durant et al., 1989; Evans and Durant, 1995). Out of these four General Science literacy questions, we found that only about 40% of the sample was able to correctly answer all four questions. The variable “General Science literacy” measures the number of correct answers to these four questions. On a scale of 1 to 4, corresponding to correctly answered questions, the sample mean of General Science literacy stands at 3.08 ± 0.91 . These four questions are relatively crude measures of General Science literacy and they have significant methodological limitations in capturing the scientific literacy of the survey respondents, as extensively discussed by Pardo and Calvo (2002, 2004).

Questions 18 to 20 measure Global Warming literacy. Only 20% of the sample was correctly able to answer all three questions. The variable “Global Warming literacy” measures the number of correct answers to these three questions. On a scale of 1 to 3, corresponding to correctly answered questions, the sample mean of Global Warming literacy stands at 1.54 ± 0.99 . Again, Global Warming literacy is a crude measure of quantifying citizen literacy on climate change issues and it suffers from similar methodological limitations to those that apply to Eurobarometer type of questions derived for quantifying scientific literacy (e.g. Pardo and Calvo, 2002, 2004).

Regression analysis

Linear regression models are derived to estimate significant variations in the present and future concern of citizens for the five most important issues. Table 1 shows results of five regression models with present and future concern for the five issues as the dependent variables. The independent variables in the regression models of Table 1 are the same as used by Wood

and Vedlitz (2007: 558–9) to analyze the nation-wide survey sample in their study. We find their statistical model fairly robust and confirm the broader guns versus butter political agenda theory for our study sample.

More specifically, Wood and Vedlitz (2007: 558) found that as the ideology of respondents moves from liberal to conservative on the seven-point scale, respondents' present concern for terrorism significantly increases by 0.19 points, comparable with the 0.18 point increase in our sample as shown in Table 1. Wood and Vedlitz (2007: 558) report 0.26 and 0.48 point less concern among conservative ideologues for poverty and global warming, respectively. Our sampled conservative ideologues have similarly 0.23 and 0.28 point less concern for poverty and global warming, respectively. Respondent future concern for these five issues is also similar across Wood and Vedlitz (2007: 559) and our study sample (Table 1). Wood and Vedlitz (2007: 559) find a 0.45 point less future concern for global warming among conservative ideologues, while we find a 0.32 point less future concern for global warming among conservative ideologues.

We are able to confirm our first hypothesis [H_1] that ideology does have a significant effect on citizen concern for global warming. Further, as citizens' ideology becomes more conservative, concern for global warming significantly decreases.

In terms of testing our second hypothesis [H_2], our sample results are different from those reported by Wood and Vedlitz (2007: 558–9), who found that college education significantly reduces present citizen concern for terrorism, the economy, health care and global warming by 0.41, 0.38, 0.34 and 0.48 points respectively. Our study results in Table 1 show that college education has no significant effect on reduced concern for these five issues. In terms of future concern (Table 1), our study does show that college education significantly reduces citizen concern for global warming by 0.49 points (compared with an insignificant effect in Wood and Vedlitz model).

Similarly, in terms of testing the effect of general science literacy on present citizen concern, Wood and Vedlitz (2007: 558) found that general science literacy significantly reduces citizen concern for terrorism (0.22 point), the economy (0.26 point) and health care (0.18 point), but general science literacy has no significant effect on citizen concern for poverty or global warming. Our study results show no significant effects of general science literacy on global warming, poverty, health care or the economy, but higher general science literacy does seem to significantly reduce citizen concern for terrorism (0.27 point).

Overall, we reject hypothesis [H_2], as we are not able to confirm whether college education or general science literacy increases citizen concern for global warming. This hypothesis will require further testing in future studies that use more sophisticated questions to assess scientific literacy, as recommended by Pardo and Calvo (2004). One possible explanation for the counter-intuitive evidence that college education decreases future citizen concern for global warming may be the enhanced belief in the capacity of human societies to adapt to change. This explanation will also require further empirical testing.

For testing our hypothesis [H_3] about the interaction effect of college education and political ideology, we re-specified the above regression models by adding an interaction variable (college education*ideology) in the list of independent variables. We also added five additional variables—Global Warming literacy, Science Unclear, Personal Experience, Attention and Social Network Concerned—to further improve explanatory power of the regression models. The re-specified regression models reported in Table 2 have in general higher R^2 and lower model error as compared to regression models reported in Table 1. Wood and Vedlitz have not tested the effect of college education*ideology in their regression models, but they do report the results of five additional variables just for present and future global warming concern (2007: 561).

Table 2 shows the results of re-specified regression models. We reject the null hypothesis with 95% confidence level that college educated conservative ideologues have similar concern

Table 1. Determinants of level of concern for five important issues facing the nation now and in the future: reduced models

Determinant condition	Terrorism		Economy		Health care		Poverty		Global warming	
	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future
Ideology	0.18* (0.09)	0.18* (0.09)	-0.18* (0.07)	-0.10 (0.07)	-0.07 (0.07)	-0.10 (0.07)	-0.23** (0.07)	-0.14 (0.08)	-0.28** (0.08)	-0.32** (0.08)
Party	0.88* (0.36)	1.16** (0.37)	-0.24 (0.30)	-0.62* (0.31)	-0.52 (0.28)	-0.26 (0.28)	-0.51 (0.30)	-0.51 (0.31)	-1.05** (0.31)	-1.12** (0.33)
Income	-0.001 (0.03)	-0.03 (0.03)	0.04 (0.03)	0.08** (0.03)	-0.01 (0.03)	0.04 (0.03)	0.02 (0.03)	0.01 (0.03)	0.01 (0.03)	0.04 (0.03)
Age	0.02* (0.009)	0.01 (0.01)	-0.002 (0.008)	0.003 (0.008)	0.01 (0.008)	0.005 (0.008)	-0.008 (0.008)	-0.001 (0.008)	-0.005 (0.008)	-0.007 (0.009)
Religion conservative	0.55 (0.36)	0.22 (0.38)	0.51 (0.31)	0.45 (0.32)	-0.01 (0.29)	0.18 (0.29)	0.006 (0.32)	0.23 (0.32)	-0.36 (0.33)	0.01 (0.34)
Race white	-0.03 (0.24)	0.17 (0.25)	-0.38 (0.20)	-0.03 (0.21)	-0.11 (0.19)	-0.26 (0.20)	-0.02 (0.21)	0.02 (0.21)	0.34 (0.22)	-0.05 (0.23)
Gender female	0.61* (0.28)	0.74* (0.29)	0.27 (0.24)	0.58** (0.24)	0.61** (0.22)	0.85** (0.22)	0.80** (0.24)	0.85** (0.24)	0.84** (0.25)	0.87** (0.26)
Children	0.01 (0.34)	-0.47 (0.35)	-0.42 (0.29)	-0.14 (0.30)	-0.47 (0.27)	-0.09 (0.27)	0.03 (0.29)	0.07 (0.30)	-0.21 (0.30)	-0.15 (0.31)
Gender female*	-0.16 (0.49)	0.55 (0.51)	0.42 (0.42)	0.23 (0.43)	0.50 (0.39)	0.19 (0.40)	0.10 (0.42)	0.23 (0.43)	0.44 (0.43)	0.31 (0.45)
Education college	-0.26 (0.25)	-0.22 (0.26)	0.14 (0.21)	0.01 (0.22)	-0.002 (0.20)	-0.20 (0.20)	-0.22 (0.22)	-0.20 (0.22)	-0.43 (0.23)	-0.49* (0.24)
General science literacy	-0.27* (0.13)	-0.17 (0.14)	0.02 (0.11)	-0.06 (0.12)	0.02 (0.11)	-0.11 (0.11)	-0.13 (0.12)	-0.05 (0.12)	0.06 (0.12)	0.04 (0.13)
Number of information sources	-0.15 (0.11)	-0.17 (0.11)	0.11 (0.09)	0.15 (0.10)	0.03 (0.09)	-0.05 (0.09)	-0.06 (0.09)	-0.09 (0.10)	-0.005 (0.10)	-0.05 (0.10)
Self-reported knowledge of issue	0.37** (0.04)	0.29** (0.05)	0.09* (0.04)	0.07 (0.04)	0.28** (0.04)	0.19** (0.04)	0.49** (0.04)	0.44** (0.04)	0.42** (0.04)	0.30** (0.05)
Constant	3.17** (0.69)	3.97** (0.72)	7.22** (0.60)	6.55** (.62)	5.51** (.62)	6.76** (0.57)	5.14** (0.62)	4.91** (0.63)	4.87** (0.63)	6.98** (0.65)
N	495	495	496	496	495	495	496	496	494	493
$\sigma_{e, average}$	2.53	2.63	2.15	2.22	2.03	2.05	2.20	2.23	2.26	2.36
Adjusted R ²	19.3%	14.0%	2.7%	3.9%	12.3%	8.2%	28.6%	23.0%	29.7%	22.7%
F	10.06**	7.18**	2.06*	2.55*	6.35**	4.37**	16.22**	12.37**	17.01**	12.12**

*shows significance at 0.05 level and ** shows significance at 0.001 level. Numbers in parentheses show standard errors. F statistic shows joint significance for all variables.

Table 2. Determinants of level of concern for five important issues facing the nation now and in the future: expanded models

Determinant condition	Terrorism		Economy		Health care		Poverty		Global warming	
	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future
Ideology	0.10 (0.12)	0.11 (0.12)	-0.15 (0.10)	-0.10 (0.10)	0.05 (0.09)	-0.03 (0.09)	-0.07 (0.10)	-0.06 (0.10)	-0.05 (0.09)	-0.05 (0.10)
Party Republican	0.47 (0.39)	0.81* (0.40)	-0.47 (0.32)	-0.70* (0.34)	-0.97** (0.30)	-0.56 (0.31)	-0.47 (0.33)	-0.37 (0.33)	-0.75* (0.31)	-1.12** (0.33)
Income	0.01 (0.04)	-0.04 (0.04)	0.03 (0.03)	0.09** (0.03)	-0.01 (0.03)	0.06* (0.03)	0.03 (0.03)	0.03 (0.03)	0.02 (0.03)	0.03 (0.03)
Age	0.02* (0.01)	0.02 (0.01)	-0.001 (0.009)	0.000 (0.009)	0.01 (0.008)	0.000 (0.009)	-0.009 (0.009)	-0.003 (0.009)	-0.01 (0.009)	-0.01 (0.009)
Religion conservative	0.56 (0.40)	0.10 (0.41)	0.47 (0.33)	0.39 (0.35)	-0.12 (0.31)	0.02 (0.32)	0.007 (0.34)	0.27 (0.34)	-0.47 (0.32)	-0.01 (0.34)
Race white	-0.23 (0.27)	0.13 (0.27)	-0.33 (0.22)	-0.04 (0.24)	-0.11 (0.21)	-0.31 (0.22)	-0.03 (0.23)	0.05 (0.23)	0.38 (0.21)	0.02 (0.23)
Gender female	0.60* (0.30)	0.84* (0.31)	0.37 (0.25)	0.67* (0.27)	0.73** (0.23)	1.01** (0.24)	0.98** (0.26)	0.81** (0.26)	0.67** (0.24)	0.87** (0.26)
Children	0.08 (0.37)	-0.30 (0.38)	-0.30 (0.31)	-0.09 (0.33)	-0.27 (0.29)	0.04 (0.30)	0.25 (0.32)	0.27 (0.34)	-0.33 (0.30)	-0.24 (0.32)
Gender female* Children	-0.25 (0.54)	0.48 (0.56)	0.20 (0.45)	-0.01 (0.48)	0.21 (0.42)	-0.10 (0.44)	-0.19 (0.46)	0.12 (0.47)	0.72 (0.43)	0.43 (0.47)
Education college	-1.03 (0.59)	-0.96 (0.61)	0.20 (0.49)	0.10 (0.52)	0.50 (0.46)	0.19 (0.48)	0.70 (0.50)	0.44 (0.51)	0.42 (0.47)	0.54 (0.51)
General science literacy	-0.28 (0.16)	-0.14 (0.16)	0.000 (0.13)	-0.06 (0.12)	0.02 (0.12)	-0.10 (0.13)	-0.19 (0.13)	-0.03 (0.13)	-0.16 (0.13)	-0.17 (0.14)
Number of information sources	-0.15 (0.12)	-0.16 (0.12)	0.15 (0.10)	0.21* (0.10)	0.14 (0.09)	0.05 (0.10)	0.02 (0.10)	-0.03 (0.10)	0.04 (0.10)	-0.03 (0.10)
Self-reported knowledge of issue	0.35** (0.05)	0.33** (0.05)	0.13** (0.05)	0.09 (0.05)	0.33** (0.04)	0.22** (0.04)	0.51** (0.04)	0.47** (0.04)	0.26** (0.05)	0.20** (0.05)

(Continued)

Table 2. (Continued)

Determinant condition	Terrorism		Economy		Health care		Poverty		Global warming	
	Now	Future	Now	Future	Now	Future	Now	Future	Now	Future
Global warming literacy	-0.01 (0.13)	0.03 (0.13)	0.14 (0.11)	0.14 (0.11)	0.10 (0.10)	-0.04 (0.11)	-0.10 (0.11)	-0.20 (0.11)	0.18 (0.11)	0.21 (0.11)
Global warming science unclear	0.09 (0.19)	-0.008 (0.19)	0.15 (0.16)	0.04 (0.17)	0.29* (0.15)	0.15 (0.15)	-0.22 (0.16)	-0.07 (0.16)	-0.42** (0.15)	-0.63** (0.16)
Personal experience with global warming	0.10 (0.18)	0.000 (0.18)	-0.16 (0.15)	-0.07 (0.15)	0.03 (0.14)	-0.14 (0.14)	-0.03 (0.15)	-0.09 (0.15)	0.46** (0.14)	0.26 (0.15)
Attention to global warming	-0.47* (0.20)	-0.29 (0.21)	0.02 (0.17)	-0.06 (0.18)	-0.02 (0.16)	0.10 (0.16)	0.19 (0.17)	0.28 (0.17)	0.30 (0.16)	0.27 (0.18)
Social network concerned about global warming	0.07 (0.05)	0.04 (0.06)	0.04 (0.04)	0.03 (0.05)	-0.03 (0.04)	-0.03 (0.04)	-0.06 (0.05)	0.000 (0.05)	0.15** (0.04)	0.04 (0.05)
Ideology*Education college	0.22 (0.15)	0.22 (0.15)	-0.03 (0.12)	-0.03 (0.13)	-0.18 (0.11)	-0.13 (0.12)	-0.27* (0.13)	-0.18 (0.13)	-0.26* (0.12)	-0.29* (0.13)
Constant	4.08** (1.09)	4.13** (1.12)	6.61** (0.90)	6.65** (.96)	4.08** (0.85)	6.16** (0.88)	4.99** (0.93)	4.15** (0.94)	3.68** (0.85)	6.89** (0.91)
N	420	421	421	421	420	420	421	421	419	419
$\sigma_{\text{e average}}$	2.51	2.59	2.10	2.22	1.97	2.04	2.15	2.17	2.02	2.17
Adjusted R ²	18.0%	14.7%	3.2%	3.9%	16.1%	9.6%	30.3%	24.9%	42.9%	33.6%
F	5.85**	4.80**	1.73*	1.90*	5.24**	3.34**	10.61**	8.35**	17.55**	12.14**

* shows significance at 0.05 level and ** shows significance at 0.001 level. Numbers in parentheses show standard errors. F statistic shows joint significance for all variables.

about global warming (both present and future) as non-college educated conservative ideologues. The interaction variable is statistically significant in the negative direction in Table 2 for the regression equations with present and future concern for global warming as dependent variable. This implies that college educated conservative ideologues have lower concern for global warming in both present (0.26 points) and future (0.29 points). College education does not appear to trump ideology of our sampled Bay Area residents.

Unlike Wood and Vedlitz (2007: 561), we found no significant effect of global warming literacy or personal attention on increased concern for global warming. Conversely, Wood and Vedlitz (2007: 561) found no significant effect of social network concerned on present or future citizen concern about global warming, but our study found a significant effect of social networks for present (0.15 points) citizen concern about global warming. The effect of social networks on future concern for global warming is, however, insignificant in our study. While Wood and Vedlitz (2007: 561) found that the “science unclear” perception of citizens reduces global warming present (0.22 points) and future (0.17 points) concern, we found a stronger effect of “science unclear” in the same direction for both present (0.42 points) and future (0.63 points) concern of citizens about global warming.

Elicitation of cultural models from survey data

Implementation of this survey reveals complex interaction effects among variables exerting positive and negative effects on citizen concern for various policy issues. We analyze this interaction complexity by constructing and comparing cultural models of citizens with different political and religious ideologies. We use survey data of San Francisco Bay Area residents to construct a universe of cultural maps, a simplified version of which is shown in Figure 3. Statistically significant correlations (in plus or minus % points) show the corresponding magnitude and direction of positive and negative relationships among important variables shown as nodes in Figure 3. This simplified figure shows only 20% or higher correlations among the study variables, which have the same coding scheme as described in the survey questionnaire for regression models. Dashed and solid lines connect the nodes. Dashed lines show negative correlations and solid lines show positive correlations. Lines are scaled according to their magnitudes, i.e. Pearson correlation coefficients.

Figure 3 shows that the cultural models of politically conservative ideologues and religious conservatives demonstrate ideological preferences that are systematically different from those of the cultural models of liberal ideologues and religious liberals (or even moderates). While females in general appear to be more concerned about every public issue, younger people appear to be more liberal and older people appear to be more conservative. While educated people have relatively higher General Science and Global Warming literacy, as well as higher incomes, college education does not significantly correlate with religious or political ideologies. Further, it is not educational background, but religious and political ideologies that influence citizen concern about policy issues such as global warming, terrorism, poverty, health care and the economy. College education is, however, strongly correlated with higher income, age and race.

The assessment of cultural models, as shown in Figure 3, demonstrates the strength of the correlation effect of ideology, religious identity and political party affiliation vis-à-vis other background variables on public concern about global warming. This implies that citizen cultural models are driven by ideological predispositions, which have strong effects on citizen understanding of scientific forecasts, while college education has no significant effect in shaping ideologically driven cultural models. Improving education of citizens will thus not be enough to communicate the urgency and implications of climate change science.

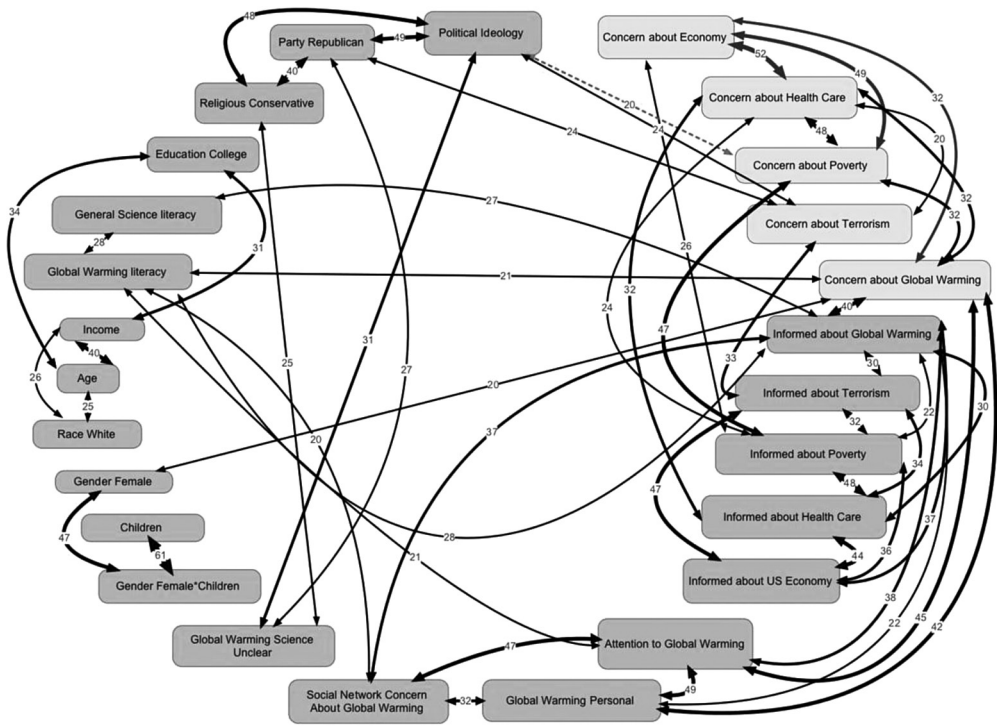


Figure 3. Universe of cultural models (numbers represent significant Pearson correlations, 20% or higher).

More sophisticated strategies will need to be developed to communicate climate change forecasts that cut across ideologically divided cultural models.

4. Implications: communicating climate change science across ideological divides

Our study shows that many conservative ideologues are less concerned about climate change science because they believe that scientists do not have adequate/clear understanding of climate change science. The strong significance of the variable “science unclear” in Table 2 for global warming concern testifies to this problem. Further, Figure 3 shows a very strong correlation (31%) between “science unclear” and “ideology,” i.e. as ideology shifts from liberal to conservative, survey respondents are more likely to believe that climate change scientists are not clear about understanding the climate change science. This belief among the conservative ideologues has to do with the longstanding discourse in the US whether climate change is human-made (anthropogenic) or “natural.” Many conservative ideologues tend to believe that climate change is natural and not anthropogenic, thus society and governments need not take any action to deal with climate change. While systematic efforts have been put in place by climate change scientists, especially after the Intergovernmental Panel on Climate Change (IPCC) was awarded the 2007 Nobel Prize, to dispel the belief that climate change is merely “natural,” conservative ideologues (as shown in our spring 2008 survey) tend to disbelieve IPCC consensus that climate change is anthropogenically induced through the momentous release of greenhouse gas emissions in the atmosphere since the beginning of the industrial era.

Previous researchers have noted that messages about climate change “need to be tailored to the needs and predispositions of particular audiences; in some cases to directly challenge fundamental misconceptions, in others to resonate with strongly held values” (Leiserowitz, 2006: 64). Our study implies that scientific forecast messages must be further tailored to cut across ideological predispositions. Moser and Dilling (2004) urge public communicators to address the emotional and temporal components of “urgency,” and tap into individual and cultural values, in order to conquer ideological differences. Specifically, our findings demonstrate that conservative political and religious ideologues are least likely to name climate change as an important present or future concern. Returning to the “guns versus butter” theory, we identify three strategies of climate change communication that might be used to more specifically appeal across the conservative–liberal ideological divide. We discuss how security appeals can potentially frame climate change as a “guns” issue. We then explore how religious appeals can frame climate change as a “butter” issue. Finally we suggest how framing climate change mitigation and adaptation as part of our response to the economic crisis might cut across ideological lines.

A significant trend in public discourse is framing climate change as a security issue. This is evident in President Obama’s efforts to add experts on “climate security” in the membership of the National Security Council. “Energy security” is a loaded phrase used by oil companies and grassroots groups alike. Ungar (2007: 85) notes that links between security concerns and energy supplies in public discourse are a potentially effective strategy at gaining public adherence. Climate change can be framed as more of a security issue by emphasizing the risks and impacts of drastic climatic change. Climate change is an invisible threat, with no immediate proof of its danger, or existence for that matter. Since “security” is a guns issue, ideologically predisposed conservatives might have higher concern about “climate security” as opposed to “climate change.” As a guns issue, climate change is positioned as more relevant to citizens’ personal security. Appeals to security are persuasive when threats seem real. In the same way that the color-coded terror alert levels explain the need for security procedures, climate security threats could be publicized to justify government action. This could be accomplished by incorporating evidence of tangible effects of anthropogenic climate change into discussions of present and future threats to environmental security. This would link present policy to concerns of future impacts, and reframe climate change as a direct threat to security.

A second trend in public discourse about climate change is reframing climate change as a “religious” issue. James Dobson and Reverend Sally Bingham are among American religious leaders calling for clergy to advocate more action on climate change (e.g. Bingham, 2007: 153). Since conservative ideologues are typically “religious minded” (as is obvious from cultural models elicited in Figure 3), it might help to improve the communication of climate change science across ideological divides if climate change is framed as an issue of “pain and suffering for fellow humans, animals and plants” (Bingham, 2007: 153). As a moral issue, climate change is important to religious communities (see Leiserowitz, 2007). As in the case of “climate security” reframing, theologizing of climate change scientific communication might have some appeal for conservative ideologues. Climate change can be framed as a “butter” issue through appeals to religious values, such as a moral obligation to protect the Earth and God’s living things, and alleviate suffering. Mitigation and adaptation strategies may be framed as ways to protect communities and as part of our moral obligation to future generations. As a moral issue, climate change becomes more of a question of compassion. Such communication strategies could bring climate justice issues more to the forefront of the public mind and provide a more global perspective on the impacts of climate change.

A third strategy for improving communication of climate change along ideological lines is to explicitly frame climate change as an economic issue. The long-term economic effects of climate change were extensively documented in the widely read Stern Report (Stern, 2008). Yet for many citizens, these remain long-term effects, with little relevance for today's consumers. In this way, economic issues are related to questions of certainty: the uncertainty of climate change impacts works to distance the economic impacts as well. Yet, while scientific uncertainty remains high for conservative ideologues, reframing of climate change across economic lines can tap into the emotional urgency of the economic crisis and create a new sense of certainty: the need for the certainty of action. Connecting climate change and economic recovery will effectively reframe the issue as a butter issue, while also appealing to conservative economic beliefs. The global economic crisis has extreme emotional and temporal urgency as citizens see their investments dwindle and the future become more uncertain. Connecting the climate crisis to the economic crisis frames mitigation as an investment in the future of society and adaptation as a protective measure for the well-being of citizens. For example, eliminating waste is an important aspect of economic recovery: witness President Obama's elimination of expenditures in the federal budget, and perhaps more poignantly, the state of California's warehouse sale. Framing energy efficiency as a cost-cutting and waste-saving measure is a strategy to persuade conservative ideologues of the importance of climate change. Questions about the costs of scientific investigation, and the costs of greenhouse gas mitigation can be framed as an investment in green technologies, or weighed against the future cost of predicted effects on agricultural industries. The economic crisis has altered America's (and the world's) confidence in short-term economic policies, and has increased receptiveness to long-term economic investments. Explicitly connecting our response to climate change to economic issues will tap into the personal and national importance citizens attach to the economic crisis. Framing climate change policy as a stabilizing response to economic uncertainty can mitigate questions about scientific uncertainty.

While careful research needs to be conducted to evaluate the effects of reframing the climate change discourse in security, religious, or economic terms, the reframing of climate change discourse as a security or an economic issue might help to successfully communicate the climate change science across ideological divides. These strategies for improving communication about climate change respond to institutional and social changes such as those to international security and economic markets. Framing climate change as a problem related to these issues will help to affect behavioral change in individuals across ideological divides. Framing climate change policies as part of broader public discourse about international and economic security may increase support of more climate-neutral behavior in ways that are amenable to those with different ideological stances.

5. Conclusions

This study demonstrates that ideology results in significantly different concern, and by implication understanding, of citizens for different policy issues that are at the intersection of science and politics. Ideology even trumps college education in the formulation of citizen cultural models. This study demonstrates the utility of mental models in assessing public understanding of climate change. Public knowledge of climate science that cuts across ideological divides is crucial to public action toward addressing these impacts. Reframing climate change knowledge along guns versus butter political agenda theory can potentially empower people across ideological divides to act locally on a global issue. However, the effects of reframed

risk communication must be carefully investigated in future studies that also take into account cognitive dissonance and trust-gap effects.

Follow-up research must investigate whether and how changes in the informational content of scientific messages affect a change in the concern of citizens across a larger variety of socio-political and economic issues. Another question of interest is how long do citizens remain committed to their religious and/or political ideologies after scientific messages are tailored to unravel unscientific beliefs of citizens. Such research would be worthwhile for understanding the effects of ideology in communication of other kinds of science to the public, such as pesticide exposures; DDT effects; impacts of tobacco, alcohol and other drugs; biotechnology, nanotechnology and other cutting edge scientific discoveries. As society at large gains more scientific knowledge, we must find ways to disseminate that knowledge across the ideological divides to engage citizens in matters of public policy.

Acknowledgements

We acknowledge the great effort of students in the spring 2008 Global Climate Change course (COMM/ENVS/GEOL/METR 168) to collect survey data. We are also grateful to San Jose State's Undergraduate Studies for providing us with a grant to design and implement the course. Part of the research was funded by the National Science Foundation, Human and Social Dynamics Program grant # 0433165. We are also very grateful to two anonymous reviewers and the editor for very constructive comments and suggestions.

Notes

- 1 Throughout this article we use the term climate change, and use it here to refer to the term "global warming" as used in the authors' survey instrument.
- 2 Corresponding null hypotheses are as follows: [H₁] Ideology has no significant effect on citizen concern for global warming. [H₂] College education and general science literacy have no significant effect on citizen concern for global warming. [H₃] College education increases global warming concern for ideologically predisposed conservatives.
- 3 San Francisco Bay Area demographics used for comparison with this study sample are available online at <http://www.bayareacensus.ca.gov/bayarea.htm> (accessed 16 November 2009). These demographic data are compiled from 2006–2008 American Community Survey 3-Year Estimates.
- 4 As introduced earlier in the paper, ideology is a complex multi-dimensional concept that shows axiological, normative and political preferences of the citizens. This study measures only one dimension of this multi-dimensional concept, which is the political positioning of the survey respondents. This is another significant operational limitation of our study and the results vis-a-vis political ideology must be interpreted accordingly.

References

- Adger, W. N. (2003) "Social Capital, Collective Action, and Adaptation to Climate Change," *Economic Geography* 79(4): 387–404.
- Antonakis, N. (1999) "Guns Versus Butter: A Multisectoral Approach to Military Expenditure and Growth with Evidence from Greece, 1960–1993," *Journal of Conflict Resolution* 43(4): 501–20.
- Axelrod, R. (1976) *Structure of Decision: The Cognitive Maps of Political Elites*. Princeton, NJ: Princeton University Press.
- Bingham, S. (2007) "Climate Change: A Moral Issue," in S. Moser and L. Dilling (eds) *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, pp. 153–66. New York: Cambridge University Press.
- Bord, R. J., O'Connor, R. E. and Fischer, A. (2000) "In What Sense Does the Public Need to Understand Global Climate Change?," *Public Understanding of Science* 9(3): 205–18.
- Bostrom, A., Morgan, M. G., Fischhoff, B. and Read, D. (1994) "What Do People Know about Global Climate Change? 1. Mental Models," *Risk Analysis* 14(6): 959–70.
- Caputo, D. A. (1975) "New Perspectives on the Public Policy Implications of Defense and Welfare Expenditures in Four Modern Democracies, 1950–1970," *Policy Sciences* 6: 423–46.

- Carrubba, C. J. and Singh, A. (2004) "A Decision Theoretic Model of Public Opinion: Guns, Butter, and European Common Defense," *American Journal of Political Science* 48(2): 218–31.
- Carvalho, A. (2007) "Ideological Cultures and Media Discourses on Scientific Knowledge: Re-Reading News on Climate Change," *Public Understanding of Science* 16(2): 223–43.
- Christensen, G. L. and Olson, J. C. (2002) "Mapping Consumers' Mental Models with ZMET," *Psychology and Marketing* 19(6): 477–501.
- Clark, D. H. (2001) "Trading Butter for Guns: Domestic Imperatives for Foreign Policy Substitution," *Journal of Conflict Resolution* 45(5): 636–60.
- Clayton, J. L. (1976) "The Fiscal Limits of the Warfare-Welfare State: Defense and Welfare Spending in the United States since 1900," *Western Political Quarterly* 29: 364–83.
- Durant, J., Evans, G. A. and Thomas, G. P. (1989) "The Public Understanding of Science," *Nature* 340: 11–4.
- Eagelton, T. (1991) *Ideology: An Introduction*. London: Verso.
- Evans, G. A. and Durant, J. (1995) "The Relationship between Knowledge and Attitudes in the Public Understanding of Science in Britain," *Public Understanding of Science* 4: 57–74.
- Frumkin, H., Hess, J., Luber, G., Malilay, J. and McGeehin, M. (2008) "Climate Change: The Public Health Response," *American Journal of Public Health* 98(3): 435–45.
- Hartman, S. W. (1973) "The Impact of Defense Expenditure on the Domestic American Economy, 1964–1972," *Public Administration Review* 33: 379–90.
- Kempton, W. (1991) "Lay Perspectives on Global Climate Change," *Global Environmental Change* June: 183–208.
- Kempton, W. (1997) "How the Public Views Climate Change," *Environment* 39(9): 12–21.
- Kosko, B. (1986) "Fuzzy Cognitive Maps," *International Journal of Man-Machine Studies* 24(1): 65–75.
- Leiserowitz, A. (2006) "Climate Change Risk Perception and Policy Preferences: The Role of Affect, Imagery and Values," *Climatic Change* 77: 45–72.
- Leiserowitz, A. (2007) "Communicating the Risks of Global Warming: American Risk Perceptions, Affective Images, and Interpretive Communities," in S. Moser and L. Dilling (eds) *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, pp. 44–63. New York: Cambridge University Press.
- Lorenzoni, I. and Pidgeon, N. F. (2006) "Public Views on Climate Change: European and USA Perspectives," *Climatic Change* 77: 73–95.
- McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J. and White, K. S. (2001) *Climate Change 2001: Impacts, Adaptation and Vulnerability*. New York: Cambridge University Press.
- Mintz, A. and Huang, C. (1991) "Guns Versus Butter: The Indirect Link," *American Journal of Political Science* 35(3): 738–57.
- Morgan, M. G., Fischhoff, B., Bostrom, A. and Atman, C. J. (2002) *Risk Communication: A Mental Models Approach*. New York: Cambridge University Press.
- Moser, S. and Dilling, L. (2004) "Making Climate Hot: Communicating the Urgency and Challenge of Global Climate Change," *Environment* 46(10): 32–46.
- Moser, S. and Dilling, L. (eds) (2007) *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*. New York: Cambridge University Press.
- National Science Foundation (NSF) (1999) *Geosciences Beyond 2000: Report of a Long-Range Planning Effort for Geosciences in the 21st Century*. NSF 00–28.
- Pardo, R. and Calvo, F. (2002) "Attitudes toward Science among the European Public: A Methodological Analysis," *Public Understanding of Science* 11: 155–95.
- Pardo, R. and Calvo, F. (2004) "The Cognitive Dimension of Public Perceptions of Science: Methodological Issues," *Public Understanding of Science* 13: 203–27.
- Peroff, K. and Podolak-Warren, M. (1979) "Does Spending on Defence Cut Spending on Health? A Time-Series Analysis of the U.S. Economy, 1929–1974," *British Journal of Political Science* 9: 21–39.
- Priest, S. H., Bonfadelli, H. and Rusanen, M. (2003) "The 'Trust Gap' Hypothesis: Predicting Support for Biotechnology across National Cultures as a Function of Trust in Actors," *Risk Analysis* 23(4): 751–66.
- Russett, B. M. (1969) "Who Pays for Defense?," *American Political Science Review* 63: 412–26.
- Russett, B. M. (1970) *What Price Vigilance? The Burdens of National Defense*. New Haven: Yale University Press.
- Slovic, P. (2000) *The Perception of Risk*. London: Earthscan.
- Sterman, J. D. and Sweeney, L. B. (2007) "Understanding Public Complacency about Climate Change: Adults' Mental Models of Climate Change Violate Conservation of Matter," *Climatic Change* 80: 213–38.
- Stern, N. (2008) "The Economics of Climate Change (Richard T. Ely Lecture)," *American Economic Review: Papers and Proceedings* 98(2): 1–37.
- Stoll-Kleemann, S., O'Riordan, T. and Jaeger, C. C. (2001) "The Psychology of Denial Concerning Climate Mitigation Measures: Evidence from Swiss Focus Groups," *Global Environmental Change* 11: 107–17.

- Taylor, S. E. and Fiske, S. T. (1981) "Getting inside the Head: Methodologies for Process Analysis in Attribution and Social Recognition," in J. A. Harvey and W. J. Kidd (eds) *New Directions in Attribution Research*, Vol. 3, pp. 459–524. Hillsdale, NJ: Erlbaum.
- Trumbo, C. (1996) "Constructing Climate Change: Claims and Frames in US News Coverage of an Environmental Issue," *Public Understanding of Science* 5: 269–83.
- Ungar, S. (2007) "Public Scares: Changing the Issue Culture," in S. Moser and L. Dilling (eds) *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, pp. 81–8. New York: Cambridge University Press.
- US Department of State (2002) *US Climate Action Report*. URL (consulted February 2009): www.gcric.org/CAR2002/
- Weingart, P., Engels, A. and Pansegrau, P. (2000) "Risks of Communication: Discourses on Climate Change in Science, Politics, and the Mass Media," *Public Understanding of Science* 9: 261–83.
- Wilensky, H. (1975) *The Welfare State and Equality*. Berkeley: University of California Press.
- Wood, B. D. and Vedlitz, A. (2007) "Issue Definition, Information Processing, and the Politics of Global Warming," *American Journal of Political Science* 51(3): 552–68.
- Zaltman, G. (1997) "Rethinking Market Research: Putting People Back In," *Journal of Marketing Research* 34(4): 424–37.

Authors

Asim Zia is an assistant professor of public policy in the Department of Community Development and Applied Economics at the University of Vermont. His research is focused on analysis of decision behaviors and public policies in complex systems such as climate change, energy, transportation and international development. Correspondence: University of Vermont, Department of Community Development and Applied Economics, Morrill Hall 208E, 146 University Place, Burlington, VT 05405, USA; e-mail: Asim.Zia@uvm.edu

Anne Marie Todd is an associate professor of public communication in the Department of Communication Studies at San Jose State University. She has published numerous articles in the area of environmental communication including analyses of the rhetoric of conservation movements and ecological messages in popular culture. She also publishes in the area of environmental education, most recently a book for 9–11 year olds on reducing their ecological footprint. She continues to teach the interdisciplinary climate change course.