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# Climate Change Survey Measures: Exploring Perceived Bias and Question Interpretation

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# Climate Change Survey Measures

## *Exploring Perceived Bias and Question Interpretation*

Tarik Abdel-Monem, Lisa M. PytlikZillig,  
Tonya K. Bernadt, and Nicole A. Wall

**ABSTRACT**—Climate change has become an important yet politically divisive topic in recent years. Further complicating the issue are assertions that climate change–related public opinion surveys used by social scientists are biased or otherwise problematic. We conducted a pilot study to explore questions concerning bias and interpretation of climate change surveys. Our study sample was composed of adult residents of Nebraska ( $n = 115$ ). We augmented our survey findings with cognitive interviews of a subsample of respondents ( $n = 20$ ). We assessed study participants’ attitudes about climate change, and perceptions of bias and interpretation of survey questions drawn from previously used survey instruments and national polls. Among our study sample, we found little support for perceived bias within the survey items employed. However, interview findings indicated that particular survey language may have elicited unexpected associations among respondents. We discussed implications for further research.

**Key Words:** climate, climate change, public opinion, public understanding, risk communication, science, survey bias

### Introduction

As climatologists work to find ways to measure and track climate change and its effects, social scientists have assessed the changing environment of people’s knowledge and attitudes toward climate and climate change. However, less work has been done on the second question than the first, and little attention has been focused on examining the *approaches* used to gauge public opinion about climate change. The issue is relevant because the discourse about climate policy has become a politically polarized topic. Accusations have become common about the objectivity of climate scientists, the influence of media entities, the role of special interest groups, and other assertions that have complicated the overall discussion (Trumbo 1996; Weingart et al. 2000; Carvalho 2007; Sandell 2007). Concerns have been voiced about climate change public opinion polls becoming part of “framing debates,” with frequent assertions that polls or their results are poorly constructed, biased, or mis-

reported (Hoffman 2011; Kohut 2010; Krosnick 2010; Solomon 2010). Some of these claims may be closely entangled with partisan commentary about the climate change issue. Others may simply be manifestations of professional disagreement. Regardless, in general there is little empirical basis that informs questions about perceived or actual bias in climate change survey methods.

We conducted a pilot study to explore questions concerning public perceptions of surveys related to climate change. How common is perceived bias of survey questions among the public? What unintended constructs are elicited among respondents in climate change–related surveys? To answer these questions, we employed survey and interview methods using a variety of climate change questions based on previously used survey questionnaires. Our study population was a convenience sample of adults visiting an event at a natural history museum in the state of Nebraska, and the results are thus not necessarily representative of the general population. They may, however, offer insight into the perceptions and thought processes of those members of the public who are, or strive to be, literate in “lay science.” Our study results should inform future efforts to further investigate this area.

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## Background

### *Climate Change*

The global atmospheric concentration of carbon dioxide, methane, and nitrous oxide has increased substantially as a result of industrialization, large-scale agriculture, and sustained fossil fuel use (IPCC 2007). Atmospheric greenhouse gas levels strongly suggest a relationship with corresponding increases in air and ocean temperatures, and widespread glacial and snow cover melting. Mean near-surface temperature has increased 0.76°C from the period between 1850 and 1899 to the period between 2001 and 2005, and global sea levels have risen an average of 1.8 mm per year since 1961 (IPCC 2007). Within the Great Plains, average temperatures have risen 0.9°C over the previous 115 years. It is estimated that by 2100, average temperatures in the region could increase anywhere from 1.6°C to 4.4°C (High Plains Regional Climate Center n.d.; US EPA 1998; NCADAC 2013). Average temperature increases might lead to corresponding effects in the prevalence of smog, or increase the likelihood that Lyme disease, encephalitis, or other insect-borne diseases could spread (EPA 1998; IPCC 2007; CDC, EPA, NOAA, and AWWA 2010). Precipitation in the Great Plains will increase in some areas, and decrease in others (GCRP 2009; NCADAC 2013). It is possible that overall ecosystem changes will have considerable social and economic effects throughout the Great Plains (Ojima et al. 2002).

Residents of Nebraska have a major stake in climate change-related outcomes due to its potential impact on the agricultural economy of the state. A warmer climate can result in increased variability and can increase the risks of both floods and droughts (IPCC 2007). Studies on Great Plains states indicated that climate change could significantly impact wheat and corn yields due to shortened crop life cycles (Rosenzweig 1989), the duration of growing seasons, changes in planting dates, seasonal irrigation requirements (Easterling et al. 1993; Karl et al. 2009), and total stream flow in the Missouri River and other basins (Frederick 1993). Increased mean temperatures might also have an impact on animal feed and production rates that would require considerable management changes in the regional livestock industry (Mader et al. 2007). The interaction between natural conditions and human factors, such as employing more groundwater in response to drought, could exacerbate environmental impacts (IPCC 2007).

Climate change could result in both benefits and

losses for the agricultural sector, with actual effects contingent on the degree of climate change and effectiveness of mitigation and adaptation efforts (Ojima et al. 2002). Greenstone and Deschenes estimated long-term losses to state agricultural profits in Nebraska of \$670 million, second only to California at long-term losses of \$750 million (2006). Another study indicated that for Nebraska, up to \$1.4 billion in losses to gross domestic product could accrue between 2010 and 2050 as a result of climate change (Backus et al. 2010). Both of these studies converge on the idea that climate change will have a significant impact on Nebraska's economy. In contrast, other studies have found net gains in agricultural production depending on the location, but with considerable adjustment or mitigation costs (Reilly et al. 2003; Kelly et al. 2005).

### *Public Opinion on Climate Change*

Early international efforts to gauge public views on global warming included the 1989 Harris and Associates survey on global environmental issues, conducted for the United Nations Environmental Programme (Harris and Associates 1989), and the Gallup Health of the Planet survey (Dunlap et al. 1993), which coincided with the 1992 United Nations Conference on Environment and Development (Brechin 2003). Further opinion research was conducted as public awareness of climate change increased in the 1990s. Important early efforts examined the public's understandings of climate change causes and effects (Bostrom et al. 1994; Read et al. 1994) and associated value judgments (Kempton 1991; Kempton et al. 1996). Early survey research efforts found that the public tends to believe that climate change is occurring as a result of human activity and views it as an important problem, but generally lacks detailed understandings of cause and effect models (Kempton 1997; Kempton et al. 1996), climate change processes, and climate science (Kasemir et al. 2000; Morgan et al. 2001).

Within the United States, researchers have conducted a number of opinion surveys on climate change using national samples. Primary examples of academic research on national public opinion of climate change include work affiliated with the Stanford Woods Institute for the Environment (Krosnick et al. 2000; Malka et al. 2009; Villar and Krosnick 2011) and the Yale Climate and Energy Institute and Yale Project on Climate Change Communication (Leiserowitz 2004, 2005, 2006; Leiserowitz and Smith 2010; Leiserowitz et al.

2010). However, there are fewer studies of survey research specifically targeting midwestern or Great Plains populations about climate change. Examples include Diggs's survey of dryland farmers in North Dakota and northern Colorado to assess decision-making behavior related to climate change (Diggs 1991), the Energy Center of Wisconsin's nine-state study of perceptions of energy and climate change issues in the Midwest (Energy Center of Wisconsin 2008), Hamilton and Keim's study of climate change attitudes in rural areas (2009), and a 2008 study by Vogt and colleagues on rural Nebraskans' perceptions of climate change. Not unlike national polls, the Vogt study found that a majority of rural Nebraskans are concerned about climate change (60%), believe it is happening (58%), and that it is caused by human activity (65%).

Previous opinion studies conducted in various regional contexts indicate that respondent characteristics may be associated with perceptions and attitudes toward climate change, though the relationship is complex and unclear. For example, associations have been suggested between perceptions of climate change and socioeconomic characteristics (Bord et al. 1998; O'Connor et al. 2002; Wood and Vedlitz 2007), cultural and social values (Kahan et al. 2007; Braman et al. 2011), state residence (Shwom et al. 2008), and recent experiences with weather (Joireman et al. 2010; Spence et al. 2011; Egan and Mullin 2012). Several polls have suggested that political and social conservatives are less concerned about climate change and/or are less supportive of policies aimed at addressing climate change (Leiserowitz 2005; Krosnick et al. 2006; Dietz et al. 2007; McCright and Dunlap 2011). For example, Hamilton and Keim (2009) found that both Republican party identification and participation in religious services reduced the likelihood of recognizing climate change effects. National public opinion polls also regularly show that there are major partisan differences in perceptions, with self-identified Republicans or conservative-leaning individuals being significantly less likely than Democrats or liberals to believe that human activity is causing climate change (Pew Research Center 2010, 2012). This ideological divide is well acknowledged in current policy discourse and is reflected in the official platforms of both national parties (Democratic National Committee 2012; Republican National Committee 2012).

Public attention has focused on allegations of bias within climate change science or climate change-related surveys. Many—though not all—of these

debates, tend to have sharp partisan or ideological implications. For instance, assertions are frequently made alleging a politically liberal tendency among the climate science community. In support of these assertions are studies indicating that climate or natural scientists tend to identify as politically liberal (Pew Research Center 2009b; Rosenberg et al. 2010). Some climate scientists have alleged to have felt pressure to filter or exaggerate climate data (Lichter 2008). Reports in the media and other commentary have also alleged examples of potential or real conflicts of interest among climate scientists (Morello 2009; Pexton 2012). Within this context, assertions have been made that some climate public opinion surveys are intentionally biased or politically motivated. As opposed to critique aimed at sampling errors or selection bias, commentators have argued that opinion survey language itself may be deliberately leading in order to generate results that support policy positions on climate (Harris 2012; Pielke 2012).

Examining perceptions of bias in climate change survey questionnaires is important for several reasons. From a methodological perspective, an obvious concern exists regarding the face and content validity of surveys, and their implications for relevance, reliability, and interpretive value. These are general concerns that are not topically specific to climate change survey instruments in particular, and have been discussed elsewhere (Fowler 1995, 2008; Litwin 1995). Second is the interest in developing an empirical basis examining if, or the extent to which, people perceive climate change survey instruments as biased. Because of the politically charged discourse surrounding climate change, an empirical rather than anecdotal foundation can be valuable in providing transparency and guidance around questions of bias or undue influence on respondent answers. This is important because questions of trust and credibility have become distractions to the issue of climate change generally (Leiserowitz et al. 2012; Maibach et al. 2012). Third is the general interest in advancing cognitive science related to public understanding and thinking about climate change. Fourth—and related to each of the previous concerns—is the interest in informing an agenda for climate and public opinion science that is ethical, responsive, and provides value to stakeholders.

## Methods

We explored perceptions of climate change survey items among a sample of adult Nebraskans. The survey

items examined were used previously in other climate change public opinion surveys verbatim or based on modified versions. Our pilot study was composed of individuals who attended a public science event called *Dinosaurs and Disasters*, held at the State Museum in Lincoln, Nebraska, in February 2012. We used a cognitive interview process augmented with a survey of our convenience sample to learn about perceptions of both climate change and the climate change survey items we asked them. Although our research focused on this subsample of residents of Nebraska and may not yield widely generalizable results, it does provide insight into some Nebraskans' perceptions and interpretations of climate change survey items used in previously conducted national polls. Beyond this principal inquiry, we were interested in knowing to what extent local concerns or issues experienced in the regional context—for example, drought—might be relevant to our study participants. Additionally, because of the assumption that our sample may be “lay scientific literate” as science museum attendees, we were interested in exploring the extent to which concerns about bias in climate science may resonate with them at all.

Prior to choosing the items for the survey in this study, we examined 17 climate change–related questionnaires to review how other researchers were assessing knowledge, attitudes, and behaviors. This review included both national studies by public opinion research firms such as Pew (2009a, 2009c), as well as a sample of surveys in academic literature which were relevant to our research interests. The review was not meant to be a comprehensive analysis of climate change–related survey instruments or measures, but rather an overview to identify what general constructs were assessed by commonly referenced surveys. Working independently, we first worked in two sets of pairs and coded a subset of survey items and categorized them under five constructs: (1) questions about attitudes, (2) behaviors, (3) beliefs, (4) knowledge, and (5) policy preferences regarding the climate or climate change. These categories were major constructs identified by us using a coding and classification approach that were shared across multiple surveys we reviewed (Glaser 1978; Strauss and Corbin 1990). Each pair of coders agreed on a common category for 92% of the survey items reviewed. We then

reviewed all items and discussed items with which there were initial disagreements, and came to decide on the final classification of items by unanimous consensus. Source citations of the surveys reviewed are listed in the appendix.

Next, we constructed a paper survey questionnaire that featured eight substantive questions related to the climate or climate change. We intentionally chose to include items in the questionnaire that spanned four out of five of our major categories of survey item constructs identified in the review phase—attitudes, behaviors, beliefs, and knowledge—and represented a diverse mix of topical content related to climate change. To mitigate the possibility of generating overtly partisan reactions to our questionnaire, we omitted measures that fell under the policy preferences category. Three of the questions and their response categories we used were borrowed verbatim from either the 2004 national public survey conducted by Texas A&M University's Institute for Science, Technology, and Public Policy (Vedlitz et al. 2008) or from the 2010 national public survey conducted by the Yale Project on Climate Change Communication (Leiserowitz et al. 2010). Three of the remaining questions were slight adaptations of measures used in either the Texas A&M or Yale Project surveys, the 2008 survey of rural Nebraskans conducted by the University of Nebraska–Lincoln's Center for Applied Rural Innovation (Vogt et al. 2008), or the May 2009 national public survey conducted by the Pew Research Center for the People and the Press on science (Pew Research Center for the People and the Press 2009a). We modified these questions for purposes of brevity, or to create uniform response categories. A remaining question was used from the Nebraska rural survey but paired with response categories from the Pew survey. We created a final substantive measure on the topic of perceived risks of drought in the Great Plains due to its local relevance. Questions used, their identified construct, and their source references are presented in Figure 1. At the end of the survey, participants were asked to rate their agreement (on a 1 to 5, strongly disagree to strongly agree, scale) with six statements designed to gauge general impressions of the survey, survey experience, and one's subjective knowledge (see Table 1 for items).

FIGURE 1. Survey questions and sources.

**Question 1 (Beliefs).** Which of the following best describes your views about climate change?\*

Climate change is happening mostly because of natural changes in the atmosphere.

Climate change is happening mostly because of human activity such as burning fossil fuels.

Climate change is happening equally because of human activity and natural changes.

Climate change is happening but there is not enough evidence to determine its cause.

Climate change is not happening.

(Source: Pew 2009a; Vogt et al. 2008)

**Question 2 (Attitudes).** I am very concerned about global warming and climate change.\*\*

Strongly agree > Agree > Slightly agree > Slightly disagree > Strongly disagree, Don't know

(Source: Vedlitz et al. 2008)

**Question 3 (Attitudes).** To what extent do you feel concerned about climate change affecting: (your family, community, Nebraska, United States, other countries)?\*\*\*

Your family	United States
Your community	Other countries
Nebraska	

(Source: Vogt et al. 2008)

**Question 4 (Attitudes).** How concerned, or worried, are people in your social network about the issue of global warming and climate change, using a scale of 0 to 10 where 0 is not concerned at all and 10 is extremely concerned.†

(Source: Vedlitz et al. 2008.)

**Question 5 (Behavior).** My actions to reduce the effects of global warming and climate change in my community will encourage others to reduce the effects of global warming through their own actions.\*\*

Strongly agree > Agree > Slightly agree > Slightly disagree > Strongly disagree, Don't know

(Source: Vedlitz et al. 2008)

**Question 6 (Beliefs).** The Great Plains have been subject to many prolonged droughts over the years (e.g., the “Dust Bowl” of the 1930s, the 1950s, and most recently in the Southern Plains states). Do you think the severity and length of droughts will continue to increase (even beyond the major historical events) due to climate change?‡


Yes  
No  
Unsure

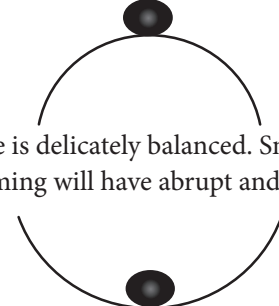
(Source: Authors)

**Question 7 (Behavior).** Please indicate whether you do any of the following things: Always, Often, Rarely, or Never.†


Car pool  
Walk or ride a bike instead of driving a car  
Use public transportation  
Turn off lights and appliances when not in use  
Recycle  
Set the thermostat lower in winter and higher in summer  
(Source: Vedlitz et al. 2008)

**Question 8 (Knowledge).** People disagree about how the climate system works. The five pictures below illustrate five different perspectives. Each picture depicts the Earth's climate system as a ball balanced on a line, yet each one has a different ability to withstand human-caused global warming. Which one of the five pictures best represents your understanding of how the climate system works?†

  
*Gradual*  
Earth's climate is slow to change. Global warming will gradually lead to dangerous effects.

  
*Fragile*  
Earth's climate is delicately balanced. Small amounts of global warming will have abrupt and catastrophic effects.

  
*Stable*  
Earth's climate is very stable. Global warming will have little to no effects.

  
*Threshold*  
Earth's climate is stable within certain limits. If global warming is small, climate will return to a stable balance. If it is large, there will be dangerous effects.

  
*Random*  
Earth's climate is random and unpredictable.

Source: Leiserowitz et al. 2010.

\*Question statement modified from Vogt et al. (2008), with substitution of “global climate change” for “climate change.” Response categories adapted from Pew (2009b).

\*\*Response categories broadened to include “Slightly agree” and “Slightly disagree.”

\*\*\*Question statement modified from “How concerned are you about the possibility of global climate change impacting the following groups?”

†Reproduced verbatim from cited source.

‡Developed by authors.

In addition, we used a  $2 \times 2$  experimental design in which we randomly varied whether or not people received a page of brief *definitions* (e.g., defining weather versus climate, climate change, climate variability, and climate impacts) and whether or not people were asked to *explain* their answers to the eight survey questions (using the prompt “If you are willing, please indicate *why* you answered as you did” after each question). These manipulations were included in order to determine whether or not such instructions impacted people’s perceptions of the survey. Unfortunately, observations and actual surveys indicated that many participants did not read the definitions when they received them, and did not write explanations when asked. Because we also found no significant or marginal main or interactive effects of these experimental conditions on any of the variables in this study, we do not discuss them further. For example,  $2 \times 2$  univariate analyses of variance (ANOVAs) found no significant or marginal main or interactive effects of reading or not reading definitions relating to climate change and writing or not writing explanations for one’s answers (all  $F_s(3,81) < 2.50$ ,  $p_s > .10$ , partial  $\eta^2 \leq .030$ ).

We invited interested individuals to participate in the survey about climate change at the museum event. A total of 115 individuals completed the survey. All respondents were also asked if they would participate in an interview until a targeted quota of 20 interviewees was filled. As an incentive, we gave a free notebook to those survey participants who agreed to be interviewed. We provided interested individuals with study consent materials that were approved by the University of Nebraska–Lincoln Institutional Review Board prior to participation. We conducted interviews in a quiet area of the museum, and recorded those interviews with participant consent.

Our interview questions were based on a cognitive interviewing approach. Cognitive interviewing is a widely used method developed by psychometrics researchers to examine and improve survey instruments, and has been discussed at length in survey methodology literature (Tourangeau 1984; Jobe and Mingay 1991; DeMaio and Rothgeb 1996). Cognitive interviewing essentially involves asking study participants a series of probing questions about survey items in a controlled environment to examine their understanding and processing of items and responses (Forsyth and Lessler 1991; Oksenberg et al. 1991). We were interested in understanding the respondents’ comprehension and

interpretation of the survey items, decision processes behind question responses, perceptions of whether survey items were biased or in need of improvement, and respondent biases that may have been activated by the questions. Interview questions are presented in Figure 2. Interviewers were randomly assigned to interviewees.

FIGURE 2. Interview questions.

1. Tell me a little bit about what you thought as you answered this question. What went through your mind when you read it, or your reaction to the question as you read it?
2. Tell me why you chose to answer the question the way you did.
3. The questions refer to things happening due to climate change. What did those words mean to you? How do you interpret the words climate change and global warming?
4. What have you heard, or what experiences have you had that influenced your answer to this question?
5. Would you change this question in any way? Was there anything about this question that was confusing or unclear or biased?

## Results

### *Survey Results*

We analyzed data from the survey using SPSS v.21, and, when relevant, statistical significance was evaluated at the  $p < .05$  level. Of the 115 adults who participated in the paper questionnaire, a clear majority (85%,  $n = 98$ ) indicated that they were concerned about global warming and climate change. Nearly half the respondents indicated that they believed climate change was occurring because of an equal mix of human activity and natural causes (48%,  $n = 55$ ). Twenty-eight percent ( $n = 32$ ) believed it was occurring mostly because of human activity, and 15% ( $n = 17$ ) believed it was occurring mainly because of natural factors. Only 10% ( $n = 11$ ) of the questionnaire sample believed that either climate change was not happening or, if it was happening, believed there was not enough evidence to indicate its cause. On a scale of 1–4 (1 = not concerned, 4 = very concerned), respondents indicated that they felt the most amount of concern about the impacts of climate change on other countries ( $M = 2.75$   $SD = .974$ ), followed by concern about impacts on the United States ( $M = 2.68$   $SD = .879$ ), Nebraska ( $M = 2.54$   $SD = .853$ ), their community ( $M =$

2.53  $SD = .885$ ), and their family ( $M = 2.5$   $SD = .934$ ). Examination of the data using paired  $t$ -tests revealed that concern about impacts on one's family, community, and Nebraska were each significantly lower than concern about impacts on the United States or other countries,  $dfs = 112-113$ ,  $ts > 2.74$ ,  $ps < .01$ . However, there were no significant differences between concern about impacts on one's family, community, and Nebraska. The difference between concern about impacts on the United States and other countries also was not significant. Thus, the more local the target of concern, the less concern they expressed. We also asked respondents to assess their overall level of concern, and the level of concern among their social networks toward global warming and climate change. On a scale of 1–6 (1 = strongly disagree, 6 = strongly agree, that "I am very concerned about global warming and climate change"), the average overall concern was 4.5 ( $SD = 1.14$ ). On a scale of 0–10 (0 = not concerned at all, 10 = extremely concerned), the average perceived level of concern among their social networks was 4.9 ( $SD = 2.36$ ). All results from the main survey questions are presented in Figure 3.

In Table 1, we report the results from the questions about the survey, survey experience, and subjective knowledge. As shown, 7% percent of respondents ( $n = 7$ ) indicated that they agreed with the statement "This survey seemed biased," 60% ( $n = 65$ ) disagreed with the statement, and 33% ( $n = 36$ ) remained neutral. Table 1 (rightmost columns) also shows the correlations between one's own overall concern or the concern perceived in one's social networks and questions assessing impressions of the survey. The correlations between one's own concern ( $r = -.18$ ,  $p = .064$ ) or the perceived concern of one's social network about climate change ( $r = -.07$ ,  $p = .498$ ), and the rating of perceived bias in the survey, were small and did not achieve statistical significance. Examination of the data categorically also confirmed that individuals who agreed that they were concerned about global warming and climate change were approximately equally as likely as those that did not agree, to perceive that the survey was biased ( $X^2(1) = 2$ ,  $p = .157$ ). We found very similar results when examining the other statements related to bias ("I think that the survey designers had ulterior motives" and "This survey seemed like a good way to measure people's views on this topic"). Very few participants thought the survey designers had ulterior motives or that the survey was not a good way to measure people's views, and answers to these questions were not significantly related to either one's own or one's social network's concern about

climate change and global warming. In fact, only two correlations were significant: the correlation between appreciation about being able to give their views and personal concern about climate change, and between one's subjective knowledge and one's perception that one's social network was concerned about climate change. Interestingly, having high subjective knowledge did *not* correlate with one's own reported concern.

### *Interview Results*

We transcribed and reviewed all 20 interviews using a constant comparative approach to identify themes relevant to our research questions (Strauss 1987; Strauss and Corbin 1990). The interviews provided us with an opportunity to explore, beyond the paper questionnaire, the attitudes and beliefs of participants in regard to these issues.

### *Respondent Perceptions of Bias in the Survey*

None of the 20 individuals we interviewed indicated that they felt specific items were biased, unfair, or leading. Almost all interviewees believed that the questions were clear and affirmatively stated that they raised no concerns. Most interviewees simply stated that the survey questions were "good" or "seemed solid." Two interviewees alluded to bias in surveys more generally; both indicated that they were skeptical of human-caused climate change. This may indicate that belief in causes of climate change may influence how they perceive the validity of surveys:

I was anticipating that answers would skew towards man-made issues, but they actually didn't. I chose [response] A—that it's caused by natural causes.

In other [surveys], scientists seem to turn questions towards their thoughts. We have a lot of historical climate change occurrences before people were even on the planet, so humans weren't the cause of prior ones. There's a lot of stuff coming out of volcanos so it just makes sense to me that it's natural.

It is important to note that besides these two references, there were no indications that specific language or response categories of the questions were of concern to the interviewees. However, it is noteworthy that of the interviewees that did acknowledge the possibility of bias, both indicated that they had doubts about human causation of climate change.



FIGURE 3. Paper survey results.

Q1. Which of the following best describes your views about climate change?

Climate change is happening mostly because of natural changes in the atmosphere.	15%, 17 / 115
Climate change is happening mostly because of human activity such as burning fossil fuels.	28%, 32 / 115
Climate change is happening equally because of human activity and natural changes.	48%, 55 / 115
Climate change is happening, but there is not enough evidence to determine its cause.	9%, 10 / 115
Climate change is not happening.	1%, 1 / 115

Q2. I am very concerned about global warming and climate change.

$M = 4.5, SD = 1.135, n = 113$

(1 = Strongly disagree, 6 = Strongly agree)

Question 3. To what extent do you feel concerned about climate change affecting . . .

Your family	$M = 2.5, SD = .934, n = 114$
Your community	$M = 2.53, SD = .885, n = 114$
Nebraska	$M = 2.54, SD = .853, n = 114$
United States	$M = 2.68, SD = .879, n = 113$
Other countries	$M = 2.75, SD = .974, n = 114$
(1 = Not concerned, 4 = Very concerned)	

Q4. How concerned, or worried, are people in your social network about the issue of global warming and climate change, using a scale of 1 to 10 where 0 is not concerned at all and 10 is extremely concerned.

$M = 4.88, SD = 2.36, n = 113$

Q5. My actions to reduce the effects of global warming and climate change in my community will encourage others to reduce the effects of global warming through their own actions.

$M = 4.17, SD = .932, n = 108$

(1 = Strongly disagree, 6 = Strongly agree)






Q6. The Great Plains have been subject to many prolonged droughts over the years (e.g., the “Dust Bowl” of the 1930s, the 1950s, and most recently in the Southern Plains states). Do you think the severity and length of droughts will continue to increase (even beyond the major historical events) due to climate change?

Yes	51%, 56 / 111
No	11%, 12 / 111
Unsure	39%, 43 / 111

Q7. Please indicate whether you do any of the following things:

	Never	Rarely	Often	Always
Car pool	19% 21 / 112	49% 55 / 112	26% 29 / 112	6% 7 / 112
Walk or ride a bike instead of driving a car	17% 19 / 111	52% 58 / 111	29% 32 / 111	2% 2 / 111
Use public transportation	52% 55 / 105	43% 45 / 105	2% 2 / 105	3% 3 / 105
Turn off lights and appliances when not in use	1% 1 / 111	1% 1 / 111	24% 27 / 111	74% 82 / 111
Recycle	4% 4 / 111	10% 11 / 111	36% 40 / 111	51% 56 / 111
Set the thermostat lower in winter and higher in summer	1% 1 / 112	6% 7 / 112	40% 45 / 112	53% 59 / 112

Q8. People disagree about how the climate system works. The five pictures below illustrate five different perspectives. Each picture depicts the Earth's climate system as a ball balanced on a line, yet each one has a different ability to withstand human-caused global warming. Which one of the five pictures best represents your understanding of how the climate system works?

 <b>Gradual</b> Earth's climate is slow to change. Global warming will gradually lead to dangerous effects.	24% 26 / 108
 <b>Fragile</b> Earth's climate is delicately balanced. Small amounts of global warming will have abrupt and catastrophic effects.	17% 18 / 108
 <b>Stable</b> Earth's climate is very stable. Global warming will have little to no effects.	6% 6 / 108
 <b>Threshold</b> Earth's climate is stable within certain limits. If global warming is small, climate will return to a stable balance. If it is large, there will be dangerous effects.	40% 44 / 108
 <b>Random</b> Earth's climate is random and unpredictable.	13% 14 / 108

Gender	
Female	63% 69 / 109
Male	37% 40 / 109
Education	
Less than high school	1% 1 / 111
Some high school, no diploma	
High school graduate	2% 2 / 111
Some college, no degree	21% 23 / 111
Associate's degree	15% 17 / 111
Bachelor's degree	30% 33 / 111
Some graduate school	11% 12 / 111
Graduate or professional degree	21% 23 / 111

### *Global Warming versus Climate Change*

Several of the survey questions we asked made direct reference to the terms “global warming” and/or “climate change.” Climate scientists, policy makers, media entities, and others have made use of both terms historically, and some degree of discussion exists as to the appropriateness of each term and their accuracy and relevance to discussions of bias (Schumacher-Matos 2011). During the interviews, we probed for whether or not interviewees distinguished between the two terms, and found that the words elicited a very wide variety of associations and thoughts, some that possibly implied inaccurate understanding.

Three interviewees indicated that global warming referred specifically to increasing atmospheric tempera-

tures, whereas climate change was a broader phenomenon that described other climatic changes in addition to temperature increase. This distinction is generally considered to be scientifically accurate (NASA 2008):

I think global warming came about because the average temperature was increasing, and that was mostly true, but there are some places where temps were actually decreasing. And climate change was a more appropriate term from what I understand. So it's the same thing but rebranded.

Global warming is what they are talking about with the greenhouse gases, and they are worried with the chlorofluorocarbons. . . . Climate change [is when] they are talking about the planet as a whole, not just

TABLE 1. Percentage responses to perception of survey questions, and correlations with concern (Questions Q2 and Q4).

Item	Strongly disagree (1)	Disagree (2)	Neither / Neutral (3)	Agree (4)	Strongly agree (5)	Mean (SD)	Correlation with own concern (1–6 scale)	Correlation with network concern (0–10 scale)
This survey seemed biased.	14%	46%	33%	6%	1%	2.33 (.82)	-.18	-.07
I think that the survey designers had ulterior motives.	16%	39%	38%	6%	1%	2.36 (.85)	-.16	-.02
This survey seemed like a good way to measure people's views on this topic.	1%	3%	26%	61%	9%	3.75 (.70)	.08	-.04
I appreciated being able to offer my views on this topic.	2%	2%	24%	55%	18%	3.85 (.80)	.26**	.12
While taking this survey, I learned something I did not know before.	6%	28%	35%	27%	5%	2.97 (.99)	.13	-.09
I am very knowledgeable about climate science.	5%	40%	35%	19%	1%	2.71 (.86)	.14	.20*

Note:  $N = 105-110$  (listwise  $N = 102$ ) depending on the question, \* $p < .05$ , \*\* $p < .01$ .

the atmosphere, but the ocean and sea temperature. It is physical, I have seen them. Global warming is just the gases in the atmosphere.

Yes, because I think there are different types of climate change that are not just global warming. So, they interact with one another and overlap, but I would see them as different things.

In contrast, an approximately equal amount of interviewees acknowledged that the two terms had different meanings but did not offer specific definitions to distinguish between the two terms, or they gave explanations that suggested misconceptions about climate change and global warming:

It is kind of similar, not the same. They are in a category together. They have to do with each other.

I think they are separate, global warming is more natural.

This indicates the possibility that there is awareness of the different terms but a lack of clarity as to what phe-

nomenon they refer to. One individual noted that both terms refer to the same phenomenon, but that use of these terms by the media has changed over time:

I see climate change as the new PC term for global warming. I think it's a change in terms. It was always climate change or always on a grander scale, not well understood. People labeled it global warming and the media is choosing to call it [climate change] late. It's getting out more as climate change.

These results indicate some degree of variation exists in how the terms "global warming" and "climate change" are understood or interpreted. Some individuals may have little understanding of the phenomena referred to by these terms, and that use of these terms evokes a wide variety of associations that are likely to impact participant responses. For example, one interviewee indicated having the following political and religious associations with the terms:

First thing I think of is Al Gore. I think of the glaciers and people in Antarctica talking about an ice

shelf falling off. I am not concerned the earth goes through cycles. We are not the only people or creatures that have seen this happen. This isn't the first time that things have happened and they have proven that with the thing in Antarctica. I know that Venus has global warming but our planet has regulated. I am also a Christian so I believe in creationism and not evolution so I don't believe that the planet is going to destroy itself.

#### *Factors Influencing Concern*

Related to such associations, we were interested in identifying what general personal, social, or contextual factors influenced our survey respondents in their consideration of our survey questions, even absent any indication of perceived bias in the survey measures we used. In response to open-ended questions about why they answered the survey questions as they did, several interviewees made references to Nebraska's agricultural character playing a role in their levels of concern regarding climate change:

I am slightly concerned because Nebraska is an agricultural state. Our main source of everything is farming. I am slightly concerned that there is not a lot done. Other than my family and community, we are concerned, but not everybody is concerned enough to act upon it.

You can see some of the impacts and changes. Plants that we grow in Nebraska are not the same that were growing before. Some things are dying out.

Specific reference was also made to droughts affecting Nebraska:

I think that droughts are a problem. I think that if you watch, they get worse every year. They last longer, and when I first moved to Nebraska, it didn't seem like they talked about it as much as they do now.

A few interviewees mentioned personal experiences as a frame of reference for their concern, or lack of concern, about the climate, although they were a minority. One interviewee indicated that his lack of concern for climate change was based on personal observations:

I grew up in a desert, so water conservation was sort of second in nature. But it's not everywhere I have been, but then again, growing up I was used to triple digit summers and low humidity. The first-hand in-

formation and sorts of experiences I have had don't show anything like trends. I go back and look at it and it's been pretty much the same. So I don't think that, one of the problems I have is how drastic the information is being put before us, I think for sort of shock value.

Although survey responses indicated that our sample was generally concerned about climate change, none of our interviewees indicated that their concern had reached a level of alarm or anxiety. Likewise, none of the interviewees indicated that their social network or context played a significant role in their level of concern about climate change:

I laughed when I saw it [the question about social network] because most people I know don't care. It amused me not because the question is bad but because of how my friends feel—no one cares.

Some people think climate change is bogus and others do not. It's really all over the map. I personally think on average there are more people that are concerned than not concerned. . . . Even if people aren't in a panic I think they are thinking about things they can do like turning off lights when they need them, and it's not just about the environment, it's about not being wasteful. I'm in the median of all those views, I don't think it's a panic situation.

#### Discussion and Conclusion

We were interested in exploring participant interpretations of climate change survey questions, and whether our study sample would perceive any bias or related concerns regarding survey items presented to them. Neither our survey nor interview results indicated that there were widespread concerns over bias with the sample of questions presented to them, though the possibility of bias was indicated by a small portion of survey and interview respondents, and a small, marginal ( $p < .10$ ) negative correlation between concern about climate change and perceptions of bias. In fact, none of the three questions designed to assess perceptions related to bias were significantly correlated with either one's own or one's social network's concern. On the other hand, our study sample was skewed in that it contained a higher-than-typical proportion of persons who indicated some concern about climate change and global warming. If the sample had included more variability, that is, more persons who disbelieved that climate change and global

warming was a problem, we may have found stronger relationships between concern and the questions used to assess bias. Our results suggest that for those members of the public who are concerned about climate change, and are at least to some extent already scientifically or climate literate or seek to be so, concerns over bias are minimal. This seems to affirm a general assumption that greater knowledge about the issue may mitigate the salience of problems related to perceptions of trust.

Our interviews indicated that the words and questions within our survey resulted in varying cognitive associations and interpretations, and that constructs were elicited that may not have fit the intentions of the survey question writers. For example, our findings suggest no clear consensus exists on the meaning of frequently used terminology like “global warming” or “climate change”—terms that refer to concepts which are arguably fundamental to understanding the issues. In addition, use of such terms can evoke mental associations with politics, politicians, and religious beliefs. Further research could examine the extent to which variations in understandings or interpretations of climate-related terms predict beliefs and impact survey results.

Finally, relating to factors impacting levels of concern about climate change, our convenience sample of Nebraskans referenced observations of agriculture and weather (e.g., drought) as impacting their levels of concern. Nonetheless, they appeared to believe that their social networks had relatively little concern about changes that might occur due to climate change. Persons who did perceive their social networks as having concerns also indicated higher subjective knowledge. However, subjective knowledge did not predict one’s own personal concern. These relationships may be worthy of further study. For example, they could indicate that subjective knowledge makes one more attentive to the concerns of one’s social networks, increases one’s perception that others will be concerned, or indicate the influence of a third variable (e.g., social discourse about climate change) impacting both. Such work would build off previous research conducted on how social networks impact individual engagement in climate change (Lorenzoni et al. 2007; Robelia et al. 2011).

It should be noted that our study participants were not a representative sample, and our findings should thus not be reflective of the state of Nebraska or other populations. Further research is thus needed using a

representative study population. Specifically, perceived bias in survey items should be measured among a study population that does not have the relatively high rates of concern about climate change as ours did. This is particularly important since some of our interview findings suggest that individuals who do not share those concerns may be more critical or more likely to perceive bias in survey measures than those who do.

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### Appendix: Surveys Reviewed

Anable et al. (2006)  
 Armel et al. (2011)  
 Bostrom et al. (1994)  
 Bray and von Storch (2007)  
 Dunlap et al. (2000)  
 ecoAmerica and Strategic Business Insights (2011)  
 Kellstedt et al. (2008)  
 Leiserowitz (2006)  
 Leiserowitz et al. (2010)

Li et al. (2009)  
 Maibach et al. (2009)  
 Pew Research Center for the People and the Press (2009a, 2009c)  
 Vedlitz et al. (2008, 2010)  
 Vogt et al. (2008)

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