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The Association of Knowledge With Concern about Global Warming:

Trusted Information Sources Shape Public Thinking

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Abstract

During the last decade, a great deal of news media attention has focused on informing the American public about scientific findings on global warming (GW). Has learning this sort of information led the American public to become more concerned about GW? Using data from two surveys of nationally representative samples of American adults, this paper shows that the relation between self-reported knowledge and concern about GW is more complex than previous research has suggested. Among people who trust scientists to provide reliable information about the environment and among Democrats and Independents, increased knowledge has been associated with increased concern. But among people who are skeptical about scientists and among Republicans, more knowledge was generally not associated with greater concern. The association of knowledge with concern among Democrats and Independents who trust scientists was mediated by perceptions of consensus among scientists about GW's existence and by perceptions that humans are a principal cause of GW. Moreover, additional analyses of panel survey data produced findings consistent with the notion that more knowledge yields more concern among Democrats and Independents, but not among Republicans. Thus, when studying the relation of knowledge and concern, it is important to take into account the content of the information that different types of people acquire and choose to rely upon.

Keywords: Climate Change, Global Warming, Political Attitudes, Source Credibility

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Introduction

Climate experts generally agree that human-induced global warming (GW) is occurring and that it may have devastating consequences [(1)]. But while recent surveys show that public concern about the issue has grown, neither the level of concern nor the demand for remedies have reached the levels that some climate scientists believe is merited. For example, in an open-ended question in an ABC News/Washington Post/Stanford University poll in 2007, 33 percent of Americans called GW the "biggest environmental problem the world faces at this time," up from 16 percent a year earlier. But 67 percent picked some other issue or no issue at all [(2)]. In polls conducted by the Pew Research Center in 2006 and 2007, GW was rated 19th out of 23 problems that might be policy priorities for the President and Congress to address [(3)]. In another recent survey, Americans expressed less concern about GW than did respondents in all of the 14 other countries studied [(4)].

There are a variety of possible explanations for the discrepancy between the level of concern expressed by a large number of climate scientists and that expressed by the public. One such explanation is that the public's low level of concern about GW results from a lack of public understanding of the problem [(5)]. Decades of survey research have shown that the American public has often been under-informed about matters that have been the focus of considerable political debate [(6)]. GW may not be unusual in this regard, as evidenced by the fact that many Americans have confused GW with ozone depletion [(2, 7, 8)]. If Americans were more fully informed about GW, they might express higher levels of concern and might demand more

remedial action.

One way to test this hypothesis is to explore whether citizens who are better informed about climate change are more concerned about it. Although such a cross-sectional correlation would not document causal impact of knowledge on concern, evidence that knowledge and concern are not positively correlated would challenge this hypothesis.

Some studies have gauged the relation of knowledge about GW with what researchers sometimes consider to be indirect indicators of concern about GW: people's perceptions of the likelihood that GW will have undesirable effects. In these studies, knowledge has usually been measured with questions asking about people's perceptions of the causes of GW [5, 9, 10, 11]. For example, statements that GW is caused by industrial emissions or destruction of tropical forests are assumed to indicate high knowledge, and statements that GW is caused by aerosol spray cans or ozone depletion are assumed to indicate low knowledge [10] . Beliefs about the effects of GW have often been measured by questions assessing perceived impact of GW on the respondent, on his/her local area, and on the world. For example, some studies have asked about the degree to which people believe GW would decrease their own standard of living, decrease other people's standards of living, cause food shortages where they live, and cause food shortages where others live [10]. Knowledge and perceived effects of GW measured in these ways have usually been found to be positively correlated with one another. [9, 10, 11]. Thus, knowing more about the causes of GW seems to be associated with perceiving that GW will have various undesirable consequences.

In contrast to these findings, Kellstedt, Zahran, and Vedlitz recently found a negative partial association between knowledge and perceptions of undesirable effects of GW [12]. These researchers examined people's perceptions of the likelihood that GW will affect their own health,

economic situation, and local living area, and will affect public health, economic development, and the environment in their state. Kellstedt et al. found that a composite of these measures correlated positively with respondents' reports of how much they knew about GW (see footnote 7, p. 120). But when the composite was regressed on knowledge volume and other variables (demographics, party identification, liberal/conservative identification, general environmental orientation, feelings of efficacy related to GW, trust in climate change experts, trust in the news media, and confidence in scientists), a small and significant negative partial association appeared between knowledge and perceptions of undesirable effects of GW.

Although such findings have often been discussed as addressing the relation of knowledge with concern, none of these past studies measured concern simply by asking respondents how concerned they are about GW, how serious a problem they consider it to be, or how important it is to them. By asking instead about perceived effects of GW, researchers have apparently presumed that concern is based upon perceptions of effects: people who believe GW will have more undesirable consequences are presumably more likely to be concerned about it. This is a reasonable assumption, but the existing literature on the formation of political attitudes suggests that perceptions of some effects may instigate concern about a problem, whereas perceptions of other effects are unlikely to do so [13, 14, 15, 16]. Therefore, if researchers wish to study the impact of knowledge on concern, it seems preferable to measure concern with broadly-phrased questions that have more face validity tapping concern, rather than measuring perceptions of specific effects of GW, which may or may not be the bases of concern.

It is interesting to note that Kellstedt et al. measured knowledge differently than past studies did. These prior studies employed quiz questions gauging beliefs about the causes of GW [5, 9, 10, 11]. Respondents who reported holding beliefs in line with those of mainstream

scientists were viewed as having more knowledge about the issue. In contrast, Kellstedt et al. [12] measured knowledge volume by asking respondents how informed they considered themselves to be about GW. Both approaches to measuring knowledge are justifiable and have long histories in social science research, and each has advantages and disadvantages [17].

Any quiz that can be practically administered in a survey will, of necessity, tap only a portion of the topic-related knowledge a person might have. And rarely if ever have researchers selected the particular pieces of knowledge sought by randomly sampling them from the universe of possible knowledge a person might have on the topic. So a quiz may mischaracterize a person's true overall level of knowledge about an issue if the items included happen to be idiosyncratic in some way [18, 19]. More general self-assessments of knowledge volume may also be inaccurate if some individuals are motivated to appear highly knowledgeable or to be humble about their stated understanding. Nonetheless, some past studies suggest that these two types of measures display similar patterns of correlations with other variables [8, 20], so they may both be effective at differentiating more knowledgeable people from less knowledgeable people.

But when gauging the relation of knowledge volume to concern in the domain of global warming, it seems important to take into account not only the amount of knowledge a person possesses but also the likely content of the knowledge that they would acquire [21]. Americans cannot learn much about GW directly. Unless a person earns a living by conducting research on the topic or otherwise gaining mastery of that research, he or she is unlikely to have the time to absorb the full array of available scientific evidence. Most Americans must therefore rely on informants to provide guidance about this complex and worldwide phenomenon. But not all informants provide the same messages to their audiences.

Prominent informants on this issue during the past decade may be said to fall into two

groups. The first is comprised of natural scientists (as embodied by the Intergovernmental Panel on Climate Change), environmental advocacy groups, and some politicians associated with the Democratic Party, such as Al Gore, who have argued that climate change is real, is caused by people, may be catastrophic, and merits substantial remedial efforts. The second group of sources consists of other scientists [22], advocacy groups such as the Heartland Institute, and some Republican politicians (e.g., President Bush) and media figures (e.g., commentator Rush Limbaugh) who have expressed skepticism about the existence and consequences of temperature increases and the degree to which they are caused by people, and have advocated hesitation before taking remedial steps [23].

Much research has shown that when faced with such a bifurcated flow of information, people rarely internalize the full array of information to which they are exposed. Instead, people often choose to rely on the sources that they trust most [24, 25], internalizing information from sources they consider reliable and rejecting information from sources they consider unreliable. Thus, some citizens may have accorded more attention to and confidence in the flow of information suggesting that concern about climate change is merited, whereas other citizens may have chosen to place their confidence in the flow of information from skeptics.

If this is so, then asking whether more knowledge about GW is associated with more concern about it across all Americans is a bit too simple. An exploration of the relation between knowledge volume and concern must take into account dispositions of people that might incline them to rely on particular streams of available information. Among citizens who trust the flow of information suggesting that GW is problematic, more knowledge may yield more concern. But among people who trust the voices of skeptics, more knowledge may not yield more concern and might even yield less concern. Given the flow of information about climate change in recent

years, trust in what scientists say about the environment and identification with political parties might be determinants of which information a citizen will accept, and thus determinants of the relation between knowledge volume and concern.

Trust in scientists is not uniformly high in the United States [2], and people who trust scientists in a particular domain seem to pay more attention to the findings of and opinions expressed by scientists in that domain [26, 27]. Much news media coverage has portrayed many mainstream scientists as believing that GW is happening and merits concern. Therefore, the more citizens who trust these scientists have been exposed to this message, the more concerned they may be about GW. But among people skeptical about mainstream climate science, more exposure to this message may have had no effect on concern and may have reduced it.

Consistent with the notion that party identification may moderate the knowledge-concern relation in this domain, many past studies have shown that party identification acts as a filter through which political messages are processed: a person is most likely to accept and internalize messages from elites who affiliate with his or her own political party [24, 25, 28, 29, 30, 31, 32, 33, 34, 35]. Therefore, more awareness of the expressions of concern made by some Democratic politicians might have led Democratic citizens to become more concerned, whereas more awareness of the skepticism expressed by some Republican politicians may have led Republican citizens to adopt a more skeptical stance. That is, more knowledge about GW may be associated with greater concern among Democrats (and possibly among Independents), but not among Republicans.

The Present Study

In the present investigation, we set out to address the following questions:

1) Is the amount of information people have about GW related to personal concern about GW or judgments about how serious of a problem it is for the nation, for the world,

and for people in general?

2) Does the relation of knowledge with concern differ between Americans who trust what scientists say about the environment and those who do not?
3) Does the relation of knowledge with concern differ between Americans who identify with the Democratic Party, those who identify with the Republican Party, and those who do not identify with either party?
4) Might the observed relations between knowledge volume and concern be due to increased knowledge volume causing increased concern?

We addressed these questions by analyzing data from two surveys of nationally representative samples of American adults that were conducted in 2006 and 2007, and from a panel survey conducted in 1997-1998. Using data from the first two of these surveys, four measures of concern were examined. One, which was assessed in both surveys, asked about the amount of personal importance that respondents attached to the issue of GW. Personal importance ratings have been shown to correlate strongly with questions addressing how concerned people are about a political issue [(20)]. We also asked respondents three questions tapping perceptions of the overall degree to which GW is a serious problem for collectivities: how serious a problem they believed GW will be for the United States (in the 2006 survey), for the World (in the 2006 survey), and in general (in the 2007 survey) if nothing is done to stop it.[1] This array of measures allowed us to explore whether the correlates of seriousness judgments varied across these collectivities. We explored the relations of these measures of concern with survey respondents' self-assessments of their knowledge volume, as was done in Kellstedt et al.'s work [(12)].

We also explored two possible mediators of the association between knowledge and

concern. Among people who are inclined to accept the claims that most reputable scientists agree that GW has been happening and that human activity is importantly responsible for this phenomenon, more learning about GW may yield perceptions of more scientific consensus and more belief in human responsibility, and these beliefs may in turn cause increased concern about GW.

Finally, using the 1997-1998 panel data, we examined whether the associations between knowledge and concern observed thus far are at least partly attributable to the causal impact of the former on the latter. To do so, we regressed reports of concern about GW measured during the respondents' second interviews, in late 1997 and early 1998, on their reports of concern expressed during their initial interviews a few months earlier and their reports of knowledge volume also provided during those earlier interviews. After controlling for the stability of concern in this fashion, the only variance left unexplained in the Time 2 measurements of concern is any change in concern that occurred between Time 1 and Time 2. Therefore, the effect of knowledge measured at Time 1 on concern measured at Time 2 identifies the amount of change in concern that was predictable by prior levels of knowledge. If such lagged effects appear, they are consistent with the hypothesis that knowledge caused changes in concern [36, 37]. Although trust in what scientists say about the environment was not measured in that panel study, party identification was measured, so we conducted the regression among groups of respondents differing in party identification to test our moderation hypothesis.

Study 1: Moderated Associations of Knowledge Volume With Concern

Method

Samples

For both cross-sectional surveys, samples were generated using random digit dialing

(RDD), and interviews were conducted by telephone by TNS of Horsham, Pennsylvania[2]. The 2006 survey was administered between March 9 and 14, 2006; 1,002 respondents were interviewed; and the AAPOR Response Rate 3 was 27.8%. The 2007 survey was administered between April 5 and 10, 2007; 1,002 respondents were interviewed; and the AAPOR Response Rate 3 was 28.7%. Columns 3 though 6 of Table I display distributions of unweighted demographics for these two samples alongside national benchmarks computed using data from the U.S. Census Bureau's Current Population Survey [(38)]. As is typical in survey research, the samples under-represented young adults, African-Americans, males, and people with relatively little education. Weighting the data for analysis adjusting for these discrepancies did not change the substantive results but did increase the standard errors. We therefore report unweighted results.

Measures

Personal importance. The personal importance of GW was measured in both the 2006 and 2007 surveys by a question that asked, "How important is the issue of global warming to you personally? Extremely important, very important, somewhat important, not too important, or not at all important?" Responses were coded 1, .75, .5, .25, and 0, respectively, so larger numbers indicated more importance.[3]

National seriousness. In the 2006 survey, perceived national seriousness was gauged with a question asking, "If nothing is done to reduce global warming in the future, how serious of a problem do you think it will be for the United States – very serious, somewhat serious, not so serious, or not serious at all?"[4] For respondents who indicated previously that they were "extremely sure" or "very sure" that GW was *not* happening, the national seriousness question was prefaced with the phrase, "Assuming it's happening," and the words "will be" were replaced

with "would be." Respondents' answers were coded to range from zero (meaning the lowest possible level of seriousness) to one (meaning the highest possible level of seriousness).

Global seriousness. In the 2006 survey, global seriousness was tapped by a question asking, "If nothing is done to reduce global warming in the future, how serious of a problem do you think it will be for the world – very serious, somewhat serious, not so serious or not serious at all?" For respondents who indicated previously that they were "extremely sure" or "very sure" that GW was *not* happening, this question was prefaced with the phrase, "Assuming it's happening," and the words "will be" were replaced with "would be." Responses were coded just as answers to the national seriousness question were.

General seriousness. In the 2007 survey, general seriousness was measured with this question: "If nothing is done to reduce global warming in the future, how serious of a problem do you think it will be – very serious, somewhat serious, not so serious, or not serious at all?" Parallel wording alterations and coding were implemented for this question as with the national and global seriousness questions.

Knowledge volume. In both surveys, respondents were asked: "How much do you feel you know about global warming - a lot, a moderate amount, a little, or nothing?" Responses were coded 1, .66, .33, and 0, respectively.

Trust in scientists. In both surveys, trust in scientists was measured by this question: "How much do you trust the things that scientists say about the environment - completely, a lot, a moderate amount, a little, or not at all?" Responses were coded 1, .75, .5, .25, and 0, respectively.

Party identification. In both surveys, respondents were asked whether they generally considered themselves to be a Republican, a Democrat, or an Independent. Responses were

coded 0 for Republican, 1 for Democrat, and .5 for Independents and all others.

Cause of global warming. Respondents were asked: "(Assuming it's happening,) do you think a rise in the world's temperatures (is being/would be) caused mostly by things people do, mostly by natural causes, or about equally by things people do and by natural causes?" "Assuming it's happening" and "would be" were read to respondents who had said previously that they were extremely sure, very sure, or somewhat sure that global warming was not happening. Responses were coded as follows: mostly by nature = 0, equally by people and nature = .5, and mostly by people = 1.

Agreement among scientists. Respondents were asked, "Do you think most scientists agree with one another about whether or not global warming is happening, or do you think there is a lot of disagreement among scientists on this issue?" People who said they thought most scientists agreed with one another were then asked, "Do you think most scientists believe that global warming is happening or is not happening?" Respondents who believed that most scientists agreed that GW is happening were coded 1, and respondents who said that there was a lot of disagreement among scientists or that most scientists agreed that GW is not happening were coded 0.

Demographics. Interviewers coded respondent sex (1=female, 0=male), and respondents reported their age (represented in our equations by age in years)[5], educational attainment (represented by four dummy variables, with the omitted category being people who did not graduate from high school), household income (represented by six dummy variables, with the omitted category being households that earned less than $20,000 per year), and a dummy variable indicating whether the respondent had children (coded 1 for people who did and 0 for others). Following the procedure established by the U.S. Census Bureau in 2000, we measured

race and Hispanic ethnicity separately with two different questions. Race was then represented by two dummy variables for Blacks and Asians, respectively; Whites and all other races were the omitted category. Hispanic ethnicity was represented by a dummy variable contrasting Hispanic vs. not Hispanic. Thus, a respondent could be coded as both Black and Hispanic.

Results

Covariation of Knowledge with Concern

Knowledge was positively correlated with personal importance (2006: $r = .18$, $p<.001$; 2007: $r = .20$, $p<.001$), national seriousness ($r = .09$, $p < .01$) and global seriousness ($r = .09$, $p < .01$), though not with general seriousness ($r = .02$, ns) [6]. In OLS regressions controlling for the demographics and the two hypothesized moderator variables (i.e., party identification and trust in scientists), knowledge was significantly associated with personal importance (2006: $b = .20$, $p<.001$; 2007: $b = .20$, $p < .001$), national seriousness ($b = .11$, $p < .01$), and global seriousness ($b = .10$, $p < .01$), and was uncorrelated with general seriousness ($b = .02$, n.s.).

Moderation by Party Identification and Trust in Scientists

Consistent with the moderation hypotheses, the relation of knowledge with concern varied depending upon both trust in scientists and party identification. Significant positive interactions of knowledge with trust appeared when predicting all five measures of concern (see row 4 of Table II). Significant positive interactions of knowledge with party identification appeared when predicting four of the five concern measures, and a nearly significant positive interaction appeared when predicting the fifth (see row 5 of Table II). These coefficients indicated that the moderation effects were independent of one another, since both interaction terms were entered simultaneously.

The association of knowledge with concern was uniformly positive among respondents

who trusted scientists completely or a lot and among respondents who trusted scientists at least moderately (see rows 1 and 2 of Table III). But among people who trusted scientists only a little or not at all, the associations of knowledge with personal importance, national seriousness, and global seriousness were zero, and the association between knowledge and general seriousness was significantly negative (see row 3 of Table III). Thus, more knowledge among people who were skeptical about scientists was associated with no change in concern or with reduced concern.

Similar results appeared when we separated respondents according to party identification. The association of knowledge with concern was uniformly positive among Democrats (see row 1 of Table IV) and positive in all but one case among people who were Independents or had no party affiliation (see row 2 of Table IV). Among Republicans, the association of knowledge with four measures of concern was zero, and was relatively weak and positive with 2006 personal importance (see row 3 of Table IV). So more knowledge among Republicans was generally associated with little or no increase in concern.

Mediation

Using data from the respondents who both (a) did not identify as Republican (i.e., Democrats, Independents, and others) and (b) trusted what scientists say about the environment at least a moderate amount, we estimated the parameters of the causal models depicted in Figures 1 and 2 with the 2006 and 2007 data, respectively. In Figure 1, we see that increased knowledge was positively and significantly associated with greater likelihood of believing that GW is caused by human activity and of believing that scientists agree on the existence of GW. And these beliefs were in turn positively and significantly associated with the three available measures of concern. Sobel tests [42] (shown at the bottom of each figure) revealed statistically

significant indirect associations between knowledge and each of the three measures of concern, mediated by perceptions of the cause of GW and by agreement among scientists. However, this mediation was partial, because knowledge manifested direct relations with each of the three concern measures as well, suggesting that other mediators were partly responsible as well. The same patterns are apparent in Figure 2, illustrating the associations in 2007.

Study 2: A Longitudinal Test of the Impact of Knowledge Volume on Concern

Method

Samples

For the 1997-1998 panel study, a representative national sample of American adults was generated via random digit dialing (RDD), and interviews were conducted by telephone by the Ohio State University Survey Research Unit. Six hundred eighty-eight respondents were interviewed between September 17 and October 5, 1997. The AAPOR Response Rate 3 for this sample was 30.0%. Four hundred ninety seven of these respondents were reinterviewed between December 20, 1997, and February 13, 1998. This group comprised our panel for the present analyses. The demographic breakdown for this sample is presented alongside that of the U.S. population in 1997 in columns 1 and 2 of Table I. As is typical in survey research, the samples under-represented young adults, African-Americans, males, people with high incomes, and people with relatively little education. Weighting the data for analysis did not alter the substantive findings but did increase standard errors, so we presently report unweighted analyses.

Measures

Personal importance. Personal importance was measured during both interviews with the same question that was used with the cross-sectional samples. Responses were again coded to

range from zero (meaning the lowest possible level of importance) to one (meaning the highest possible level of importance).

National seriousness. In both assessments, respondents were told, “I'd like to ask you about a series of specific issues that may challenge this country in the future. You may think some of these are likely to be serious problems, and others are not likely to be problems. Here are the issues: having enough jobs, how much things cost, crime, education, the natural environment, change in the world's climate, and people being able to get good health care. Now, I'll repeat each of these issues, and I'd like you to tell me for each one, whether you think it is likely to be no problem at all, a slightly serious problem, a pretty serious problem, a very serious problem, or extremely serious problem. How serious of a problem do you think change in the world's climate is likely to be?” Responses were coded to range from zero (“no problem at all”) to one (“extremely serious”).

Knowledge. Knowledge was measured during the first interview with the same question that was used with the cross-sectional samples. As before, responses were coded to range from zero to one, with higher scores indicating more knowledge.

Party identification. Respondents were asked during their first interviews whether they generally considered themselves to be a Republican, a Democrat, or an Independent. Responses were coded 0 for Republicans, 1 for Democrats, and .5 for Independents and all others.

Demographics. Demographics were measured and coded similarly to the approaches used in the cross-sectional studies, except for minor changes in the coding of education, household income, and race.

Results

As expected, personal importance at Time 1 was a significant predictor of personal

importance at Time 2 (b = .48, p<.001; see row 1 of Table V). And national seriousness at Time 1 was a significant predictor of national seriousness at Time 2 (b = .39, p<.001). But both of these stabilities were low enough to suggest that real change in personal importance and national seriousness occurred between Times 1 and 2, which would then be predicted by other Time 1 measurements.

Knowledge measured at Time 1 was not a significant predictor of subsequent change in personal importance or national seriousness judgments between Time 1 and Time 2 among Republicans (as indicated by the direct effects of knowledge in the third row of Table V; b = -.03 n.s., and b = -.11, n.s., respectively). But the interaction of knowledge with party identification, shown in row 5 of Table V, was positive and significant when predicting both personal importance (b = .16, p<.05) and national seriousness (b = .30, p<.01).

The shapes of the interactions are documented in Table VI. Among Democrats, knowledge measured at Time 1 was significantly and positively related to subsequent change in personal importance (b = .13, p<.05), as well as subsequent change in national seriousness judgments (b=.23, p<.01, see columns 1 and 2 of row 3). Among Independents and others without a party identification, knowledge measured at Time 1 was positively and significantly related with subsequent change in personal importance (b = .14, p<.05), but knowledge measured at Time 1 was not significantly related to subsequent changes in national seriousness judgments (b=.00, n.s.; see columns 3 and 4 of row 3). And among Republicans, knowledge measured at Time 1 was not significantly related to subsequent change in personal importance judgments (b = -.06, n.s.), or subsequent change in national seriousness judgments (b=-.08, n.s.; see columns 5 and 6 of row 3).

Discussion

These findings suggest that the relation between knowledge and concern about GW varies as a function of trust in scientists and party identification. Knowledge was positively associated with concern among people who trusted scientists at least moderately and among Democrats and Independents. In contrast, knowledge was generally uncorrelated with concern among people skeptical of scientists and among Republicans. Among non-Republicans with at least moderate trust in scientists, increased knowledge was associated with a greater likelihood to attribute climate change to human action and to perceive agreement among scientists about the existence of climate change, and these two beliefs partially mediated the association between knowledge and concern. Furthermore, findings from a panel study suggested that initial knowledge volume predicted subsequent changes in concern among Democrats and Independents, but not among Republicans. These latter findings are consistent with the hypothesis that the observed associations between knowledge and concern are at least partially attributable to the influence of knowledge on concern.

According to some prior studies, people who believe mainstream scientists' assertions about GW's causes are also especially likely to believe that GW will have undesirable consequences [9, 10]. This association has sometimes been interpreted as evidence that knowledge about GW correlates positively with concern about it. We are inclined to view these findings a bit differently, because measures of perceptions of some of GW's consequences are not measures of concern about GW. So to address this issue, researchers need to administer more direct and explicit measures of concern.

Kellstedt et al.'s [12] negative partial association between knowledge volume and perceptions that GW will have undesirable consequences might seem inconsistent with the

findings of other studies indicating that people who believe mainstream scientists' assertions about GW's causes are also especially likely to believe that GW will have undesirable consequences [9, 10]. One possible reason why Kellstedt et al. [12] observed a negative partial association is the decision to include "New Ecological Paradigm" as a predictor in their regression (see p. 119). New Economic Paradigm [43] has often been used in environmental attitudes research and is thought to represent a general value orientation or "non-issue-specific cognitive orientation" toward the environment [10, p. 462]. And researchers have often controlled for measures of such general environmental orientations when gauging associations of specific GW beliefs with intentions to perform specific GW-mitigating behaviors [9, 10].

However, some of the components of the abbreviated New Ecological Paradigm measure used by Kellstedt et al. (e.g., "If things continue on their present course, we will experience a major ecological catastrophe" and "When humans interfere with nature, it produces disastrous consequences.") seem to tap the dependent variable they predicted: perception of undesirable environmental consequences of human activity. Consequently, it may not be sensible to treat this value orientation as a predictor of risk perceptions, because the measures of the two constructs appear to at least partly tap the same construct. This would render their regression coefficients difficult to interpret. Future research can explore the plausibility of this and other explanations for differences between studies in terms of findings regarding the association of knowledge with risk perceptions.

In contrast to our study and Kellstedt et al.'s, much past research has measured concern about GW using questions measuring people's perceptions of the consequences of GW. Some such consequences are effects on the respondent directly, whereas other consequences are effects on the respondent's local area or his/her country or the entire world [10, 11]. A useful direction for

future research will be to investigate the relation of perceptions of consequences with concern about GW. Bord et al. found that perceptions of undesirable personal consequences and of undesirable societal consequences each independently predicted people's intentions to perform behaviors to mitigate GW [9]. The same may be true with regard to the impact of risk perceptions on concern as well, and careful study may reveal which particular consequences are most likely to instigate concern, thus providing handles for interventionists interested in increasing public concern about this issue.

Our evidence that party identification moderates the relation of knowledge with concern is consistent with a large and growing body of scholarship on partisan cue-taking by citizens. Many studies have suggested that Republican citizens are more accepting of messages from Republican leaders, whereas Democratic citizens are more accepting of messages from Democratic leaders [24, 25, 28, 29, 30, 31, 32, 33]. The evidence reported here is consistent with the same notion. We have seen as well that acceptance of messages in this domain is governed partly by trust in scientists, the original source of much relevant information.

From the evidence we have reported here, it is impossible to discern whether moderation by trust in scientists and party identification occurred at the time of information exposure, information internalization, or both. Perhaps people who trust scientists and who are Democrats might choose to acquire information about recent scientific studies (e.g., by reading newspaper stories with relevant headlines), whereas people skeptical of scientists and who are Republicans might choose not to acquire this information at all (e.g., by turning a newspaper page instead of reading the particular story). But it is also possible that trust in scientists and party identification do not regulate which information people choose to acquire but rather determine whether acquired information is accepted as reliable or is rejected as uninformative. Past studies have

documented both selective exposure to information and selective acceptance of information [44, 45], so it would be useful for future research to explore which of these mechanisms are at work in this domain.

Regardless of the mechanisms of the moderation we observed, our findings suggest that disseminating more information to the American public about climate change may alter concern among some Americans but not among others. If information flow on this topic continues to come from two distinct groups of informants, then citizens' reactions to those information flows may remain as shown here. Continued information flow may even cause more people who trust scientists and more Democrats or Independents to perceive increased scientific consensus, to believe that humans have been causing GW, and to be concerned about GW. But information would enhance such beliefs among the remainder of the public only if trust in scientists were higher, and/or voices trusted by Republican citizens more consistently endorsed the concern about GW expressed by many scientists.

Our research contributes to the growing literature on trust in information sources generally and on trust in scientists in particular. Decades of research in social psychology show that people are more receptive to the views of information sources they trust, just as we found [46, 47]. And research on trust in scientists in particular domains has shown that such trust can have important behavioral and cognitive consequences relevant to those domains [26, 48]. With this study, we have built a bridge between these two lines of research by showing that trust in scientists may regulate acceptance of their messages about GW.

Consistent with much prior research on knowledge about GW, we analyzed cross-sectional national survey data. But we also carried out relatively unusual analyses of panel data as well. Although lagged analyses such as those reported here do not offer definitive proof of

causal influence, they do permit an increase in confidence in a theory-grounded hypothesis about causality. Therefore, the panel analyses results reported here justify more confidence that increased knowledge among Democrats and Independents may have caused increased concern about GW in recent years. We look forward to future research assessing the degree to which trust in what scientists say about the environment moderates this longitudinal relation as well.

Conclusion

Many people and organizations these days are devoting considerable effort to educating the American public about climate change with the goal of increasing concern about it. The sort of research reported here can help to illuminate the effects of such educational efforts as they are implemented in a cacophonous partisan environment. Our research suggests that the impact of these efforts will depend upon the predispositions of citizens.

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Footnotes

[1] The surveys were designed by different teams of collaborating investigators in the different years, so the questionnaires were not identical across the years. Consequently, different seriousness measures were included in different surveys.

[2] One survey was created and directed by ABC News, Time Magazine, and Stanford University; the other survey was created and directed by ABC News, The Washington Post, and Stanford University.

[3] Age was coded in its natural metric. All other variables (except those that were represented as sets of dummy variables) were coded to range from zero to one to make interpretation of unstandardized regression coefficients easy. With that sort of coding, a main effect coefficient indicates the percent of movement from the lowest possible value of the dependent variable to its highest possible value that would be produced by changing the independent variable from its lowest possible value to its highest possible value. The verbal labels on the rating scale points were chosen based on past research to approximate equal perceived intervals as closely as possible [(39)]. When interactions are present in an equation, the main effect coefficient for a variable coded this way indicates its impact when other variables with which it interacts are at their lowest possible value (0 in this study).

[4] The phrase "if nothing is done to reduce global warming in the future" was included because we sought to measure perceived seriousness such that it might predict support for ameliorative policies. If that introductory phrase had been omitted, the measure would have confounded the seriousness judgment we did asses with two other judgments: the

perceived likelihood that ameliorative action will be taken in the future and the perceived likelihood that such actions will be successful.

[5] Respondents who had missing values on age (3.1% of the 2006 sample and 2.9% of the 2007 sample) were given the mean age for the sample. Missing values on income were represented by a dummy variable contrasting respondents who did not report their income with all other respondents.

[6] P-values for tests of all directional hypotheses are one-tailed where the observed relation was in the expected direction. All other reported p-values are two-tailed. Because past studies indicate that the verbal labels on the concern rating scale points that we used have approximately equally spaced meanings to respondents, coding responses with equal intervals most likely adequately represents these measures in our analyses [40, 41]. Nonetheless, we conducted analyses using ordinal logistic regression and found results comparable to those reported in the text and tables.

Table I
Comparison of Survey Respondents' Demographic Characteristics with the Population

Characteristic	1997-1998 Panel	1997 CPS	2006 ABC News/Time Magazine/ Stanford Poll	2006 CPS	2007 ABC News/Wash-ington Post/ Stanford Poll	2007 CPS
Age						
18-29	16.9%	22.6%	11.9%	21.9%	10.3%	22.0%
30-39	27.4	22.4	16.0	18.2	14.1	18.0
40-49	22.9	20.2	23.9	20.4	21.6	20.0
50-59	13.5	13.4	21.3	17.3	23.3	17.5
60-69	10.1	9.9	13.7	10.6	17.1	11.0
70 and up	9.3	11.4	13.2	11.5	13.7	11.4
TOTAL	100%	100%	100%	100%	100%	100%
Race						
White	83.7%	83.9%	84.7%	82.6%	84.7%	82.4%
African American	6.9	11.6	7.0	11.8	8.0	11.8
Other	9.4	4.4	8.2	5.6	7.2	5.8
TOTAL	100%	100%	100%	100%	100%	100%
Sex						
Female	55.3%	51.9%	52.8%	51.6%	55.0	51.6%
Male	44.7	48.1	47.2	48.4	45.0	48.4
TOTAL	100%	100%	100%	100%	100%	100%
HH Income						
< $20,000	25.4%	21.3%				
$20,000-$29,999	17.7	13.7				
$30,000-$39,999	16.9	12.4				
$40,000-$49,999	12.4	11.2				
$50,000-$59,999	6.6	9.8				
$60,000-$69,999	6.0	7.8				
≥ $70,000	15.0	23.9				
TOTAL	100%	100%				
< $20,000			12.9%	15.2%	11.5%	13.9%
$20,000-$34,999			15.3	15.5	13.4	15.2
$35,000-$49,999			20.2	14.5	17.4	14.3
$50,000-$74,999			16.8	19.9	19.8	19.5
$75,000-$99,999			13.7	13.2	14.9	13.1
≥ $100,000			21.2	21.7	22.9	24.0
TOTAL			100%	100%	100%	100%
Education						
High School	5.4%	18.6%	5.2%	15.4%	4.9	15.1%
High School Degree	25.9	33.4	27.5	31.6	29.2	31.5
Some College/AA Degree	31.5	26.4	32.5	27.6	30.4	27.2
BA Degree or Higher	37.0%	21.8	34.9	25.5	35.6	26.1
TOTAL	100%	100%	100%	100%	100%	
N	497	95,179	1,002	145,752	1,002	144,918

The figures from our surveys reported here were calculated among respondents who provided usable responses without using weights.

Table II

Trust in Scientists and Party Identification Moderating the Association of Knowledge with Concern

Predictor	2006 Personal Importance	2007 Personal Importance	2006 National Seriousness	2006 Global Seriousness	2007 General Seriousness
Knowledge[a]	-.11	-.16*	-.21*	-.24**	-.34***
Trust in Scientists[a]	.09	.11	.02	.00	.03
Party ID (high = Dem)[a]	.06	.01	.06	.04	.08
Knowledge x Trust in Scientists	.45***	.49***	.48***	.53***	.57***
Knowledge x Party ID	.19*	.22**	.18*	.18*	.15†
Female	.08***	.08***	.09*	.08***	.08***
Age	.000	.000	-.002**	-.001*	-.003***
High school graduate	-.01	.00	-.02	.00	-.08*
Some college	-.08*	-.02	-.07†	-.05	-.09*
College graduate	-.08*	-.04	-.08*	-.08†	-.08*
Post-Graduate degree	-.06	-.04	-.07†	-.06	-.10*
Income not reported	-.05	.02	-.03	-.06†	-.01
Income: 20-35K	.02	.01	.05	.02	.00
Income: 35-50K	-.03	.01	.01	-.01	-.01
Income: 50-75K	-.03	.01	-.04	-.07*	-.03
Income: 75-100K	-.03	-.01	-.02	-.01	-.03
Income: > 100K	-.04	.01	-.01	-.03	-.04
Black	.04	.04	.09*	.06†	.01
Hispanic	.06†	.04	.09*	.08*	.03
Asian	.02	.03	.04	-.01	.05
Have children	.02	.02	.04†	.05*	-.01
R^2	.26***	.27***	.22***	.21***	.25***
N	988	983	978	977	970

Note. The cell entries are unstandardized regression coefficients. All variables except age (coded in years) were coded to range from 0 to 1, and interaction terms are the cross-products of 0-1 coded variables.

[a]Effects of knowledge, trust in scientists, and party identification are simple effects at the lowest observed level of each of the other two variables.

***p < .001 **p < .01 *p < .05 †p < .10

Table III

The Association of Knowledge with Concern at Each Level of Trust in Scientists

Level of Trust In Scientists	2006 Personal Importance	2007 Personal Importance	2006 National Seriousness	2006 Global Seriousness	2007 General Seriousness
Completely/A lot	.29***	.39***	.23***	.24***	.15**
A moderate amount	.27***	.23***	.14*	.10*	.14*
Not at all/A little	.05	.01	-.01	-.01	-.21*

Note. The cell entries are unstandardized regression coefficients with relevant variables coded to range from 0 to 1. Demographics were included as additional predictors in the equations that generated these parameter estimates.

***p < .001 **p < .01 *p < .05 †p < .10

Table IV

The Association of Knowledge with Concern Among Democrats, Independents, and Republicans

Party Identification	2006 Personal Importance	2007 Personal Importance	2006 National Seriousness	2006 Global Seriousness	2007 General Seriousness
Democrat	.34***	.42***	.25***	.21***	.22***
Independent/ Other	.25***	.24***	.14*	.17**	-.03
Republican	.18**	.11	.07	.05	-.03

Note. The cell entries are unstandardized regression coefficients; all variables were coded to range from 0 to 1. Demographics were included as additional predictors in the equations that generated these parameter estimates.

***p < .001 **p < .01 *p < .05 †p < .10

Table V

Party Identification Moderating the Lagged Effect of Knowledge on Concern

	Dependent Variable	
Predictor	Personal Importance$_2$	National Seriousness$_2$
Personal Importance$_1$	.48***	
National Seriousness$_1$		.39***
Knowledge$_1$[a]	-.03	-.11
Party ID$_1$ [a]	-.08	-.10
Knowledge$_1$ x Party ID$_1$	.16*	.30**
Female	.03	.05*
Age	.001	-.001
High school graduate	.02	.00
College graduate	-.02	-.03
Post-Graduate degree	-.03	.01
Income: 20-40K	.01	-.02
Income: 40-60K	.04	.00
Income: 60-80K	-.01	.04
Income: > 80K	.00	.00
Income not reported	.01	-.04
Black	.02	-.01
Hispanic	.02	.00
R^2	.32***	.24***
N	495	488

Note. The cell entries are unstandardized OLS regression coefficients. All variables except for age were coded to range from 0 to 1; age was coded in years.
[a]Effects of knowledge and party identification are simple effects at the lowest observed level of each of the other two variables.

***p < .001 **p < .01 *p < .05 †p < .10

Table VI

The Lagged Effect of Knowledge on Concern Among Democrats, Independents, and Republicans

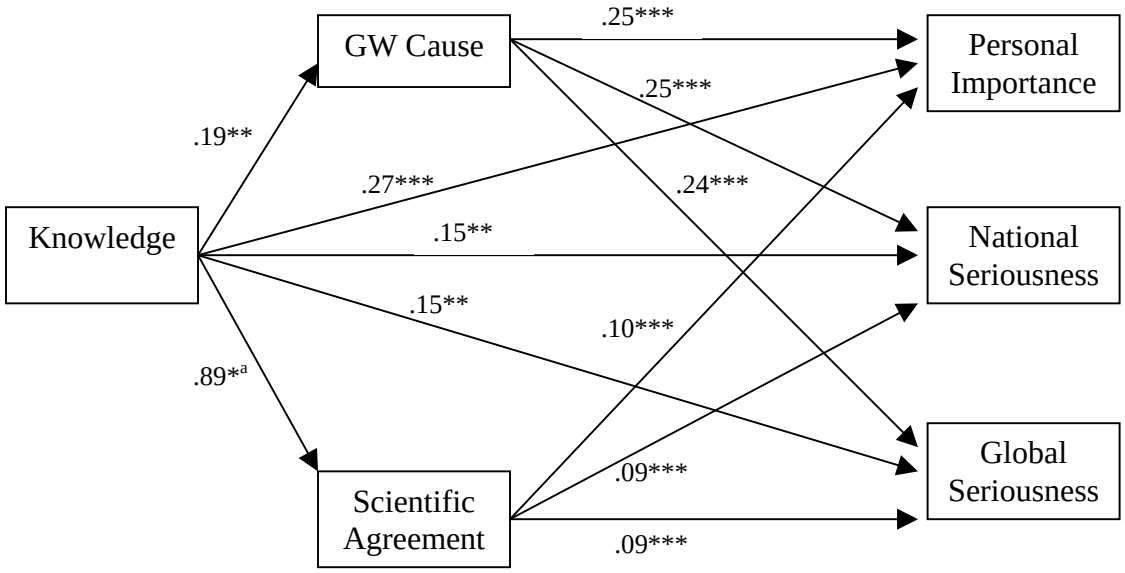
	Democrats		Independents/Others		Republicans	
Predictor	Personal Importance$_2$	National Seriousness$_2$	Personal Importance$_2$	National Seriousness$_2$	Personal Importance$_2$	National Seriousness$_2$
Personal Importance$_1$	.47***		.44***		.60***	
Seriousness$_1$		.27***		.42***		.49***
Knowledge$_1$	.13*	.23**	.14*	.00	-.06	-.08
Female	.02	.08†	.08*	.07†	-.01	.00
Age	.002*	-.002	.001	.000	.000	-.002
High school graduate	-.03	.05	.02	-.05	.02	.01
College graduate	-.02	-.03	-.05	-.07	.00	-.01
Post-Graduate degree	-.01	.07	-.12*	-.03	.00	.01
Income: 20-40K	-.04	-.04	.08†	-.01	-.01	-.06
Income: 40-60K	-.07	-.03	.13*	.01	.04	-.02
Income: 60-80K	.00	.02	.05	.14*	-.07	-.14
Income: > 80K	-.06	.15†	.05	-.08	-.01	-.09
Income not reported	-.03	-.09	.13†	.06	-.08	-.13
Black	.04	.00	-.05	.00		
Hispanic	.05	.00	.03	-.04	-.14	.09
R^2	.35***	.23***	.30***	.28***	.47***	.33***
N	172	171	182	178	141	139

Note. The cell entries are unstandardized regression coefficients. All variables except age were coded to range from 0 to 1; age was coded in years. Black was not included as a predictor among Republicans because the sample did not include any Black Republicans.

***p < .001 **p < .01 *p < .05 †p < .10

Figure 1

2006 Survey: Mediated Associations Between Knowledge and Concern among Democrats and Independents who Trust Scientists at least moderately, N = 505.



Indirect effects via GW Cause
GW Knowledge on GW Importance: Z = 2.74, p < .01
GW Knowledge on National Seriousness: Z = 2.71, p < .01
GW Knowledge on Global Seriousness: Z = 2.74, p < .01

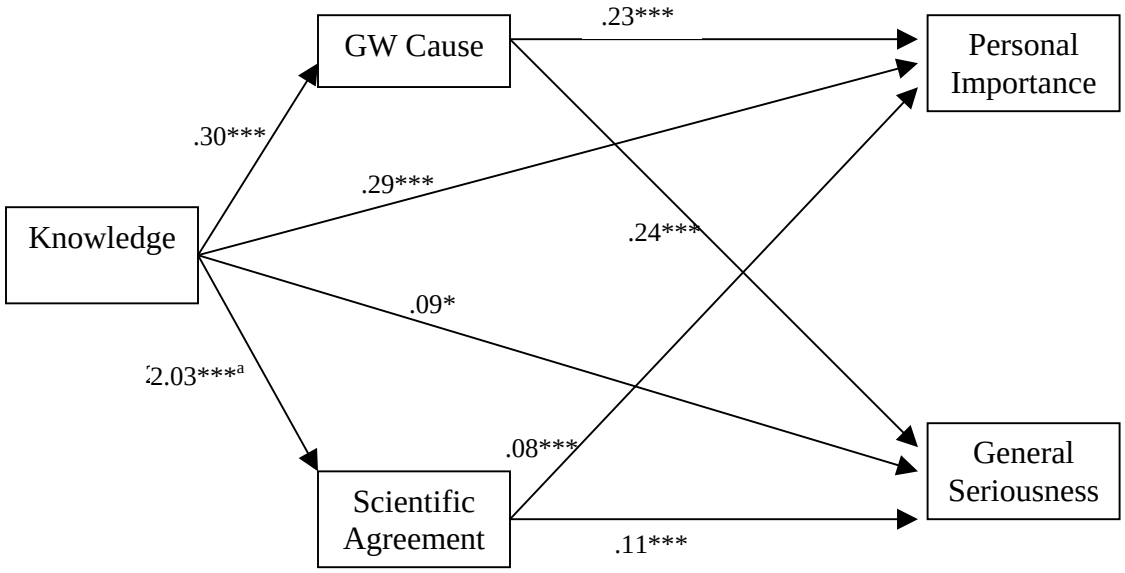
Indirect effects via Scientific Agreement
GW Knowledge on GW Importance: Z = 1.86, p < .05
GW Knowledge on National Seriousness: Z = 1.88, p < .05
GW Knowledge on Global Seriousness: Z = 1.85, p < .05

[a] Coefficient for the effect of Knowledge on Scientific Agreement is from binary logistic regression analysis. All other coefficients are from OLS regression analyses.

***p < .001 **p < .01 *p < .05

Figure 2

2007 Survey: Mediated Associations Between Knowledge and Concern among Democrats and Independents who Trust Scientists at least moderately, N = 561



Indirect effects via GW Cause
GW Knowledge on GW Importance: Z = 4.10, p < .001
GW Knowledge on General Seriousness: Z = 4.15, p < .001

Indirect effects via Scientific Agreement
GW Knowledge on GW Importance: Z = 3.20, p < .001
GW Knowledge on General Seriousness: Z = 3.71, p < .001

[a] Coefficient for the effect of Knowledge on Scientific Agreement is from binary logistic regression analysis. All other coefficients are from OLS regression analyses.

***p < .001 *p < .05