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Physical-World Knowledge and Public Views on Climate Change

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Abstract

Climate change is a formidable topic, challenging the research efforts of countless scientists across many different fields. Surveys find surprisingly high levels of confidence among nonscientists, however, regarding their own understanding of climate change. More than three-fourths of the respondents on recent U.S. surveys claimed to understand either a moderate amount or a great deal about climate change. Follow-up questions testing actual knowledge suggest that self-assessments are high relative to physical-world knowledge. For some people, self-assessments reflect confidence in their political views rather than geographical or science knowledge. This paper replicates and extends previous research using new data: an October 2018 survey that included a four-item test of basic, climate-relevant but belief-neutral geographical or physical knowledge, such as locations of the North and South Pole. Mean knowledge scores are higher among younger, male, and college-educated respondents, and also differ significantly across political groups. Relationships between physical/geographical knowledge and self-assessed understanding of climate change, or between knowledge and agreement with the scientific consensus on climate change, are sometimes positive as expected — but in both cases, these relationships depend on political identity.

1. Overview

Climate change is a complex topic, engaging the research efforts of thousands of scientists in scores of disciplines around the world (IPCC 2013; USGCRP 2017). Public understanding of this complex science proves, unsurprisingly, to be somewhat limited (Hamilton 2012; Leiserowitz et al. 2010). Scientific information in the public sphere also is actively countered by scientific-sounding misinformation from political, economic and media forces opposed to climate-change mitigation (Dunlap and McCright 2015; Farrell et al. 2019). Despite the inherent complexity of the science, and organized distraction of opposing voices, surveys find the American public fairly confident about their understanding of this topic: most people say they understand “a moderate amount” or “a great deal” about this issue (Hamilton 2011). Some analysts have treated such self-assessments as a rough proxy for actual knowledge, but an obvious high bias and correlations with political identity make self-assessments poorly suited for this purpose. A more empirical approach views self-assessments as interesting in their own right, worthy of focused research.

A recent paper by Hamilton (2018) analyzed self-assessed understanding of climate change in a 2016 nationwide survey. That survey included five questions testing climate-relevant but belief-neutral awareness of the physical world, such as knowing about the locations of North and South Poles. Scores on this five-item test confirm earlier impressions of limited public knowledge, and of self-assessments confounded with politics. The association between self-assessed understanding and actual knowledge appears modest but positive (higher self-assessments coinciding with greater knowledge) among self-identified liberal and moderate respondents (or Democrats and Independents). Among the most conservative, however, self-assessments appear unrelated or even negatively related to knowledge. Within that group, self assessed “understanding of climate change” to a greater degree reflects political confidence, rather than confidence in knowledge of science or the physical world. This result was replicated in that 2018 paper using data from statewide 2014–2015 New Hampshire surveys, in addition to the main 2016 nationwide survey.

The present paper presents a third replication, this time using a newer statewide New Hampshire survey conducted in October 2018. The new survey is smaller in scale, and included only four of the original five knowledge questions, but it did ask the same self-assessment and climate-change belief questions as the earlier surveys. Results from this analysis broadly agree with main conclusions from both datasets in the earlier study.

2. October 2018 survey

From October 19 to 28, 2018, trained personnel at the Survey Center of the University of New Hampshire conducted 607 cell and landline telephone interviews with randomly-selected New Hampshire residents for a quarterly Granite State Poll. Climate change understanding and belief questions were asked, along with the four-item knowledge quiz, respondent background characteristics, and other questions for different projects. Response rate for this poll was 20 percent, calculated by AAPOR (2016) definition 3. Sampling weights, applied to all graphs and analyses in this paper, allow for minor adjustments to achieve more representative results with respect to respondent age, sex, education and region of the state, along with household size and number of telephones. On climate-change and science-related topics, Granite State Poll results often fall close to those of nationwide surveys (Hamilton 2016a, 2016b; Hamilton et al. 2015, 2018).

Table 1 gives the question wording and response distributions for variables from the October 2018 survey. *Climate* is a standard climate-beliefs question, with one response choice (climate change is happening now, caused mainly by human activities) corresponding to consensus statements of most science organizations (e.g., first two sentences of AGU 2013). This question has been carried on many different surveys, cumulatively tens of thousands of interviews (e.g., Hamilton 2019; Hamilton et al. 2015). In almost all of these interviews, the *climate* question immediately followed the *understand* question, which introduced the topic of climate change or global warming (e.g., Hamilton 2011). The four knowledge questions listed in Table 1, placed later in the interview after some unrelated intervening questions, ask about very basic and mostly geographical information that has high relevance to climate-change topics. By design, these questions do not explicitly address the reality of climate change, and their correct answers cannot be guessed from (or biased by) politically-linked climate change beliefs. The number of correct answers provides a simple knowledge score ranging from 0 to 4. These same four items, plus one other, formed the five-item knowledge quiz analyzed in Hamilton (2018).

Two other differences between this new 2018 survey and the 2014–2016 surveys in Hamilton (2018) are worth noting. The earlier analysis employed a four-party political scheme or five-category ideologies, because overall sample sizes were large enough to support such divisions. In a similar vein, the earlier analysis focused on respondents who claimed “a great deal” of understanding about climate change. A smaller sample for the 2018 New Hampshire survey (607 instead of 1,411 or 1,571 interviews) makes the finer gradations of the previous analysis less practical in this case; smaller subsamples yield unstable results. To keep subsamples sufficiently large, in this paper we employ a simple 3-party political scheme, and focus on respondents who understand either “a great deal” or “a moderate amount.” The codes listed for *understand* and *party* in Table 1 reflect these decisions.

Table 1: Variable definitions with regression codes and weighted summary statistics from October 2018 Granite State Poll, $n = 607$. Order of responses to climate and knowledge question rotated in interviews.

Understanding and Views about Climate Change

Understand — “How much do you feel you understand about the issue of global warming or climate change?”

- A great deal (1, 23%)
- A moderate amount (1, 57%)
- Only a little (0, 17%)
- Nothing at all (0, 3%)

Climate — “Which of the following three statements do you think is more accurate?”

- Climate change is happening now, caused mainly by human activities (1, 63%)
- Climate change is happening now, but caused mainly by natural forces (0, 28%)
- Climate change is not happening now (0, 3%)
- Don't know/no answer (0, 6%)

Knowledge Questions

Greenhouse — “Scientists use the term greenhouse effect to describe...”

- A hole in the ozone layer (22%)
- The heat-trapping properties of certain gases such as CO₂ (correct, 67%)
- The warming effect of pavement and cities (4%)
- Don't know/no answer (7%)

Npole — “Which best describes the North Pole?”

- Ice a few feet or yards thick, over deep ocean (correct, 43%)
- Ice more than a mile thick, over land (38%)
- Rocky, mountainous landscape (4%)
- Don't know/no answer (14%)

Spole — “Which best describes the South Pole?”

- Ice a few feet or yards thick, over deep ocean (20%)
- Ice more than a mile thick, over land (correct, 48%)
- Rocky, mountainous landscape (16%)
- Don't know/no answer (16%)

Sealevel — “Which would do the most to raise sea level, if it melted?”

- Arctic sea ice (39%)
- Greenland & Antarctic land ice (correct, 31%)
- Himalayan glaciers (12%)
- Don't know/no answer (18%)

Knowledge — Number of knowledge questions answered correctly (0 to 4, mean 1.9)

Respondent Characteristics

Age — Age in years (18 to 92 years, mean 48)

Sex — (0 if male, 49%; 1 if female, 51%)

Education — “What is the highest grade in school, or level of education that you've completed and received credit for?” (1 if High School or less to 4 if postgraduate work, mean 2.2)

Party — “Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent or what?” (1 if Democrat, 43%; 2 if Independent, 17%; 3 if Republican, 40%)

3. Self-assessed understanding of climate change

Figure 1a charts responses to the *climate* question. Sixty-three percent agree with the scientific consensus that climate change is happening now and caused mainly by human activities. This resembles findings from other recent U.S. and New Hampshire polls (Hamilton et al. 2019). Twenty-eight percent concede that climate change is happening, but mainly for natural reasons. These two responses, with opposite implications for whether mitigation policies are needed, together account for 91 percent of the sample—and illustrate how misleading it would be to simply ask people whether they think that climate is changing, without reference to cause.

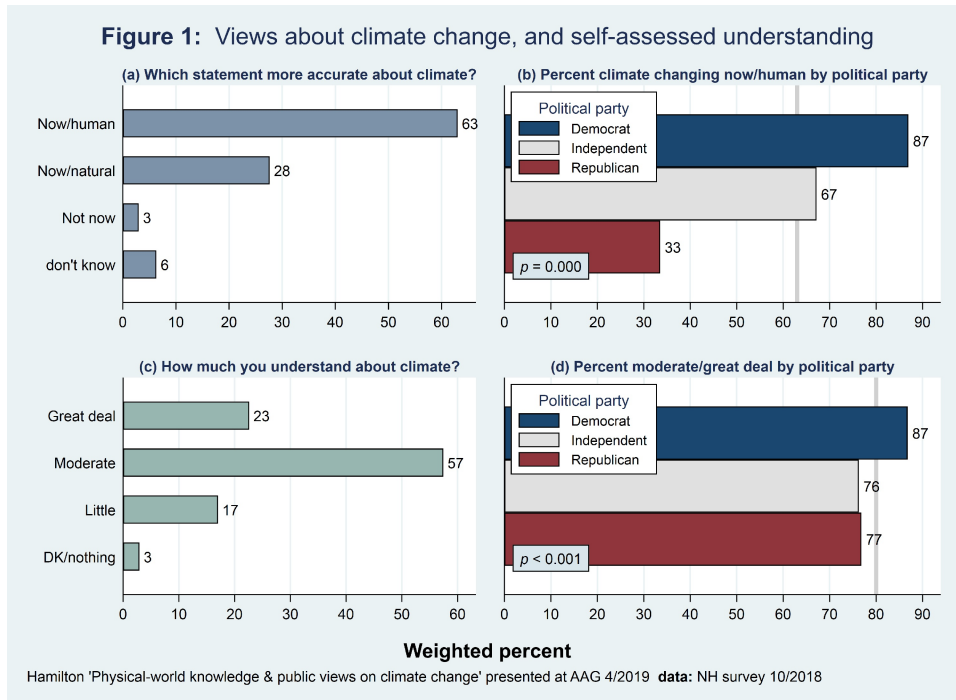


Figure 1b charts the percentage of now/human responses by political party, showing a 54-point gap between Democrats and Republicans. Large majorities of Democrats and Independents accept the scientific consensus on climate, but two-thirds of Republicans reject it.

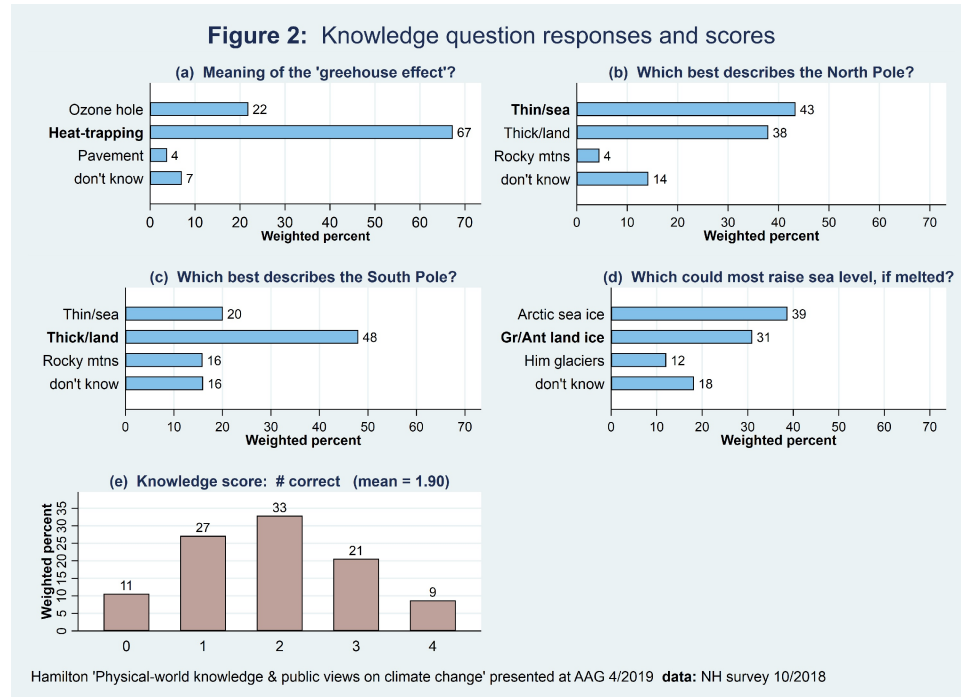
On this 2018 survey, most people said they understand either “a moderate amount” (57 percent) or “a great deal” (23 percent) about the issue of climate change (Figure 1c). That high result almost duplicates the corresponding responses on a 2016 nationwide survey (57 percent moderate, 24 percent a great deal) analyzed in Hamilton (2018). On the 2018 survey in Figure 1d, Democrats appear more likely than Independents or Republicans to say they understand a moderate amount or a great deal.

4. A simple test of knowledge

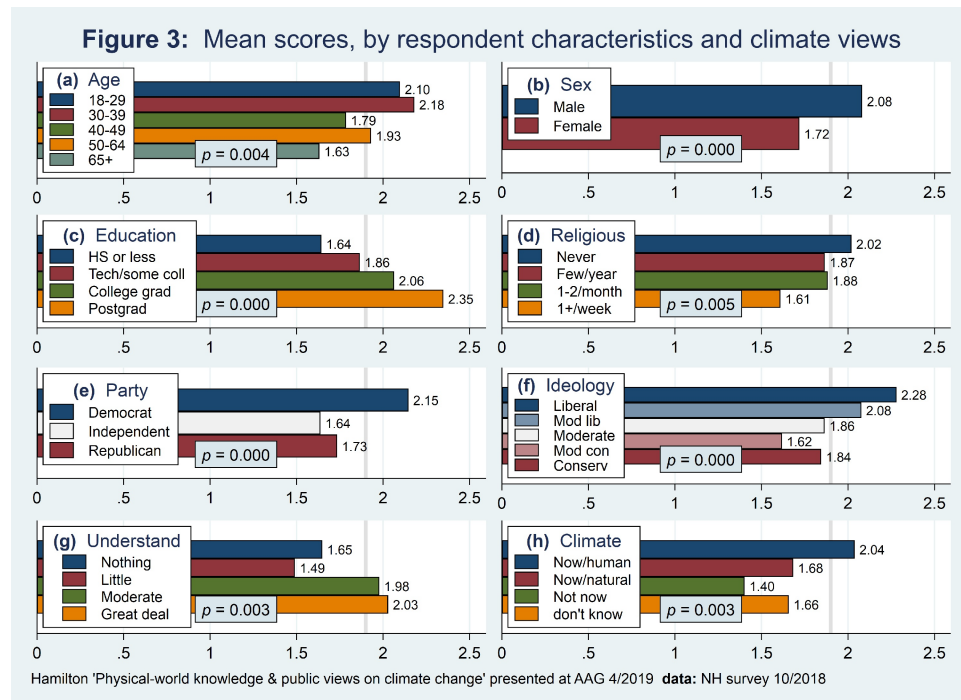
Previous surveys identified two broad kinds of climate-related knowledge among the public: facts that can or cannot be guessed (right or wrongly) on the basis of one’s beliefs about climate change (Hamilton 2012, 2015). For example, the rise in atmospheric CO₂ concentrations, or the decline in Arctic sea ice, are universally accepted scientific observations of central importance to the topic of climate change. When these facts are posed as questions on surveys, however, many people respond as if we had asked for their opinions about climate change. Those who reject the reality of anthropogenic climate change (ACC) are more likely also to reject the reality of CO₂ increase or Arctic sea ice decline. Responses to these factual questions thus are contaminated by opinions, so that we cannot meaningfully analyze them as separate cognitions.

The four knowledge questions studied here represent a different kind of fact, which cannot be guessed from opinions about climate change. Consequently, as survey questions they behave more like neutral knowledge, although still directly relevant to the understanding of climate change (see discussion in Hamilton 2018). Someone who does not know the meaning of “greenhouse effect,” for example, or that the North Pole is in the middle of an ocean, could not plausibly be considered to understand “a great deal” or even “a moderate amount” about climate change.

Figures 2a-d chart responses to each of the four knowledge questions. Figure 2e graphs overall scores; only 30 percent of respondents answered more than two questions correctly.



Who did relatively well, or poorly, on this knowledge quiz? **Figure 3** breaks down mean scores by respondent background characteristics, all of which exhibit significant differences. Education differences are most notable. We also see ideological or political differences, with Democrats or liberals scoring highest (roughly consistent with their relatively higher knowledge scores seen in Figure 1d). People who claim moderate or great understanding also tend to score higher—but even among those claiming “a great deal” of understanding, the average is barely above two answers correct out of four.



5. Predictors of knowledge and understanding

Table 2 summarizes results from three regressions. The first of these involves knowledge scores regressed on respondent age, sex, education and party, all of which have statistically significant effects. Other things being equal, knowledge scores tend to be higher among younger, male, well-educated and Democratic respondents.

Table 2: Predictors of knowledge scores, understand moderate/great amount about climate change (self assessed), and agreement that climate change is happening now, caused mainly by human activities. Coefficients and standard errors from weighted linear (*knowledge*) or weighted logistic (*understand*, *climate*) regressions.

	<i>Knowledge</i>	<i>Understand</i>	<i>Climate</i>
Age	-0.009 (0.003)**	0.005 (0.008)	-0.027 (0.007)***
Sex (female)	-0.472 (0.106)***	-0.459 (0.312)	0.779 (0.283)**
Education	0.270 (0.047)***	0.250 (0.147)†	0.177 (0.128)
Party			
<i>Democrat</i>
<i>Independent</i>	-0.420 (0.164)*	0.487 (0.685)	-0.043 (0.722)
<i>Republican</i>	-0.347 (0.116)**	0.851 (0.621)	-1.238 (0.572)*
<i>Knowledge</i>	...	0.993 (0.247)***	0.671 (0.208)**
Knowledge×party			
<i>Knowledge×Democrat</i>
<i>Knowledge×Independent</i>	...	-0.594 (0.362)	-0.637 (0.330)†
<i>Knowledge×Republican</i>	...	-0.882 (0.327)**	-0.661 (0.260)*
constant	2.234	-0.373 (0.729)	1.229 (0.698)
F test vs. constant only	14.36***	3.03**	11.83***
estimation sample	544	544	544

† $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

The second model in Table 2 is a logit regression of claiming to understanding a moderate amount or great deal about climate change (*understand* = 1) on the same background characteristics, and also on knowledge scores. Probabilities of claiming moderate/great understanding are significantly higher among respondents with more education, and also with greater knowledge. One noteworthy result: although political party exhibits a significant bivariate association with self-assessed understanding (Figure 1d), party differences are not significant once we control for knowledge scores in the multivariate analysis of Table 2. These results suggest that the party differences seen earlier reflect differences in knowledge rather than knowledge-free differences in confidence.

Finally, a third column in Table 2 summarizes the logit regression of recognizing the reality of ACC (*climate* = 1) on background characteristics, objective knowledge, and self-assessed

understanding. Other things being equal, agreement with the scientific consensus is higher among younger, female, and Democrat or Independent respondents with greater knowledge.

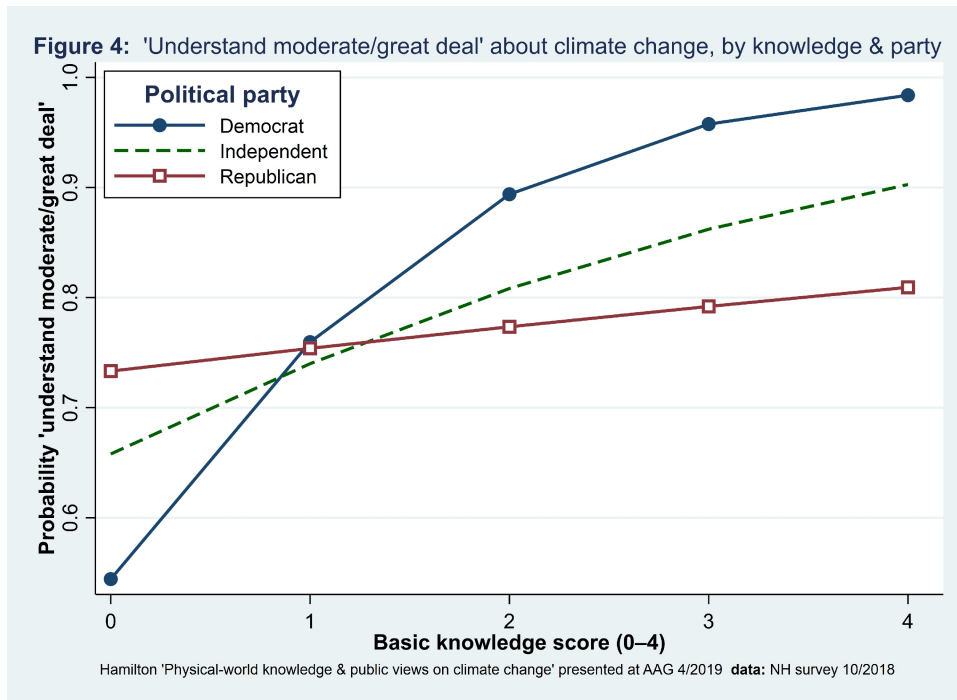
The models for both *understand* and *climate* also include interaction terms for *knowledge* × *party*, which previous work (Hamilton 2018) found to be important. The presence of these interactions, significant in both models, alters the interpretation of main effects from *knowledge* and *party*. The significant main effects of *knowledge* indicate that among Democrats (the base category of *party*), *knowledge* has a positive effect on self-assessed understanding, and on acceptance of ACC. More knowledgeable Democrats more often claim moderate/high understanding. Also, they more often accept the reality of ACC.

The main effects of *party*, by similar reasoning, represent the effects of each category of *party* (relative to Democrats, the base category) when *knowledge* = 0, that is for people who answered no questions correctly. Only Republican party identification in the *climate* model exhibits a significant main effect. This indicates that Republicans with zero knowledge scores are less inclined than Democrats with zero knowledge to accept the reality of ACC.

Knowledge × *party* interaction terms have significant effects in both models, more interesting than the main effects themselves. Such interactions, a key finding of Hamilton (2018), are replicated here with somewhat different variables and completely new data.

6. Interaction of knowledge with politics

The adjusted margins plot in **Figure 4**, calculated from the second model in Table 2, visualizes the *knowledge* × *party* interaction effect on *understand*. Among Democrats and to a lesser degree Independents, self-assessed understanding is positively related to knowledge. Among Republicans on the other hand, understanding and knowledge appear almost unrelated. This result parallels the key finding from both nationwide and earlier New Hampshire surveys in Hamilton (2018).



People of all political identities tend to overstate their understanding of climate change, judging from simple knowledge tests in this study and others (Hamilton 2012; Leiserowitz et al. 2010). That tendency is stronger in some groups than others, however, which might partly reflect different concepts of “understanding.” A scientist or science-aware layperson could interpret this question as asking about their comprehension of scientific research, or of evidence from the physical world. Alternatively, however, others could interpret the question as referring to their political certainty on the topic, such as firmly believing that anthropogenic climate change is real or not real. This second interpretation appears more prevalent among conservatives.

7. Discussion

If the scientific evidence for human-caused climate change is overwhelming, and has been for years, why does a large fraction of the U.S. public still reject its reality? One simple hypothesis, called the *information deficit* model, holds that people fail to accept scientific conclusions because they lack good information (Suldoovsky 2017). Experimental studies that find opinions changing after provision of information give support to this view, as does recent work on “inoculating” people against misinformation (Cook et al. 2017; Farrell et al. 2019; van der Linden et al 2017). Nonexperimental studies provide some support also, in the widely noted positive effects of education, knowledge or science literacy on ACC acceptance (Ehret et al. 2017; Hamilton et al. 2012, 2015).

The information deficit model does less well at explaining other aspects of ACC rejection, which reflect organized disinformation campaigns that often target scientific conclusions and scientists

along with the concept itself (Dunlap and McCright 2015). Among the public, well-educated conservatives are among the most vehement opponents (Drummond & Fischhoff 2017; Hamilton 2008, 2011, 2012; McCright and Dunlap 2011). Rejection of ACC by conservative information elites requires different hypotheses involving the politically selective acquisition of information. Many overlapping theories incorporate this process, such as *biased assimilation* (Corner et al. 2012; Ehret et al. 2017; McCright and Dunlap 2011), *elite cues* (Brulle et al. 2012; Carmichael and Brulle 2017; Darmofal 2005), *motivated reasoning* (Kraft et al. 2015; Kunda 1990; Taber and Lodge 2006), *compensatory control* (Kay et al. 2009), or *cultural cognition* (Kahan et al. 2011).

The information-deficit and information-filtering hypotheses are not mutually exclusive, and both well supported by different lines of evidence. They evidently apply to different degrees among different people and on different topics. The *knowledge* × *party* interaction effects of Table 2 and Figure 1 appear consistent with both information-deficit and information-filtering processes as well. Among Democrats and Independents, greater physical-world knowledge is associated with higher confidence about understanding climate change, and higher probabilities of agreeing with scientists on ACC. These patterns are consistent with information deficit, and its corollary that improving science communication could shift views—for some people. Among Republicans, on the other hand, there appears to be less relationship between physical-world knowledge and self-assessed understanding. Consequently, their beliefs about climate change may be less responsive to science communication, if that conflicts with firmly held political views. Indeed there could be a “backfire effect,” whereby provision of scientific climate-change information strengthened their conviction that it is false. Shifting firmly-held views away from climate-change rejection remains a challenge in this field, not easily resolved. For a larger fraction of the public that is not in this camp, on the other hand, results here encourage efforts at science communication.

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