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Science Beliefs, Political Ideology, and Cognitive Sophistication

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Some theoretical models assume that a primary source of contention surrounding science belief is political and that partisan disagreement drives beliefs; other models focus on basic science knowledge and cognitive sophistication, arguing that they facilitate proscientific beliefs. To test these competing models, we identified a range of controversial issues subject to potential ideological disagreement and examined the roles of political ideology, science knowledge, and cognitive sophistication on science beliefs. Our results indicate that there was surprisingly little partisan disagreement on a wide range of contentious scientific issues. We also found weak evidence for identity-protective cognition (where cognitive sophistication exacerbates partisan disagreement); instead, cognitive sophistication (i.e., reasoning ability) was generally associated with proscience beliefs. In two studies focusing on anthropogenic climate change, we found that increased political motivations did not increase polarization among individuals who are higher in cognitive sophistication, which indicates that increased political motivations might not have as straightforward an impact on science beliefs as has been assumed in the literature. Finally, our findings indicate that basic science knowledge is the most consistent predictor of people's beliefs about science across a wide range of issues. These results suggest that educators and policymakers should focus on increasing basic science literacy and critical thinking rather than on the ideologies that purportedly divide people.

Keywords: science beliefs, political ideology, cognitive reflection, motivated reasoning, identity-protective cognition

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Antiscience attitudes represent a major roadblock to developing responsible public policy. In response, a great deal of research has focused on building a better understanding of why people hold specific science beliefs. One of the most salient features of this scholarship is the focus on the apparently critical role of politics in science (Bohr, 2014; Ehret et al., 2017; Gauchat, 2012; Joslyn & Sylvester, 2019; Kahan, 2013; McCright et al., 2016; Mccright & Dunlap, 2011; Pennycook et al., 2020; Rutjens et al., 2017 2018; Scheufele, 2013, 2014; van der Linden et al., 2018; Wood & Porter, 2019), with political ideology framed as a central predictor of one's attitudes toward science (Gauchat, 2012; Iyengar & Massey, 2019; Joslyn & Sylvester, 2019; Kahan et al., 2017; Scheufele, 2014). Identity-protective cognition, a prominent theory in the context of science beliefs, argues that partisan differences are actually exacerbated by individual reasoning capacity (Drummond & Fischhoff, 2017a; Kahan, 2015; Kahan, 2013; Kahan et al., 2012). Clearly, such research has major implications for science communication and

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Jonathon McPhetres and Gordon Pennycook designed Study 1, and all authors designed Studies 2 and 3. All authors contributed to writing the article. Jonathon McPhetres conducted data analysis for Study 1, and Bence Bago conducted data analysis for Studies 2 and 3.

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education: If politics indeed clouds science belief, then the focus on increasing people's basic science knowledge (Allum et al., 2011) and analytic thinking skills (Pennycook et al., 2015) is unlikely to diminish antiscience beliefs.

One goal of the present work was to critically evaluate this zeitgeist in the literature, and we found, most notably, that much of the research in the domain of antiscience attitudes focuses on science beliefs about anthropogenic global climate change (e.g., Kahan et al., 2012), the theory of evolution (e.g., Drummond & Fischhoff, 2017b; Rutjens et al., 2017), and vaccinations (e.g., Joslyn & Sylvester, 2019). The findings of this research appear to have been generalized into larger conclusions regarding the role of political ideology (and related mechanisms) in the formation of antiscience attitudes. For example, a study that focuses specifically on climate change might be distilled into a statement such as the following: "[M]inimizing the salience of partisanship . . . can offer a useful strategy for improving public understanding of contentious scientific information in settings where polarizing issues can lead to biased interpretations" (Guilbeault et al., 2018, p. 9718). Additionally, it has been claimed that politically motivated reasoning is responsible for perverting scientific conclusions and, thus, overwhelms science communication (Iyengar & Massey, 2019), but this claim based on data relating to only a few scientific issues. Even research that claims to have tested both controversial and noncontroversial topics (Allum et al., 2011; Drummond & Fischhoff, 2017b) has often focused on a limited, potentially nonrepresentative, set of issues and science topics, which, we argue, undermines the ability of researchers to derive conclusions about the underlying mechanisms that produce antiscience attitudes. Therefore, the literature might be distorting the correlates of people's beliefs about science, which is a problem that is compounded by a lack of studies that have simultaneously tested multiple, competing accounts. Thus, based on the extant literature, we posit that it is difficult to determine which factors account for the most variance in antiscience beliefs across a range of science-related issues.

To explore this matter, we sought to expand the investigation of science beliefs by simultaneously testing multiple accounts of science beliefs across a range of ostensibly controversial issues using the same methodology. This should allow us not only to make broader generalizations about the underlying factors related to antiscience beliefs—which is important if we are to develop informed public policy on science communication—but also to test the relative roles of factors such as political ideology and basic science knowledge on antiscience beliefs. Instead of looking for evidence that a particular account of science-beliefs is correct, we focus on which of four accounts best explains the variability across a wide array of controversial science beliefs. This approach, we hope, will inform both theory and policy.

Several mechanisms, both competing and noncompeting, have been proposed to explain why people believe what they believe about science. One prominent account—which we refer to as the *politically motivated reasoning account*—argues that political ideology influences information processing and therefore plays a causal role in the formation of beliefs (Kunda, 1990; Taber et al., 2009; Taber & Lodge, 2012). This account is commonly evoked to explain partisan differences in beliefs about anthropogenic climate change, with political conservatism being typically associated with an antiscience stance (Bohr, 2014; Gauchat, 2012; Lewandowsky et al., 2013). This account reveals the importance of the cultural context. For example, climate change has been politicized by conservative think tanks and political elites (Mccright & Dunlap, 2011), which is an attitude that has been adopted by those who are motivated to believe information that is consistent with their political ideology (Kahan et al., 2012). The implication of a focus on politically motivated reasoning in the context of science beliefs is that simply being aware of a person's espoused political ideology should allow one to reliably predict where they stand on a variety of scientific issues.[1]

This general focus on the importance of political motivations is also a prominent feature of the identity-protective cognition account (Kahan, 2013; Kahan et al., 2012). However, in contrast to broader accounts of politically motivated reasoning that describe it as being driven by largely automatic and affectual processes (Erisen et al., 2014; Lodge & Taber, 2005), the identity-protective cognition account contends that cognitively sophisticated individuals are more adept at using reasoning skills to conform their evaluation of scientific evidence to their political ideology (Kahan, 2013; Kahan et al., 2012). Indeed, research has claimed that polarization around scientific issues is stronger among individuals who are more cognitively sophisticated and/or educated (Drummond & Fischhoff, 2017b). For example, it has been found that concern for anthropogenic climate change decreases as a function of increased numeracy among conservative Republicans, but the opposite association is evident for liberal Democrats (Kahan et al., 2012). Furthermore, it has been found that those with greater science literacy have more polarized beliefs about stem cell research, the Big Bang theory, and the theory of evolution (Drummond & Fischhoff, 2017b). This prior research implies that politically motivated reasoning is an active reasoning process that is facilitated by deliberative processes, hence the notion that cognitive sophistication exacerbates political polarization.

However, to reiterate an earlier point, researchers who have explored the identity-protective cognition account have focused on only a small number of prominent issues (Drummond & Fischhoff, 2017b; Gauchat, 2012; Kahan et al., 2012), with their findings being generalized to a wider range of issues. For example, the statement "Some of the most polarizing topics in American politics are scientific ones" (Scheufele, 2014, p. 13585) paints scientific topics with broad brush strokes as it is based on the results of studies that examine only a few, specific (and potentially outlying) issues, such as anthropogenic climate change, biotechnology, and gun control (Drummond & Fischhoff, 2017a; Kahan, 2013; Kahan et al., 2012). Therefore, whether the issues examined are the exceptions or the rule, and, by extension, whether the identity-protective account can be applied to a wider variety of politically relevant, antiscience beliefs remains unclear. Hence, a thorough understanding of this broader pattern of results is important because development of a public policy on science education that is based on only a few salient but exceptional cases would be problematic for myriad reasons.

[1] Note that other ideological factors, such as religiosity, also might be implicated in motivated reasoning processes. For example, religious people might be motivated to reject the theory of evolution based on theological teachings (Hill, 2014). Nonetheless, our focus is on politically motivated reasoning in the context of science beliefs, and thus our data do not speak directly to other potential motivational effects or to the importance of motivated reasoning for other (nonscience) beliefs (see the Discussion section for details).

In contrast to accounts that focus on political motivations and identity, the knowledge deficit account suggests that people who do not possess enough (or the correct) basic scientific knowledge tend to reject (or fail to accept) certain scientific claims (Allum et al., 2011; Lombrozo et al., 2008; Weisberg et al., 2021). Specifically, science knowledge is often considered in terms of either the basic science facts that an individual has learned (e.g., electrons are smaller than atoms, antibiotics do not kill viruses; see Weisberg et al., 2018) or in terms of an individual's knowledge of the scientific method itself (e.g., knowing the difference between a theory and a hypothesis; see Weisberg et al., 2021). The knowledge deficit model implies that antiscience beliefs are prevalent primarily because science is difficult to understand without advanced training. Indeed, for example, people who have greater knowledge of how science works have more proscience beliefs about evolution, anthropogenic climate change, and vaccines (Weisberg et al., 2021). A key policy prescription arising from this model is that teaching people about science will lead to an increase in proscience beliefs and attitudes.

A closely related model, which we call the *analytic thinking account*, holds that, in general, people do not think analytically enough about science (or other) issues (Pennycook et al., 2015). Whereas the knowledge deficit account suggests that having a strong, core understanding of basic scientific facts is central to the formation of proscience attitudes, the analytic thinking account argues that the disposition to think analytically and critically (over and above underlying science knowledge or trust in science; O'Brien et al., 2021) is critical. For example, some studies have found that those who reason more analytically are likelier to endorse the theory of evolution (e.g., Gervais, 2015). In contrast, individuals who are more receptive to "pseudoprofound bullshit" (i.e., randomly generated nonsense statements) are both less analytic and more likely to believe in the efficacy of nonevidence-based alternative medicines (Pennycook et al., 2015). As indicated in the preceding text, however, it is unclear whether these results are limited to specific science-related beliefs. Thus, given this cluttered theoretical space, we set out to simultaneously test all four accounts.

The Present Work

We approached the issue under examination in two ways: First, we set out to examine beliefs about a wide range of scientific topics using the same methodology. We identified a range of controversial issues on which people believe there is ideological disagreement (see Figure 1; of course, we do not assume that the topics are indeed divisive or that they are subject to politically motivated reasoning effects - rather, the goal here is to find topics that people believe to be controversial so that we can test whether they are, in fact, politically divisive). A preregistered pilot study using an independent sample demonstrated that the participants believed that each selected science topic was politically divisive (albeit to varying degrees; see Tables S1 and S2 in the online supplemental material for details). Second, we introduced an experimental manipulation of political motivations on a targeted issue (i.e., anthropogenic climate change) that showed the strongest evidence of political differences with the goal of further elucidating potential mechanisms.

To test each theoretical possibility across a range of scientific issues, we derived predictions from the four accounts of science attitudes described in the preceding text. The politically motivated reasoning account predicts that ideology will be a strong and consistent correlate of science attitudes, and the knowledge deficit account makes the same prediction for basic science knowledge rather than for ideology. Although these accounts are not mutually exclusive, our goal is to assess which model best explains the variance for each science topic. The identity-protective cognition and analytic thinking accounts do, however, make competing predictions: Whereas the former predicts that cognitive sophistication will be associated with increased political polarization, the latter

Figure 1

Science Belief Items and Distribution According to Political Partisanship for Samples 1 and 2

Note. The left panel depicts distributions for Sample 1 (N = 691); the right panel depicts distributions for Sample 2 (N = 1,018). † The item was reversed for subsequent analyses. See the online article for the color version of this figure.

predicts that cognitive sophistication will be associated with increased proscience attitudes across the board (for a similar approach, see Taber et al., 2009). Although it is possible that one of the four accounts is the best explanation for a specific science-related belief, it is crucial to ascertain which account or accounts hold the strongest, broadest predictive power. This knowledge will help inform public policy in addition to providing a greater understanding of human cognition. We tested these predictions using two samples of American participants.

The data from Study 1 found strong support for the knowledge deficit and analytic thinking accounts and surprisingly little support for the motivated reasoning account and identity-protective cognition accounts. To delve deeper into these results, we conducted Studies 2 and 3 in which we asked participants to evaluate arguments about anthropogenic climate change (a particularly divisive issue) in a partisan way. Critically, we found that cognitive sophistication was, if anything, associated with decreased polarization under partisan motivation instructions. Thus, we found a consistent pattern across several scientific issues (in Study 1) and in experimental approaches to a specific scientific issue (in Studies 2 and 3).

Study 1

We began this study by investigating the variance explained by the four accounts of science beliefs across a wide variety of issues that were considered politically divisive by a separate, independent sample.

Method

We conducted this study twice using two sample sources that closely match the demographic makeup of the United States. For Sample 1, we recruited participants through Lucid, an online panel company that provides samples that closely match U.S. demographics on age, gender, region, and ethnicity using quota-sampling. We then conducted an identical study using an independent sample to examine the replicability of our results. For this (Sample 2), we recruited participants through Dynata, an online panel company that provides representative samples that are quota-matched for U.S. demographics based on age, gender, education, income, and political party affiliation. The procedures for both studies were identical, and the results are described in tandem. All studies were approved by the University of Regina Research Ethics Board.

Participants

Sample 1. We recruited 1,003 participants from Lucid (474 male, 518 female, 8 who did not identify with a gender binary; Mean age = 44.5). Further demographic information is presented in Table S3 in the online supplemental material. Following our preregistered plans, we excluded 312 individuals for failing at least one of two attention checks, resulting in 691 participants in the final sample. A sensitivity analysis indicated that this is sufficient to detect effects of $r = .13$ or larger with .95 power.

Sample 2. We recruited 1,018 participants from Dynata (439 male, 558 female, 11 who did not identify with a gender binary; Mean age = 44.5). Further demographic information is presented in Table S3 in the online supplemental material. Although we preregistered the same exclusion criteria as with Sample 1, nearly 50% of the sample ($n = 453$) failed at least one of these attention checks. Thus, in order to present the most conservative results, we deviated from our plan and did not implement exclusion criteria (we report results of key analyses using preregistered exclusion criteria in the online supplemental material). However, zero-order correlations and scale reliabilities were similar among those who met and did not meet the inclusion criteria.

Materials and Procedure

Participants completed an online study hosted on the Qualtrics platform. The order of all scales was randomized with the constraint that questions about science beliefs were always first. Sample 1 was also asked questions about natural and organic foods, and Sample 2 was also asked questions about religiosity and biblical literacy for the purposes of other studies; these questions always came last. At the end of the study, participants completed a demographic questionnaire. Descriptive statistics and reliabilities for each scale are displayed in Table 1.

Proscience Beliefs. Participants rated their agreement with 17 statements about various scientific and pseudoscientific topics on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). A preregistered pilot study demonstrated that a separate, independent sample believed all topics to be divisive (see Tables S1 and S2 in the online supplemental material).

We also created two subsets of these items based on the political frame that we used when creating them (i.e., who would be expected to be more proscience for the particular issue). Liberal proscience beliefs included belief in anthropogenic climate change, the theory of evolution, the Big Bang theory, and gender ambiguity. The remainder of the items comprised conservative proscience items (see Figure 1), which included wage gap sexism, stereotype accuracy, vaccine safety, gender detransition, gender SAT, nuclear power, the role of testosterone in athleticism, IQ heritability, homeopathy, GMO safety, acupuncture, essential oils, and detoxing. Each item could fit into either category, depending on the valence of the item's wording. Our labels were intended to identify the issues (based on the cultural narratives that were evident when the items were created) about which liberals or conservatives were most likely to hold a proscience stance. In addition, we oversampled presumedly conservative proscience issues to counterbalance the strong, established ideological differences on anthropogenic climate change, the theory of evolution, and the Big Bang theory (i.e., liberal proscience items).

Science Knowledge. Participants answered 12 general, basic science knowledge questions taken from previous surveys, with higher scores indicating more science knowledge. We excluded any items that were related to proscience belief questions (i.e., questions about anthropogenic climate change, the theory of evolution, genetics).

Science Methodology. We included nine multiple choice questions assessing knowledge about scientific methodology (e.g., "What is the difference between a theory and a hypothesis?").

Cognitive Sophistication. We selected three measures used in recent research to capture different dimensions of cognitive sophistication (Pennycook et al., 2020; Tappin et al., 2020b). First, we used the Cognitive Reflection Test (CRT; Frederick, 2005), which poses problems with incorrect intuitive answers to measure

Table 1
Reliabilities, Means, Standard Deviations, and Correlations

Variable	Sample 1			Sample 2													
	α	*M*	*SD*	α	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. Proscience beliefs (total)	0.51	3.57	0.51	0.43	3.58	0.48	—	.54**	.83**	.36**	.27**	−.44**	−.14**	−.11**	.33**	.36**	−.18**
2. Liberal proscience beliefs	0.63	3.73	1.20	0.60	3.84	1.12	.41**	—	−.01	.18**	.10**	−.44**	−.46**	−.46**	.27**	.06	.07
3. Conservative proscience beliefs	0.53	3.52	0.56	0.54	3.50	0.58	.84**	−.15**	—	.31**	.26**	−.23**	.13**	.18**	.22**	.39**	−.26**
4. Science knowledge	0.68	7.29	2.59	0.76	6.62	3.04	.37**	.20**	.28**	—	.46**	−.14**	−.03	−.02	.39**	.43**	−.18**
5. Science methodology	0.64	5.87	1.96	0.70	5.27	2.33	.31**	.10**	.28**	.51**	—	−.09*	−.06	−.06	.42**	.37**	−.27**
6. Religiosity	0.95	5.11	1.67	0.95	4.94	1.71	−.44**	−.35**	−.27**	−.15**	−.12**	—	.28**	.21**	−.25**	−.22**	.17**
7. Political ideology	0.89	4.12	1.58	0.87	4.13	1.53	−.15**	−.32**	.03	.02	−0.05	.34**	—	.67**	−.20**	.02	−.02
8. Political partisanship		3.39	1.56	—	3.34	1.52	−.14**	−.32**	.04	< .01	−0.06	.29**	.60**	—	−.15**	.06	−.05
9. AOT-E	0.74	4.33	0.83	0.72	4.20	0.84	.40**	.31**	.25**	.49**	.53**	−.24**	−.13**	−.17**	—	.33**	−.23**
10. CRT	0.72	0.35	0.29	0.73	0.30	0.28	.34**	.13**	.30**	.47**	.48**	−.18**	−.05	−.01	.41**	—	−.26**
11. BSR	0.82	2.83	0.96	0.88	2.89	1.06	−.34**	.11**	−.44**	−.17**	−.34**	.23**	.04	.03	−.26**	−.31**	—

Note. Sample 1 $N = 691$; Sample 2 $N = 1{,}018$. For political ideology and partisanship, low scores indicate liberal/Democrat, and high scores indicate conservative/Republican. AOT-E = Actively Open-Minded Thinking About Evidence; CRT = Cognitive Reflection Test; BSR = Bullshit Receptivity.
$^* p < .05$. $^{**} p < .01$.

participants' disposition to engage in analytic thinking (Pennycook et al., 2015). Our CRT was a six-item scale because we included re-worded versions of the original 3 items (Frederick, 2005) and 3 items from (Thomson & Oppenheimer, 2016 excluding the "hole" item on the basis that it did not contribute to scale reliability in our previous work). Questions were presented in an open-ended format, with correct responses coded as 1 and incorrect items coded as 0. The scores for each of the six items were averaged, with higher scores represent more analytic thinking.

Second, we used the eight-item Actively Open-Minded Thinking About Evidence Scale (AOT-E; Pennycook et al., 2020) to measure the degree to which individuals are open to information that contradicts their opinions (Example item: "People should always take into account evidence that goes against their opinions"). Items were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*), with higher scores indicating a stronger belief that beliefs should change according to evidence.

The Bullshit Receptivity (BSR; Pennycook et al., 2015) scale measures the extent to which people find randomly generated, "pseudoprofound" (i.e., "bullshit") statements as representing something that is actually profound. Participants rated the profundity of five statements (e.g., "Imagination is inside exponential space–time events") on a scale ranging from 1 (*not at all profound*) to 5 (*very profound*), with higher scores indicating greater receptivity to pseudoprofound statements.

Results

Which Issues Are Politically Partisan?

The items and distributions according to political partisanship are displayed in Figure 1. As the figure illustrates, the distribution of agreement ratings was remarkably similar between conservatives and liberals, suggesting that there is little partisan disagreement (except for a few select issues). This occurred even though we explicitly sampled issues that most of an independent sample group rated as being subject to political disagreement (see Table S2 in the online supplemental material). Furthermore, as is evident from Figure 1, most of the issues were highly contentious. That is, there was a wide range of opinions about the issues, and anti-science beliefs were common.

For all subsequent analyses, items were recoded such that high scores indicate a more proscience position. We also created two political subsets of these items based on how they were generated: Ostensibly, liberal proscience beliefs included belief in anthropogenic global climate change, the theory of evolution, the Big Bang theory, and gender ambiguity, and conservative proscience items comprised the remainder of the items (we oversampled typically conservative proscience issues to counterbalance the established, and strong, ideological differences in opinion on anthropogenic climate change, the theory of evolution, and the Big Bang theory). We then examined zero-order correlations among all measures (see Table 1).

The pattern of results from the aggregate measures of science belief supports the knowledge deficit and analytic thinking accounts. First, there is some heterogeneity across science topics (as indicated by the low reliability values), suggesting that there are a variety of reasons (as opposed to a dominant ideological reason) why people hold the beliefs they do. Second, the proscience

beliefs composite was positively correlated with science knowledge (*r*s = .36, .37 for Sample 1 and 2, respectively), knowledge of scientific methodology (*r*s = .27–.31 for Sample 1 and 2, respectively), actively open-minded thinking (*r*s = .33, .40 for Sample 1 and 2, respectively), and higher scores on the CRT (i.e., more reflective thinking; *r*s = .36, .34 for Sample 1 and 2, respectively). These effect sizes are relatively large and range from the 70th to 90th percentile based on established norms in social psychology (Funder & Ozer, 2019; Gignac & Szodorai, 2016). Proscience beliefs were also negatively correlated with religiosity (all *r*s = −.44), political ideology/partisanship (indicating lower overall acceptance of science among political conservatives; *r*s = −.14, −.15 for Sample 1 and 2, respectively), and bullshit receptivity (*r*s = −18, −.34 for Sample 1 and 2, respectively). Interestingly, CRT and BSR performance were correlated with conservative but not liberal proscience beliefs, again indicating heterogeneity across issues.

Next, we examined correlations among our predicting variables and each science topic individually (see Table 2). These results show that each measure was broadly predictive for a number of issues (to varying degrees) but that there was a great deal of variation between science issues. This demonstrates how the literature on science attitudes—which has focused almost exclusively on a few key issues—has failed to represent the apparently multifaceted nature of science acceptance or rejection. For example, although the issues are ostensibly political, ideology and partisanship had moderate-to-strong correlations (*r*s > .20; see Funder & Ozer, 2019) with only two items reaching this bar across both samples consistently (i.e., anthropogenic climate change and gender ambiguity); the other 15 items were more weakly correlated or even uncorrelated with ideology. Put differently, correlations were moderate-to-strong in only eight of 34 possible cases for ideology or partisanship. Nonetheless, it was the case that political ideology and partisanship significantly correlated with beliefs (to some extent) across most issues; however, as is evident (see Table 2), this was also the case for our measures of science knowledge and cognitive sophistication.

What Contributes More to Beliefs About Science? Science Knowledge or Political Ideology?

Next, we directly compared whether science knowledge or political beliefs correlated more strongly with science beliefs. For this, we used the two versions of the proscience beliefs composite: one where liberal beliefs accord with the proscience position, and one where conservative beliefs accord with the proscience position (this was not preregistered for Sample 1; see the online supplemental material for details). To divide the items into partisan categories, we examined the correlations between political partisanship and each science topic, grouping the items together based on the direction of the correlation. This calculation allowed us to examine the overall correlation with ideology.

We then conducted a series of Fisher's *r*-to-*Z* comparisons. Identical analyses on both samples revealed a consistent pattern of results. For issues where liberal ideology accords with the proscience position (i.e., anthropogenic climate change, the theory of evolution, the Big Bang theory, and gender ambiguity), political ideology (Sample 1: $Z = 5.85$, $p < .001$; Sample 2: $Z = 12.04$, $p < .001$) and partisanship (Sample 1: $Z = 5.85$, $p < .001$; Sample 2: $Z = 12.04$, $p < .001$) were more strongly correlated with beliefs compared to science knowledge. For conservative proscience issues (13 issues in total), the opposite pattern was evident: basic science knowledge was more strongly related to beliefs than political ideology (Sample 1: $Z = 3.52$, $p < .001$; Sample 2: $Z = 5.80$, $p < .001$) and political partisanship (Sample 1: $Z = 2.57$, $p < .001$; Sample 2: $Z = 5.58$, $p < .001$).

What Is the Role of Cognitive Sophistication?

The identity-protective cognition and analytic thinking accounts make competing predictions with respect to the association between cognitive sophistication and science beliefs. Specifically, the identity-protective cognition account predicts that people higher in cognitive sophistication are better able to interpret evidence in an ideology-consistent manner and therefore that (in the context of politicized issues) cognitive sophistication should correlate with attitudes in opposite directions for liberals/Democrats and conservatives/Republicans. Under this model, we would expect to find clear instances where cognitive sophistication correlates in opposite directions for liberals and conservatives.[2] In contrast, the analytic thinking account simply predicts that people higher in cognitive sophistication would hold more (and stronger) proscience beliefs. Under this model, we would expect to find that cognitive sophistication is associated with the proscience position.

We simultaneously regressed each of the science belief scores onto a standardized composite of the cognitive sophistication variables ($\alpha = .71$; BSR was reverse scored), political partisanship, and their interaction. Of the 17 science belief items, there were main effects of cognitive sophistication on all except for four issues: nuclear power, testosterone/athleticism, IQ heritability, and gender differences on the SAT. There were also main effects of political partisanship on all except six issues: IQ heritability, homeopathy rejection, genetically modified organisms (GMOs) acceptance, acupuncture rejection, essential oils rejection, and detoxing rejection. More importantly, significant interactions were found for all except five topics: stereotypes, vaccines, homeopathy, GMOs, and detoxing (see Tables S10 through S26 for full details of each analysis in Sample 1, and Tables S27 through S43 for Sample 2).

These results provide some partial support for identity-protective cognition. Critically, however, the identity-protective cognition account does not merely predict an interaction. Rather, the account predicts that cognitive sophistication facilitates identity-protective cognition, which means that partisans who are higher in cognitive sophistication will be more likely to hold the ideologically consistent position (the interaction emerges due to having opposing partisans in the same sample; had we completed a study only among Republicans or conservatives, the account would not predict a null correlation for a politicized issue). Thus, for an issue such as anthropogenic climate change, the prediction is a positive correlation between cognitive sophistication and belief among Democrats but a negative correlation among Republicans. Thus, cognitive sophistication should be significantly associated with science beliefs in opposite directions for

[2] The identity-protective cognition account argues specifically that cognitive sophistication increases belief when politically congenial—thus, a null correlation between cognitive sophistication and belief by itself (which would produce an interaction between cognitive sophistication and political ideology) should not constitute positive evidence for the account.

Table 2

Zero-Order Correlations (Pearsons r) for Each Science Topic for Both Samples

Variable	Anthropogenic climate change		Wage gap sexism		Gender ambiguity		Theory of evolution belief		The Big Bang theory belief	
	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]
Political partisanship	−.45**	−.27**	.34**	.13**	−.33**	−.31**	−.28**	−.16**	−.25**	−.12**
	[−.51, −.39]	[−.33, −.21]	[.28, .41]	[.07, .19]	[−.39, −.26]	[−.36, −.25]	[−.35, −.21]	[−.22, −.10]	[−.31, −.17]	[−.18, −.06]
Political ideology	−.41**	−.25**	.32**	.14**	−.37**	−.35**	−.29**	−.14**	−.22**	−.11**
	[−.47, −.34]	[−.31, −.19]	[.25, .38]	[.07, .20]	[−.43, −.30]	[−.40, −.29]	[−.36, −.22]	[−.20, −.08]	[−.29, −.15]	[−.17, −.05]
Science knowledge	.05	.15**	.04	.04	.14**	.09**	.11**	.16**	.17**	.14**
	[−.02, .13]	[.09, .21]	[−.03, .11]	[−.03, .10]	[.07, .22]	[.03, .15]	[.04, .19]	[.10, .22]	[.10, .25]	[.08, .20]
Science methodology	.11**	.17**	.07	.11**	.13**	.10**	.04	.05	.01	−.04
	[.04, .19]	[.11, .23]	[−.00, .14]	[.05, .17]	[.06, .20]	[.04, .16]	[−.04, .11]	[−.02, .11]	[−.07, .08]	[−.10, .03]
Religiosity	−.13**	−.01	.07*	−.07*	−.21**	−.38**	−.45**	−.29**	−.41**	−.23**
	[−.20, −.05]	[−.08, .05]	[.00, .15]	[−.13, −.01]	[−.28, −.14]	[−.43, −.32]	[−.51, −.39]	[−.35, −.23]	[−.47, −.35]	[−.29, −.17]
AOT-E	.25**	.28**	−.02	.01	.21**	.21**	.15**	.20**	.14**	.14**
	[.18, .32]	[.23, .34]	[−.09, .06]	[−.05, .07]	[.14, .28]	[.15, .27]	[.08, .22]	[.14, .25]	[.07, .22]	[.08, .20]
CRT	−.01	.09**	.12**	.09**	.09*	.14**	.02	.06*	.07	.07*
	[−.08, .06]	[.02, .15]	[.04, .19]	[.02, .15]	[.01, .16]	[.08, .20]	[−.05, .10]	[.00, .12]	[−.00, .15]	[.00, .13]
BSR	.11**	.13**	−.14**	−.27**	−.05	−.17**	.08*	.15**	.05	.20**
	[.03, .18]	[.07, .19]	[−.21, −.06]	[−.33, −.21]	[−.12, .03]	[−.23, −.11]	[.01, .16]	[.09, .21]	[−.02, .13]	[.14, .26]

Note. Sample 1 $N = 691$; Sample 2 $N = 1{,}018$. Higher scores reflect more proscience attitudes for each topic. For political ideology and partisanship, low scores indicate liberal/Democrat, and high scores indicate conservative/Republican. CI = confidence interval; AOT-E = Actively Open-Minded Thinking About Evidence; CRT = Cognitive Reflection Test; BSR = Bullshit Receptivity.
* $p < .05$. ** $p < .01$.

Democrats relative to Republicans across a range of issues for the identity-protective cognition account to have broad support (see Pennycook et al., 2020 for further discussion). Therefore, for the issues for which there were significant interactions, we separated Democrats and Republicans and investigated the correlations between cognitive sophistication and each issue independently (see Table 3).

Notably, there were no issues in Sample 1 where cognitive sophistication correlated significantly in opposite directions for Democrats and Republicans, as would be expected under the identity-protective cognition account. As Figure 2 illustrates, partisans did not reason in different directions based on cognitive sophistication; the relative slopes for Republicans and Democrats were remarkable similar and not contingent on the belief that a topic was politically divisive (also see Figure S2 in the online supplemental material). Instead, as regards the 12 topics for which interactions were observed, cognitive sophistication is apparently important for one party but not the other (with this varying across topics). This indicates that there might be countervailing forces that dull the positive impact of cognitive sophistication on proscience belief in some cases (consistent with politically motivated reasoning broadly), but it does not indicate that cognitive sophistication exacerbates political biases (as is the central claim of the identity-protective cognition account).

In Sample 2, we observed divergent correlations for three issues: belief in anthropogenic climate change, the Big Bang theory, and the theory of evolution. These topics are often the focus of investigatons of identity-protective cognition (Drummond & Fischhoff, 2017a; Kahan, 2013; Kahan et al., 2012), perhaps because of their extreme divisiveness along political and religious boundaries. At any rate, the pattern of results for the remaining topics does not support the identity-protective cognition account. This implies that it may not be the case that people generally use explicit reasoning (bolstered by cognitive sophistication) in a motivated way when it comes to contentious scientific issues —at least, absent direct evidence within the context of these specific issues (see Studies 2 and 3). Furthermore, there were issues that were considered to be similarly politically divisive in our pretest (see Figure 2) and that were correlated with political ideology at similar levels (such as the gender wage gap question) but that did not produce this pattern of results. Indeed, the only issue where cognitive sophistication consistently and significantly predicted the ostensibly antiscience belief related to gender detransition, and this was true among both Democrats and Conservatives in Sample 2 (for further details on why this issue is an exception, see the following text). To summarize, across 17 issues and across both samples, cognitive sophistication was significantly positively associated with proscience beliefs in 40 out of 68 possible cases, was not correlated with beliefs in 22 cases, and was significantly negatively correlated with beliefs in six cases. Removing the outlying item about gender detransition modifies this to positive in 40 out of 64 cases, null in 21, and negative in three cases. Thus, regardless of partisanship, cognitive sophistication is broadly associated with proscience beliefs across issues and only rarely associated with antiscience beliefs.

Study 2

Study 1 found surprisingly inconsistent correlations between political partisanship and science beliefs across a wide range of issues. Furthermore, cognitive sophistication was fairly consistently positively correlated with proscience beliefs across issues. There were, however, several cases in which political partisanship interacted with cognitive sophistication, which is generally consistent with politically motivated reasoning effects. Nonetheless, most of these cases were characterized by weaker (or null) correlations between cognitive sophistication and the science belief in question, indicating weak evidence for the claim that cognitive sophistication increases belief in antiscience beliefs for contentious topics (as follows from the identity-protective cognition account).

Table 2 (*continued*)

Stereotype accuracy		Vaccine safety		Gender detransition		SAT gender differences		Nuclear power		Testosterone athleticism	
Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]
.14**	.01	−.12**	−.18**	.10**	.20**	.10*	−.01	.09*	.16**	.09*	.11**
[.06, .21]	[−.05, .07]	[−.19, −.04]	[−.24, −.12]	[.03, .18]	[.14, .26]	[.02, .17]	[−.08, .05]	[.02, .16]	[.09, .22]	[.01, .16]	[.05, .17]
.11**	−.02	−.13**	−.17**	.10*	.22**	.03	<.01	.16**	.19**	.11**	.18**
[.04, .18]	[−.08, .05]	[−.20, −.05]	[−.23, −.11]	[.02, .17]	[.16, .28]	[−.04, .11]	[−.06, .07]	[.08, .23]	[.13, .25]	[.04, .18]	[.12, .24]
.16**	.14**	.21**	.25**	.01	<.01	<.01	<.01	.15**	.09**	.18**	.17**
[.09, .24]	[.08, .20]	[.14, .28]	[.19, .31]	[−.06, .09]	[−.06, .06]	[−.07, .08]	[−.06, .07]	[.08, .22]	[.03, .15]	[.11, .25]	[.11, .23]
.20**	.20**	.29**	.39**	−.05	−.15**	<.01	.04	.06	−.04	.10*	.07*
[.13, .27]	[.14, .26]	[.22, .36]	[.34, .44]	[−.12, .03]	[−.21, −.09]	[−.08, .07]	[−.02, .10]	[−.02, .13]	[−.10, .02]	[.02, .17]	[.00, .13]
−.06	−.14**	−.19**	−.23**	.06	.22**	−.01	−.09**	−.04	.08*	<.01	.19**
[−.13, .02]	[−.20, −.08]	[−.26, −.11]	[−.29, −.17]	[−.01, .14]	[.16, .28]	[−.08, .06]	[−.15, −.03]	[−.11, .04]	[.02, .14]	[−.08, .07]	[.13, .25]
.13**	.18**	.24**	.39**	−.07	−.15**	−.02	<.01	.02	<.01	.15**	.11**
[.06, .21]	[.12, .24]	[.17, .31]	[.34, .44]	[−.14, .01]	[−.21, −.09]	[−.10, .05]	[−.06, .07]	[−.05, .10]	[−.06, .06]	[.08, .22]	[.05, .17]
.20**	.20**	.22**	.28**	−.01	−.09**	.05	.04	.16**	.06	.10**	.05
[.13, .27]	[.14, .25]	[.15, .29]	[.23, .34]	[−.08, .07]	[−.15, −.03]	[−.02, .13]	[−.02, .10]	[.08, .23]	[−.00, .12]	[.02, .17]	[−.01, .11]
−.14**	−.31**	−.16**	−.38**	.05	.25**	−.04	−.20**	.01	.12**	−.05	.19**
[−.22, −.07]	[−.36, −.25]	[−.24, −.09]	[−.43, −.33]	[−.02, .13]	[.19, .30]	[−.12, .03]	[−.26, −.14]	[−.07, .08]	[.06, .18]	[−.12, .03]	[.13, .25]

Notably, and consistent with past work (Kahan et al., 2012), anthropogenic climate change was strongly correlated with political ideology/partisanship—and, indeed, was one of two issues (along with gender ambiguity) where ideology/partisanship was correlated at ≤.30 in both samples. Importantly, in at least in one of the samples, cognitive sophistication was negatively correlated with anthropogenic climate change belief among conservatives. This indicates that, although identity-protective cognition may not strongly explain most science beliefs, it may nonetheless be a good way to characterize the underlying mechanisms for some specific scientific issues.

To investigate this issue more directly, we adapted an experimental paradigm that has been used in past work (Bolsen et al., 2014) to increase political motivations and focused on anthropogenic climate change, the issue for which there was the strongest evidence for political divisiveness. Specifically, participants were given a set of arguments for or against anthropogenic climate change and were asked explicitly to "view the information through a political lens"—a manipulation that was intended to parallel what is assumed to occur under politically motivated reasoning for scientific issues. Critically, inducing this motivation among our participants allowed us to test whether increasing political motivations interacts with cognitive sophistication. The identity-protective cognition account predicts that polarization around anthropogenic climate change should increase more strongly given increased political motivations, particularly among individuals who are higher in cognitive sophistication. This allowed us to test for experimental evidence of identity-protective cognition in a particularly charged context, which informed our interpretation of Study 1.

Method

Participants

In total, 1,176 participants started the experiment. Of these, 126 participants did not give a correct response to the first attention check question and therefore could not take part in the experiment. We included all data from participants who made it to this point. In the control condition, 524 participants took part (120 female, 318 male, and two who did not identify with a gender binary; *M* age = 51.6 years, *SD* = 18.2 years), 227 identified as Democratic and 208 identified as Republican using the continuous binary partisanship measure used in Study 1. In the motivated condition, 525 participants took part (125 female, 291 male; *M* age = 52.6 years, *SD* = 18.3 years), 202 people identified as Democrat, and 214 identified as Republican.

Materials

Participants received six arguments about climate change, which were adapted from Bago et al. (2020; who pretested them). Half of the items are supporting, scientific arguments for anthropogenic climate change and explain how climate change affects the environment or how human activity causes climate change; the other half argue against human-caused climate change or that climate change will have bad consequences. All arguments were content counterbalanced and presented in a nonpartisan manner, with no party cues or politicians mentioned. There were 10 possible arguments, of which participants were presented with only one version of each, for a total of three pro and three con arguments. After each argument, we asked participants to respond on a 100-point scale, ranging from 0 (*completely disagree*) to 100 (*completely agree*), to the question "How much do you agree with this argument?" Participants could give a response on a sliding scale. To ensure that the position of the pointer on the sliding scale did not bias participants, it was not visible until participants clicked on the scale. For all participants, we categorized arguments based on their concordance with each individual's self-reported political partisan identity: con arguments were categorized as "concordant" for Republicans and "discordant" for Democrats, whereas pro arguments were categorized as discordant for Republicans and concordant for Democrats.

Experimental Manipulation

To make partisanship salient, in the motivated condition, we presented participants with the following instructions:

Table 2 (*continued*)

IQ heritability		Homeopathy rejection		GMO safety		Acupuncture rejection		Essential oils rejection		Detox rejection	
Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]	Sample 1 *r*[95% CI]	Sample 2 *r*[95% CI]
.08*	.10**	.04	−.09**	.03	−.01	−.03	−.04	.02	−.11**	−.01	−.05
[.00, .15]	[.03, .16]	[−.04, .11]	[−.15, −.02]	[−.05, .10]	[−.07, .05]	[−.11, .04]	[−.10, .02]	[−.05, .10]	[−.17, −.05]	[−.09, .06]	[−.12, .01]
.10**	.08**	−.03	−.09**	−.01	−.07*	−.05	−.04	−.02	−.16**	−.06	−.10**
[.03, .18]	[.02, .14]	[−.10, .05]	[−.15, −.03]	[−.08, .07]	[−.13, −.01]	[−.12, .02]	[−.11, .02]	[−.10, .05]	[−.22, −.10]	[−.14, .01]	[−.16, −.03]
.15**	.16**	<.01	.04	.23**	.18**	.03	−.02	.16**	.17**	.23**	.21**
[.08, .22]	[.10, .22]	[−.08, .07]	[−.02, .10]	[.15, .30]	[.12, .24]	[−.05, .10]	[−.08, .04]	[.09, .23]	[.11, .23]	[.16, .30]	[.15, .26]
.09*	.09**	−.02	.05	.18**	.20**	.06	.03	.14**	.21**	.18**	.20**
[.02, .17]	[.03, .15]	[−.09, .06]	[−.01, .11]	[.10, .25]	[.14, .26]	[−.01, .13]	[−.03, .09]	[.06, .21]	[.15, .27]	[.10, .25]	[.14, .26]
.02	.18**	−.17**	−.28**	−.22**	−.25**	−.19**	−.26**	−.23**	−.36**	−.23**	−.33**
[−.05, .09]	[.12, .24]	[−.24, −.10]	[−.34, −.23]	[−.29, −.14]	[−.31, −.19]	[−.26, −.12]	[−.32, −.21]	[−.30, −.16]	[−.41, −.31]	[−.30, −.15]	[−.38, −.27]
.11**	.17**	<.01	<.01	.15**	.19**	.03	−.06	.20**	.23**	.20**	.18**
[.04, .18]	[.11, .23]	[−.08, .07]	[−.06, .06]	[.08, .22]	[.13, .25]	[−.04, .11]	[−.12, .00]	[.13, .27]	[.17, .29]	[.13, .27]	[.12, .24]
.12**	.07*	.10**	.08*	.26**	.20**	.13**	.06	.24**	.21**	.27**	.25**
[.05, .19]	[.00, .13]	[.02, .17]	[.02, .14]	[.19, .33]	[.14, .26]	[.06, .20]	[−.01, .12]	[.16, .31]	[.15, .26]	[.20, .34]	[.19, .30]
.01	.13**	−.07	−.24**	−.20**	−.32**	−.13**	−.30**	−.25**	−.43**	−.21**	−.43**
[−.07, .08]	[.07, .19]	[−.15, .00]	[−.30, −.18]	[−.27, −.13]	[−.38, −.27]	[−.20, −.05]	[−.36, −.24]	[−.32, −.18]	[−.47, −.37]	[−.28, −.13]	[−.48, −.38]

> When thinking about the argument, please try to view the information through a political lens. This will help you put the argument in the context of the political divide that surrounds the issue. We will later ask you about your party and why you affiliate with it (or why you choose to not affiliate with a party).

Similar manipulations have been shown to be effective in making people focus on the partisanship while evaluating new information (Bolsen et al., 2014). Participants were shown these instructions at the beginning of the experiment (after the general introduction) and on the top of the screen with every argument.

Procedure

First, participants were presented with an ethical consent form, followed by two pretreatment attention check questions. After this, they were presented with the general instructions of the study (the following instructions were kept the same among conditions):

> Welcome to this experiment!
>
> In this experiment, you will be presented with different arguments regarding climate change and its potential effects. You will be asked to indicate how much you agree with the argument on a scale from 0 = *completely disagree* to 100 = *completely agree*. Please carefully read through the arguments before responding.
>
> You will be presented with six arguments. The experiment will take about 15 minutes to complete and will demand your full attention.
>
> Before you receive the arguments, we will ask you some questions concerning, science, technology, and health.
>
> Press "Next" to continue!

Next, participants received the same belief in science questionnaire as in Study 1 (i.e., 17 statements about science). After, participants in the motivated condition received the partisanship saliency instructions and were presented with the partisanship arguments in a randomized order.

At the end of the experiment, participants were asked to answer a six-item version of the CRT and then a measure of knowledge of science (from Study 1). In the end, they were presented with questions assessing various demographic characteristics and political preferences. Most importantly, to measure political preference, we asked participants, "Which of the following best describes your political preference?" Response options were as follows: strongly Democratic, Democratic, lean Democratic, lean Republican, Republican, strongly Republican. We used these responses to categorize people into Democrats and Republicans (which was necessary to be able to categorize items into "concordant" and "discordant" categories).

Exclusions

We excluded all participants who did not correctly solve the second attention screening question (although they were allowed to participate in the experiment). In total, 241 people were excluded (120 from the control condition and 121 from the motivation condition), leaving 808 participants for further analysis.

Statistical Analysis

We used linear mixed effect models and the *lmerTest* package in R (Kuznetsova et al., 2017). We deviated from the preregistration to follow best practice recommendations in the field (Barr et al., 2013), which is to try to fit the maximal model (i.e., beginning by adding all possible random slopes and removing terms until the model converges and has no singularity issues). Specifically, we preregistered that we would use random intercepts (and if the model converged, random slopes of item contents), but not random slopes for our fixed effects. However, this was suboptimal as the maximal model procedure arguably decreases false positive errors (Barr et al., 2013). We therefore ran the more conservative model, in which we allowed the random intercept of participants to vary over argument consistency and the random intercept of argument content over consistency and cognitive sophistication score. As fixed effects, we added concordance (coded as .5

Table 3
Correlations Between Cognitive Sophistication and Proscience Beliefs for Democrats and Republicans in Samples 1 and 2

	Sample 1 (N = 691)		Sample 2 (N = 1,018)	
Proscience belief	Democrats r[95% CI]	Republicans r[95% CI]	Democrats r[95% CI]	Republicans r[95% CI]
1. Global climate change belief†±	.30** [.21, .39]	−.04 [−.15, .07]	.40** [.33, .47]	−.16** [−.25, −.07]
2. Wage gap sexism†±	−.00 [−.11, .10]	.22** [.11, .32]	.02 [−.07, .10]	.32** [.23, .40]
3. Gender ambiguity†±	.37** [.28, .46]	−.02 [−.13, .09]	.29** [.21, .37]	.04 [−.06, .13]
4. Theory of evolution belief†±	.14** [.04, .24]	.01 [−.10, .12]	.27** [.19, .35]	−.15** [−.24, −.06]
5. The Big Bang theory belief†±	.20** [.10, .30]	.02 [−.09, .13]	.21** [.13, .29]	−.21** [−.30, −.12]
6. Stereotype accuracy±	.21** [.11, .31]	.29** [.18, .39]	.23** [.15, .31]	.37** [.29, .45]
7. Vaccine acceptance±	.37** [.28, .46]	.31** [.20, .40]	.46** [.39, .52]	.48** [.41, .55]
8. Transitioning genders†	−.16** [−.26, −.06]	.07 [−.04, .18]	−.16** [−.24, −.07]	−.19** [−.27, −.10]
9. Nuclear power safety†	.05 [−.06, .15]	.19** [.08, .29]	−.00 [−.09, .08]	.00 [−.09, .09]
10. Testosterone athleticism†	.07 [−.04, .17]	.28** [.18, .38]	.07 [−.02, .15]	.06 [−.03, .15]
11. IQ heritability†±	.07 [−.03, .17]	.21** [.10, .31]	.16** [.08, .25]	.01 [−.08, .10]
12. Homeopathy rejection	.14** [.04, .24]	−.08 [−.18, .03]	.12** [.03, .20]	.13** [.03, .22]
13. GMO acceptance	.35** [.25, .44]	.23** [.13, .34]	.31** [.23, .38]	.33** [.24, .41]
14. Acupuncture rejection†±	.21** [.11, .31]	−.00 [−.11, .11]	.04 [−.05, .12]	.15** [.06, .24]
15. Essential oil rejection†	.37** [.28, .45]	.20** [.09, .30]	.37** [.30, .44]	.32** [.24, .40]
16. Detox rejection	.40** [.31, .49]	.23** [.12, .33]	.34** [.27, .41]	.38** [.30, .46]
17. SAT gender differences†±	−.00 [−.11, .10]	.04 [−.07, .15]	.02 [−.07, .10]	.15** [.06, .24]

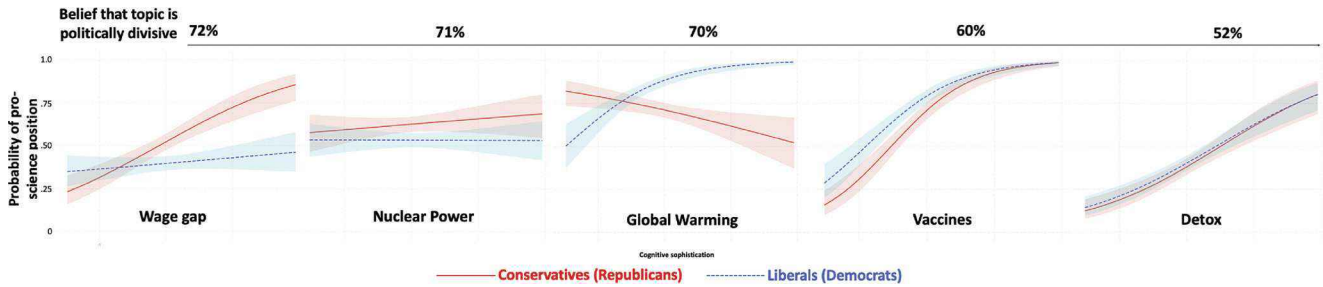
Note. CI = confidence interval; GMO = genetically modified organism; SAT = Scholastic Aptitude Test.
† Indicates $p < .05$ for the Political Affiliation × Cognitive Sophistication interaction in Sample 1. ± Indicates $p < .05$ for the Political Affiliation × Cognitive Sophistication interaction in Sample 2.
** $p < .01$.

concordant, −.5 discordant), experimental condition (0 = *control*, 1 = *motivated*) and continuous cognitive sophistication score (the average score on the CRT of each participant). The preregistered analysis is presented in the online supplementary materials.

Results

See Figure 3 for a summary of results. First—replicating the pattern for belief in Study 1 using our climate change arguments—we found a significant interaction between cognitive sophistication and concordance (b = 25.2, 95% CI [12.2, 38.3], $p < .001$), such that more cognitively sophisticated individuals were more likely to agree with concordant than discordant information (i.e., there was an association between sophistication and polarization). We did not find a significant two-way interaction between concordance and the political motivation manipulation (b = 5.7, 95% CI [−3.5, 14.9], p = .227); however, we found a marginally significant three-way interaction between political motivation, concordance, and cognitive sophistication (b = −16.5, 95% CI [−35.2, 2.1], p = .082; this three-way interaction was significant in the preregistered analysis plan and there was moderate evidence for it using a preregistered Bayesian analysis; see the online supplemental materials). Interestingly, the negative beta suggests that there was a tendency toward the opposite direction than was predicted by the identity-protective cognition account: Participants who scored *lower* on our cognitively sophistication measure were, if anything, the ones who were more divided about climate change in the political motivation condition relative to the control condition. As can be seen in Figure 3, the trend for the individuals who are higher in cognitive sophistication is for them to be *less* polarized in the political motivation condition.

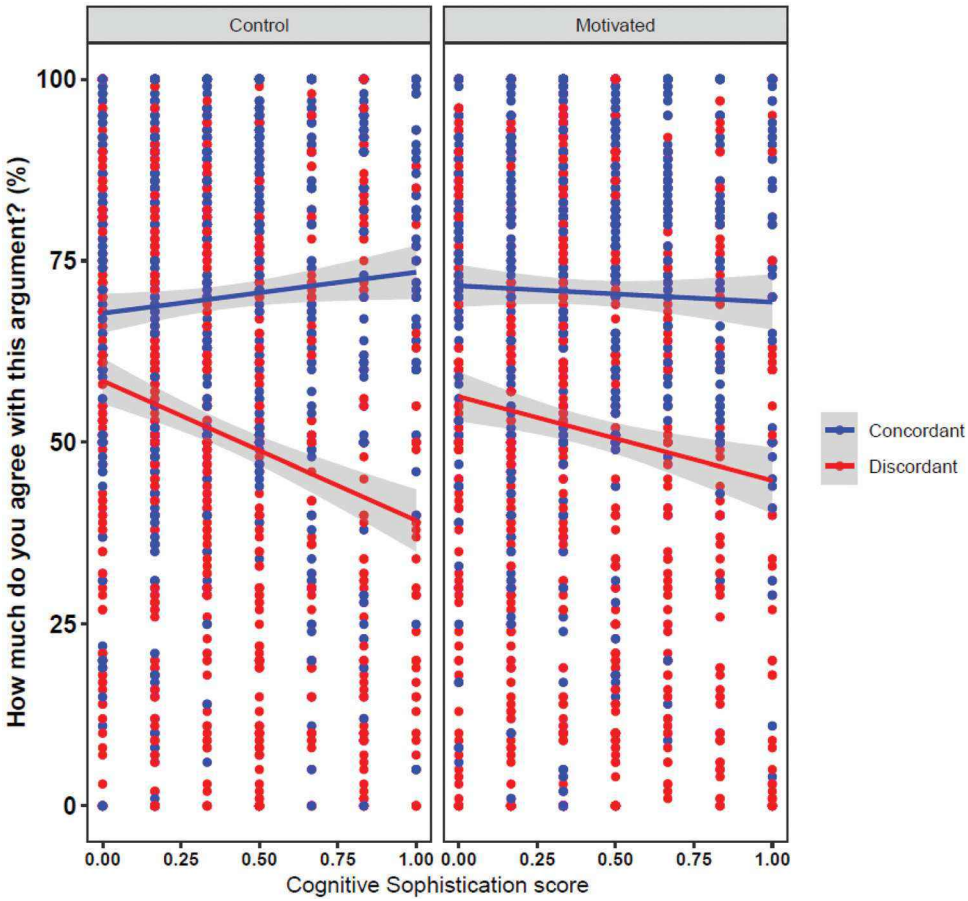
Figure 2
Depiction of Interactions Between Political Affiliation and Cognition Sophistication Arranged by Belief That the Topic Is Politically Divisive



Note. Data are from Sample 2 (Sample 2, N = 1,018) and are arranged according to the belief that the topics are politically divisive as rated by an independent sample (N = 203). Standardized cognitive sophistication appears on the x-axis; probability of agreeing with proscience position appears on the y-axis. Shaded areas indicate 95% confidence intervals. See the online article for the color version of this figure.

Figure 3

Agreement Scores on the Global Climate Change Arguments (Study 2) as a Function of Cognitive Sophistication and Concordance for the Control and Motivated Reasoning Experimental Groups



Note. Error bars represent 95% confidence intervals. See the online article for the color version of this figure.

For completeness, we also report the other effects in the model. We found a main effect of concordance ($b = 9.3$, 95% CI [2.5, 16], $p < .001$), such that people prefer concordant over discordant information (as would be expected). We also found a main effect of cognitive sophistication score ($b = -7$, 95% CI [−13.3, −.7], $p = .031$), such that more cognitively sophisticated individuals had weaker overall agreement with the arguments. There was no main effect of condition ($b = .7$, 95% CI [−3.4, 5], $p = .730$), and no interaction between cognitive sophistication and condition ($b = .44$, 95% CI [−7.9, 8.8], $p = .917$).

Study 3

Study 2 produced a surprising trend: Not only was cognitive sophistication not associated with increased polarization when participants were asked to think about the information through a partisan lens, but the opposite pattern emerged. This, however, was marginally significant. In Study 3, we set out to replicate Study 2 with one small change to the manipulation that was intended to increase partisan motivations. In particular, we removed the following sentence from the instructions: "This will help you put the argument in the context of the political divide that surrounds the issue." We thought that this might be interpreted (perhaps more so by individuals who are higher in cognitive sophistication) as an instruction to avoid the political divide. Hence, the participants were simply instructed to do the following in the partisan motivation condition: "When thinking about the argument, please try to view the information through a political lens. We will later ask you about your party and why you affiliate with it (or why you choose to not affiliate with a party)."

Method

Participants

In total, 1,404 participants started the experiment. Of these, 196 participants did not give a correct response to the first attention check question and therefore could not take part in the experiment (hence, produced no data). We included all data from participants who made it to this point. In the control condition, 567 participants took part (264 female, 238 male, and two others; *M* age = 45.6

years, *SD* = 17.6 years), 341 identified as Democrat, and 246 identified as Republican. In the motivated condition, 577 participants took part (232 female, 231 male and three who did not identify with a gender binary; *M* age = 46.4 years, *SD* = 28.6 years), 351 people identified as a Democrat and 226 identified as a Republican.

Materials and Procedure

The same materials were used as in Study 2. We changed only a few things about the experiments, including the instructions manipulation to the following: "When thinking about the argument, please try to view the information through a political lens. We will later ask you about your party and why you affiliate with it (or why you choose to not affiliate with a party)."

We then measured political partisanship before the actual arguments and instructions were presented to make sure responding to that question was unaffected by the manipulation and the arguments. Third, after the climate change experiment, we presented participants with an additional question regarding their opinion about the 2007 Energy Act (Bolsen et al., 2014), per the following instructions:

> We are next going to ask you what you think about parts of the 2007 Energy Independence Act.
>
> [Instructions for partisan motivation in the motivated condition; no other instructions in the control condition.]
>
> The Act included the following provisions:
> - Requires U.S. automakers to boost gas mileage to 35 miles per gallon for all passenger cars by 2020, which is a 40% increase.
> - Funds for research and development of solar and geothermal energy, and for the increased production of biofuels.
> - Provides small businesses loans toward energy efficiency improvements
>
> Given this information, to what extent do you oppose or support the Energy Act? (0 = *completely oppose*, 100 = *completely support*)

We included this as a conceptual replication of Bolsen et al. (2014) who they showed that once participants are instructed to think about their partisan motivation, the gap between liberal/Democrats and conservatives/Republicans for the support of the 2007 Energy Act was increased (compared with a control condition).

Exclusion

As in Study 2, we excluded all participants, who did not give a correct question to the second attention check question (although they were allowed to participate in the experiment). In total, 268 people were excluded (133 from the control and 135 from the motivated condition), and 911 were further analyzed.

Results

Figure 4 summarizes the findings for the anthropogenic climate change arguments. We used the same analysis strategy as in Study 2: We allowed the random intercept of participants to vary over argument consistency, and the random intercept of argument content over consistency and cognitive sophistication score (note that we also deviated from our preregistered analysis plan in Study 3 as we did in Study 2; see Supplement 1 for the preregistered analyses). In our replications of Studies 1 and 2, we found a two-way interaction between cognitive sophistication and argument consistency (b = 31.99, 95% CI [20.6, 43.4], $p < .001$), such that the gap between concordant and discordant arguments was greater for more cognitively sophisticated individuals. There was also an interaction between the experimental condition and consistency (b = 9.3, 95% CI [1.6, 17], p = .017), such that the overall level of political polarization was greater in the partisan motivation condition relative to the control. Critically, there was also a three-way interaction between cognitive sophistication, political motivation, and consistency (b = −26.7, 95% CI [−43.8, −9.7], p = .002), in the same direction as in Study 2 (we also found strong evidence for this interaction using a preregistered Bayesian analysis; see the online supplemental material). Specifically, participants in the motivation condition who were higher in cognitive sophistication were less politically polarized than were those with lower in cognitive sophistication. Put differently, the political motivation manipulation decreased the effect of cognitive sophistication on the gap between politically consistent and inconsistent arguments.

We also found a main effect of argument consistency (b = 6.3, 95% CI [.79, 11.8], p = .026), indicating that people agreed with concordant arguments more than with discordant arguments. However, there were no main effects of cognitive sophistication (b = −.95, 95% CI [−6.4, 4.4], p = .730) or condition (b = −.005, 95% CI [−3.4, 3.4], p = .998), and there was also no two-way interaction between cognitive sophistication score and experimental condition (b = 1.7, 95% CI [−5.9, 9.3], p = .664).

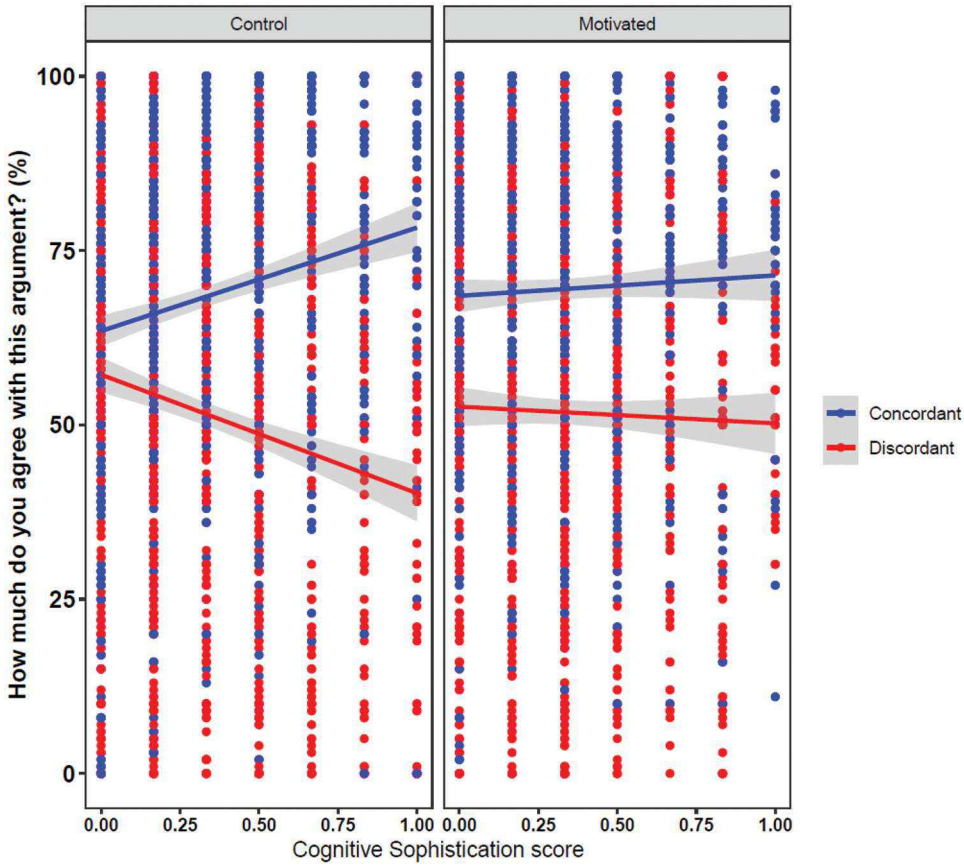
We also analyzed the responses on the Energy Act question, but instead of using "argument consistency" in the model, we simply added partisanship (−.5 for Democrats, .5 for Republicans). Overall, we replicated the patterns we observed with the climate change arguments (see Figure 5). We found a significant two-way interaction between partisanship and cognitive sophistication score (b = 26.9, 95% CI [10.9, 43], p = .001), and a three-way interaction between experimental condition, partisanship and cognitive sophistication score (b = −26.9, 95% CI [−51, −2.8], p = .029). No other interaction or main effect were significant (although two were marginally significant): no interaction between cognitive sophistication score and condition (b = −1.5, 95% CI [−13.6, 10.5], p = .805), a marginally significant interaction between condition and partisanship (b = 9.9, 95% CI [−.96, 20.7], p = .074), no main effect of cognitive sophistication (b = 5.3, 95% CI [−2.7, 13.4], p = .193), a marginally significant main effect of partisanship (b = 6.6, 95% CI [−.7, 14], p = .076,) and no main effect of condition (b = .75, 95% CI [−4.7, 6.2], p = .786).

General Discussion

We draw three main conclusions from these results. First, although political ideology and partisanship were broadly correlated with beliefs about science, these correlations were only large (rs > .30) for a minority of scientific issues. Basic science knowledge and cognitive sophistication were as correlated with science beliefs as ideology and, in many cases, were more strong and consistent predictors. Second, we found relatively weak evidence for the identity-protective cognition account, both via correlational tests across a large range of controversial scientific issues as well in two experiments where political motivation was induced. Specifically, there was not a single case across the 17 issues that we investigated where cognitive sophistication was consistently

Figure 4

Agreement Scores on the Global Climate Change Arguments (Study 3) as a Function of Cognitive Sophistication and Concordance for the Control and Motivated Reasoning Experimental Groups



Note. Error bars represent 95% confidence intervals. See the online article for the color version of this figure.

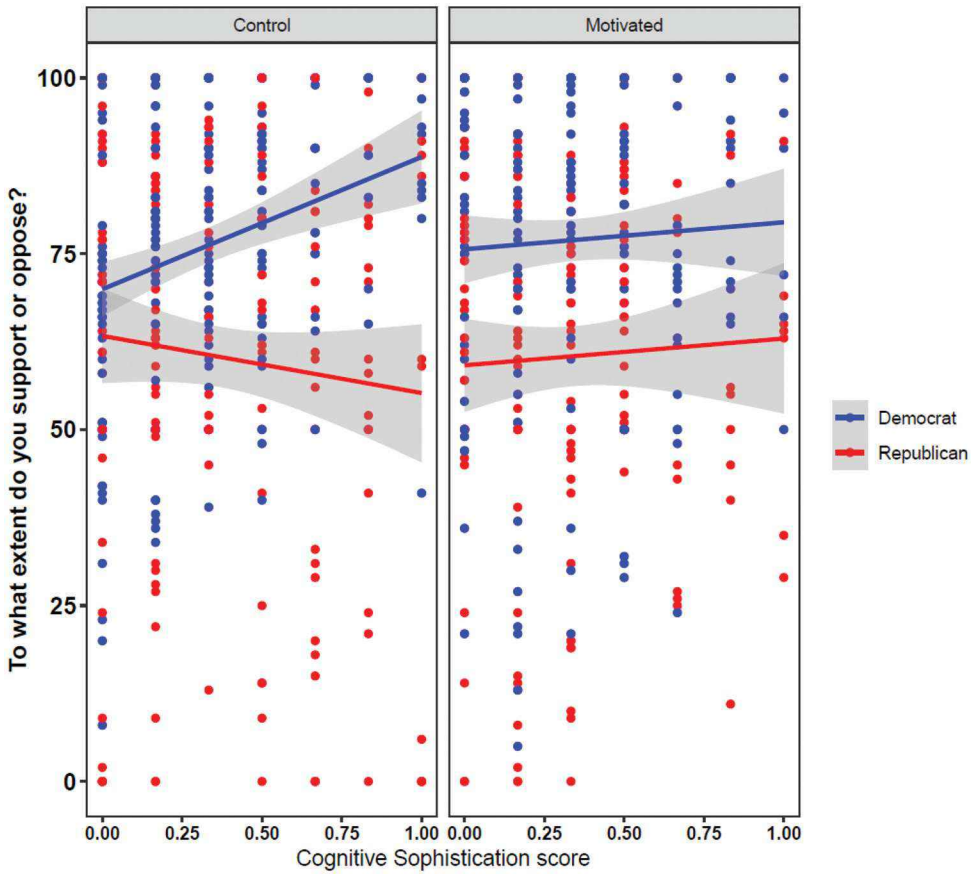
associated in opposite directions for Democrats versus Republicans across both samples (although there were three such cases in one of the two samples). Instead, cognitive sophisticated tended to be positively associated with proscience belief across issues regardless of political partisanship. Furthermore, having participants evaluate arguments about anthropogenic climate change (one of the issues where there was some evidence for identity-protective cognition) in a politically motivated way decreased polarization among cognitively sophisticated individuals. This indicates that the effect of political motivations on scientific evidence evaluation may not be as straightforward as is broadly contended.

The Role of Politically Motivated Reasoning in Science Beliefs

Consistent with the politically motivated reasoning perspective, we found that ideology was generally correlated with science beliefs. However, these correlations were perhaps weaker than one might expect. For example, in Sample 1 of Study 1, there were only five (out of 17) issues for which political ideology had a strong or medium correlation ($r > .20$) with beliefs (i.e., anthropogenic climate change, the Big Bang theory, the theory of evolution, gender ambiguity, gender wage gap), and two of them (i.e., the Big Bang theory and the theory of evolution) were more strongly correlated with religious belief. In Sample 2 of Study 1, there were only three issues (i.e., anthropogenic climate change, gender ambiguity, and detransitioning gender) with a strong or medium correlation. Interestingly, for the remainder of the issues (when aggregated), basic science knowledge was a stronger overall predictor than political ideology. This is notable because we deliberately selected issues that were considered partisan by a separate sample of participants (see Table S2 in the online supplemental material). Thus, the failure of political ideology to be the strongest and most consistent correlate of people's beliefs about a variety of topics challenges the ascribed importance of politically motivated reasoning in the literature. To be clear, however, we do not question the notion that science is often political—this is evidenced, for example, by numerous scientists working as lobbyists and advising government policymakers (Scheufele, 2013, 2014). Rather, our results indicate that the politicization of science (Gauchat, 2012; Scheufele, 2014) does not necessarily spill over (to a great extent) to the beliefs of laypeople (beyond a few select issues).

Figure 5

Responses on the 2007 Energy Act Question as a Function of Cognitive Sophistication and Concordance for the Control and Motivated Reasoning Experimental Groups



Note. Error bars represent 95% confidence intervals. See the online article for the color version of this figure.

One criticism of our approach, however, is that we only measured political ideology and partisanship, but did not assess political engagement or sophistication (Abramowitz, 2010; Prior, 2013; Vitriol et al., 2020). Models of public opinion change have long noted that one's attentiveness to political issues will be strongly related to one's political motivations (Zaller, 1992), and therefore politically motivated reasoning will be greatest among those who are the most politically sophisticated (Taber & Lodge, 2006). Our results speak to the predictive validity of political ideology/partisanship in the aggregate, but it is possible (if not probable) that ideology plays a stronger role across various scientific issues for specific segments of the population (such as the highly politically engaged). Indeed, it is unlikely that science-related information would trigger politically motivated reasoning among people who are not sufficiently engaged with politics to know how they should react to the information based on their political allegiances. Thus, our data do not rule out a potentially important role of politically motivated reasoning for some people and among some scientific issues. Still, an alternative (and plausible) pattern of results would have indicated strong correlations between political ideology and science beliefs across numerous issues, and this would have expanded the purview and importance of politically motivated reasoning; however, we did not find strong evidence for this. Nonetheless, future research on science beliefs should measure political engagement and sophistication directly and contrast this with the effects of cognitive sophistication to investigate the potential role of politically motivated reasoning more directly.

Weak Evidence for Identity-Protective Cognition

A critical prediction derived from the identity-protective cognition account is that partisans use deliberative reasoning to interpret evidence that is politically consistent and, therefore, that people who are higher in cognitive sophistication should be more likely to believe (or disbelieve) in science when it is consistent (or inconsistent) with their political ideology (Kahan, 2013; Kahan et al., 2012; Mccright & Dunlap, 2011). However, we found no correlational evidence of this in Sample 1 of Study 1 and found evidence only in Sample 2 of Study 1 on belief in anthropogenic climate change, the Big Bang theory, and the theory of evolution. Thus, we found positive evidence for identity-protective cognition in only three of 34 possible tests across both samples. These issues

are among the most investigated science beliefs in the literature, and thus it can be seen how restricting focus to these hot-button issues could lead to a distorted view of the underlying mechanisms that lead to antiscience beliefs.

Although neither the politically motivated reasoning nor identity-protective cognition accounts inherently make claims about the broadness or narrowness of their predictive utility, it is important to determine whether their predictions generalize broadly across scientific issues. Although the evidence for a broad, overriding effect of political ideology across issues was weak, there were several interactions between political partisanship and cognitive sophistication, which can be taken as evidence for identity-protective cognition. Importantly, though, examination of the interactions revealed that cognitive sophistication was, in most cases, uncorrelated with proscience beliefs for one political affiliation but significantly correlated for the political affiliation (see Table 3). Such a result, in our view, should not be considered more than weak evidence for politically motivated reasoning as the provenance of null correlations are surely multitudinous.

Indeed, null correlations between cognitive sophistication and science beliefs occurred for issues about which partisans did not disagree. For example, consider the case of acupuncture, where cognitive sophistication was associated with skepticism among liberals (but not conservatives) in Sample 1 and among conservatives (but not liberals) in Sample 2. And yet, there was also no significant overall correlation between political ideology or partisanship and beliefs about the scientific basis of acupuncture. If a mere interaction between cognitive sophistication and ideology were sufficient evidence for identity-protective cognition, one would need to contend that there is evidence in a case such as acupuncture, where partisans not only do not disagree, but also the underlying nature of the interaction reversed across samples. Thus, as with many other issues, the most parsimonious explanation is that there is an association (albeit small and potentially fleeting) between cognitive sophistication and proscience beliefs about acupuncture and that political ideology is not particularly relevant.

A potential criticism of our approach is that we investigated a set of science beliefs that have not been subject to political polarization and hence it is no surprise that political ideology was not a consistent predictor across issues. We contend that the only way to know if political ideology is relevant for a specific issue is to investigate it. Certainly, none of the issues we investigated were innocuous and, as noted, a separate sample of participants thought that each issue was likely to be politically contentious (although, of course, the degree varied substantially across issues). Furthermore, there was a great deal of disagreement across issues (see Figure 1) and partisans did, generally, disagree about most issues —however, these differences were plainly smaller, in our view, than would be expected given the literature and our estimates of political controversiality.

Focusing specifically on anthropogenic climate change—perhaps the most contentious scientific issue (e.g., the correlation between political partisanship and belief in anthropogenic climate change was $r = -.45$ in Sample 1 of Study 1)—we found no evidence that inducing political motivations caused individuals who are higher in cognitive sophistication to become more polarized. In fact, across two high-powered preregistered experiments, we found that having people consider information about climate change through a partisan lens decreased the correlation between cognitive sophistication and argument evaluation by decreasing polarization for those high in sophistication and increasing it for those low in sophistication. This result is hard to accommodate under a straightforward identity-protective cognition account. One possible explanation is that high- and low-skill reasoners might have different motivations and are thus differently affected by being asked to consider a particular issue through a political lens. Another possibility is that our manipulation did not increase political motivations in the way we intended. For example, asking people to think about the information through a political lens might have triggered their political biases, which they then suppressed. Naturally, if this is true, then we are left with the conclusion that political motivations are not as easily induced as anticipated, which in turn implies that the impact of political motivations on science beliefs might be more complicated than the literature indicates.

Interestingly, there was an association between polarization and cognitive sophistication when people evaluated anthropogenic climate change arguments under standard instructions (i.e., in the control conditions of Studies 2 and 3), which supports the identity-protective cognition account. However, it is unclear why this would essentially disappear when political motivations are made more salient. One possibility is that people who are higher in sophistication are more engaged with the task (i.e., more motivated) or have different or stronger prior beliefs (Bago et al., 2020; Tappin et al., 2020a, 2020b). A recent set of experiments found that experimentally increasing deliberation led to increased polarization in an evidence evaluation task that included pro- and anti-climate change arguments, but this primarily occurred because it increased the influence of prior beliefs in evidence evaluation (which can be a Bayesian process; Bago et al., 2020). In any case, the ambiguity of the present results indicates that more research focused on manipulating underlying motivations is necessary.

Consistency With Recent Work on Politically Motivated Reasoning

Our results are also broadly consistent with some recent work that has also begun to call politically motivated reasoning accounts into question (e.g., Druckman & McGrath, 2019). For example, recent research has shown that partisan differences observed in survey research are often due to the desire for interparty conflict and bias in the survey design rather than actual interparty differences in beliefs (Bullock et al., 2015; Bullock & Lenz, 2019; Roush & Sood, 2022). Other work shows that people who are more analytic are better able to distinguish between true and false news regardless of consistency with political ideology (Pennycook & Rand, 2019, 2021). Recent research on the increasingly polarized context of COVID-19 in the United States also shows that cognitive sophistication is associated with fewer misperceptions for Democrats and Republicans alike (despite Republicans being more likely to hold misperceptions, as defined by disagreement with expert sources; Pennycook et al., 2021).

Additionally, some research has found that providing more information does not cause a politically motivated "backfire effect" (Wood & Porter, 2019) and, more directly, that communicating facts about the scientific consensus around climate change is effective for both conservatives and liberals (van der Linden et al.,

2018). Indeed, van der Linden et al. (2018) found the pattern often used to support the identity-protective cognition account at pretest; that is, the educated participants were more polarized. However, once information about the climate consensus was provided, both liberals and conservatives increased their acceptance of climate change regardless of education levels. As with our own studies, this indicates that politically motivated reasoning may not play as strong a causal role in polarization around scientific issues as previously thought.

Importantly, these studies do *not* show that prior beliefs are not important in the context of people's evaluations about science. Rather, our evidence indicates that political ideology is not a particularly strong predictor for many science beliefs, which in turn implies that politically motivated reasoning does not offer as much of a challenge to science communication as previously thought. There are still contexts in which politics apparently has an influence on science beliefs—such as the case of global climate change. However, even here, simple manipulations of political motivations (such as having people consider evidence through a political lens) do not apparently produce straightforward evidence of political polarization in evaluations. These findings combined indicate that the literature on science beliefs may need to be recalibrated.

The Role of Cognitive Sophistication

There was not a single science belief where cognitive sophistication was consistently correlated in opposing directions for Democrats and Republicans across both samples in Study 1. This leads to our third major conclusion: thinking appears to rarely hurt. In fact, only in one instance was cognitive sophistication consistently negatively correlated with the proscience position: Namely, the claim that some transgender people transition back to their original gender (i.e., "detransition"). This item was intentionally worded to be obviously true (i.e., some people do, of course, detransition). However, it is also the case that only a very small proportion of people actually do detransition (Clarke & Spilliadis, 2019) and so the item can be reasonably read as at least somewhat (or perhaps even largely) false in terms of its implication. Nonetheless, additional analyses excluding this item from the conservative proscience composite yielded nearly identical results to those reported above (see Tables S48 and S49). Thus, even in this one exceptional case, more cognitively sophisticated individuals may hold the more proscience opinion. The present results therefore echo research demonstrating the important role of reflective thinking in belief formation and retention (Pennycook et al., 2015) and indicate that those higher in cognitive sophistication—that is, more able to think reflectively, openly, and skeptically—generally hold more proscience beliefs.

Knowledge About Basic Science Is Important and Useful

Our final conclusion emerges from the finding that knowledge about basic science was broadly quite predictive of proscience beliefs (and never predictive of antiscience beliefs). This finding has important policy implications. Put briefly, the obvious recommendation is that science can, and should, be taught; however, the obvious notwithstanding, recent research (Drummond & Fischhoff, 2017a; Kahan et al., 2012) and articles in the popular press (Kahan, 2018; Nisbett, 2016) have warned that more science knowledge could have detrimental effects—indeed, this is a key claim of the identity-protective cognition account (Drummond & Fischhoff, 2017a; Kahan, 2013; Kahan et al., 2012). Nonetheless, we find that basic knowledge of scientific facts was associated with proscience beliefs, even among politicized issues. Thus, with perhaps a few exceptions, focusing on teaching basic science is likely to yield increases in overall acceptance of science.

Our research extends past evidence, suggesting that science knowledge is a useful predictor of attitudes toward politically contentious science topics. One meta-analysis (Allum et al., 2011) has suggested that general science knowledge shows a small, but positive, correlation with attitudes toward climate and genetic sciences. Additionally, experimental research has demonstrated effective strategies in this domain. For example, teaching people about the science behind genetically modified foods results in more positive attitudes (McPhetres et al., 2019), as does teaching people about the science behind climate change (Ranney & Clark, 2016)—which is notable, as this was the most consistently ideological topic in the present studies. Further, as noted, providing people with scientific information does not appear to cause a backfire effect, contrary to the prediction by the identity-protective cognition account (van der Linden et al., 2018; Wood & Porter, 2019). In contrast, beliefs about politics, morality, and religion are closely tied to one's identity and, hence, are difficult to change. Thus, even on those few issues where political beliefs were more strongly correlated with attitudes, it may nonetheless be worthwhile to ensure that people understand the basic science.

Conclusion

Our results clarify the complex factors that help determine belief in particular scientific issues. These results suggest that political partisanship does not play as dominant a role as previously considered and that cognitive sophistication does not generally exacerbate identity-protective cognition but is instead generally associated with proscience beliefs. Instead of focusing on what divides people, we recommend that science communicators, educators, and policymakers focus on improving science literacy to improve attitudes toward science and acceptance of new technologies.

Context of the Research

This research originated from the desire to comprehensively assess different perspectives across an increasingly fractured body of research on science beliefs and attitudes. We viewed things from related but different perspectives (with a focus on science knowledge for Jonathon McPhetres and a focus on analytical thinking for Gordon Pennycook and Bence Bago), and it is noteworthy that in our discussions there were still two other prominent perspectives (politically motivated reasoning and identity-protective cognition) about who holds antiscience beliefs. For people who are focused on science communication and/or education, this lack of cohesiveness in the literature is frustrating, as experts who focus on various components of the same general topic have offered myriad perspectives, and this article is our attempt to synthesize and evaluate several of these competing perspectives.

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