7-20-2022

Knowledge Overconfidence is Associated with Anti-Consensus Views on Controversial Scientific Issues

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Abstract:

Public attitudes that are in opposition to scientific consensus can be disastrous and include rejection of vaccines and opposition to climate change mitigation policies. Five studies examine the interrelationships between opposition to expert consensus on controversial scientific issues, how much people actually know about these issues, and how much they think they know. Across seven critical issues that enjoy substantial scientific consensus, as well as attitudes toward COVID-19 vaccines and mitigation measures like mask-wearing and social distancing, results indicate that those with the highest levels of opposition have the lowest levels of objective knowledge, but the highest levels of subjective knowledge. Implications for scientists, policymakers, and science communicators are discussed.

One-Sentence Summary:

Those with the strongest counter-consensus attitudes on scientific issues have the lowest scientific knowledge but believe they understand the issues the best.

INTRODUCTION

Uncertainty is inherent to science. A constant striving toward a better understanding of the world requires a willingness to amend or abandon previous truths, and disagreements among scientists abound. Sometimes, however, evidence is so consistent, overwhelming, or clear that a scientific consensus forms. Despite consensus by scientific communities on a handful of critical issues, many in the public maintain anti-consensus views. For example, there are sizable gaps in agreement between scientists and laypeople on whether genetically modified foods are safe to eat, climate change is due to human activity, humans have evolved over time, more nuclear power is necessary, and childhood vaccines should be mandatory (*1*). The COVID-19 pandemic also continues on, fueled in part by contagion among the unvaccinated (*2*), while social movements against vaccination policies are emerging worldwide. The consequences of such anti-consensus views are dire, including property destruction, malnutrition, disease, financial hardship, and death (*3–6*).

Opposition to the scientific consensus has often been attributed to non-experts' lack of knowledge, an idea referred to as the "deficit model" (*7, 8*). According to this view, people lack specific scientific knowledge, allowing attitudes from lay theories, rumors, or uninformed peers to predominate. If only people knew the facts, the deficit model posits, they would be able to arrive at beliefs more consistent with the science. Proponents of the deficit model attempt to change attitudes through educational interventions and cite survey evidence that typically finds a moderate relation between science literacy and pro-consensus views (*9–11*). However, education-based interventions to bring the public in line with the scientific consensus have shown little efficacy, casting doubt on the value of the deficit model (*12–14*). This has led to a broadening of psychological theories that emphasize factors beyond individual knowledge. One

such theory, 'cultural cognition,' posits that people's beliefs are shaped more by their cultural values or affiliations, which lead them to selectively take in and interpret information in a way that conforms to their worldviews (*15–17*). Evidence in support of the cultural cognition model is compelling, but other findings suggest that knowledge is still relevant. Higher levels of education, science literacy, and numeracy have been found to be associated with more polarization between groups on controversial and scientific topics (*18–21*). Some have suggested that better reasoning ability makes it easier for individuals to deduce their way to the conclusions they already value (*19*, but see *22*). Others have found that scientific knowledge and ideology contribute separately to attitudes (*23*, *24*).

Recently, evidence has emerged suggesting a potentially important revision to models of the relationship between knowledge and anti-science attitudes: Those with the most extreme anti-consensus views may be the least likely to apprehend the gaps in their knowledge. In a series of studies on opposition to genetically modified (GM) foods, Fernbach et al. (2019) found that individuals most opposed were the least knowledgeable about science and genetics, but rated their understanding of the technology the highest in the sample (*25*). A similar pattern emerged for gene therapy, though not for climate change denial. Related findings have been reported for opponents of vaccination claiming to know more than doctors about autism (*26*), and for anti-establishment voters in a Dutch referendum reporting knowing more about the issues than they really do (*27*). Those with the most strongly held anti-consensus views may be the least knowledgeable, but also the most overconfident about how much they know (*28*, *29*).

These findings suggest that knowledge may be related to pro-science attitudes, but that subjective knowledge—individuals' assessments of their own knowledge—may track anti-science attitudes. This is a concern if high subjective knowledge is an impediment to individuals' openness to new information (*30*). Mismatches between what individuals actually know

("objective knowledge") and subjective knowledge are not uncommon (*31*). People tend to be bad at evaluating how much they know, thinking they understand even simple objects much better than they actually do (*32*). This is why self-reported understanding decreases after people try to generate mechanistic explanations, and why novices are poorer judges of their talents than experts (*33*, *34*). In this paper we explore such knowledge miscalibration as it relates to degree of disagreement with scientific consensus, finding that increasing opposition to the consensus is associated with higher levels of knowledge confidence for several scientific issues, but lower levels of actual knowledge. These relationships are correlational, and they should not be interpreted as support for any one theory or model of anti-scientific attitudes. Attitudes like these are most likely driven by a complex interaction of factors, including objective and self-perceived knowledge, as well as community influences. We speculate on some of these mechanisms in the general discussion.

The current research makes four primary contributions. First, we test the generality of the relation between extremity of anti-consensus beliefs and scientific knowledge overconfidence (the difference between subjective and objective knowledge). Although related effects have been demonstrated across a handful of contexts and with different operationalizations of the constructs, there has been no test with a unitary methodology across a range of issues. In Studies 1-3, we examine seven controversial issues on which there is a substantial scientific consensus: climate change, genetically modified foods, vaccination, nuclear power, homeopathic medicine, evolution, and the big bang theory. In Studies 4 and 5 we examine attitudes concerning COVID-19. Second, we provide evidence that subjective knowledge of science is meaningfully associated with behavior. When the uninformed claim they understand an issue, it is not just cheap talk, and they are not imagining a set of "alternative facts." We show that they are willing to bet on their ability to perform well on a test of their knowledge (Study 3).

Third, if the effect does not generalize to all issues, do the data give any indication why? In discussing why GM foods showed the pattern but climate change did not, Fernbach et al. (2019) suggested that a potentially important difference between the issues is degree of political polarization, with climate change attitudes much more polarized by political affiliation than attitudes on GM foods. Political polarization refers to the degree to which people from different ideological groups (e.g. conservatives vs. liberals) differ in their positions on an issue. When an issue is highly polarized there may less room for individual knowledge to influence attitudes because they are instead driven more by community influence. In Studies 1 and 2 we test whether the predicted effects are attenuated for issues that are more politically polarized. Likewise, because several issues we examine have come into conflict with religious thinking, and because religion can itself be a polarizing factor for attitudes and beliefs (*21*), we also test for an attenuation for issues more associated with religiosity.

Fourth, given the life-altering nature of the COVID-19 pandemic, do these relationships shed light on the psychology of those opposed to expert recommendations and policies aimed at reducing the infection rate? The COVID-19 pandemic is the largest spread of a respiratory disease that the world has seen in over 100 years. Although the knowledge gained and shared by the scientific community about the virus gradually increased, public health professionals prescribed traditional, time-tested and general epidemiological measures to try to mitigate its spread. Thus, while a scientific consensus on the specifics of SARS-CoV-19 viral transmission emerged slowly, consensus on how to mitigate viral contagion was well established even at the beginning of the pandemic. Nonetheless, there are notable gaps between scientists' recommendations and the public's willingness to act in accordance with them (*35*–*37*). Here we examine the relations among objective knowledge, subjective knowledge, and opposition to COVID-mitigating behaviors and policies in two studies, one focused on openness to being

vaccinated (Study 4), and the other on attitudes toward mitigation behaviors such as mask wearing and social distancing (Study 5).

RESULTS

Studies 1 and 2: Anti-consensus views across seven scientific issues

The purpose of Studies 1 and 2 was to test the generalizability of relations between participants' opposition to scientific consensus and their objective and subjective knowledge, both within and across seven scientific issues, in a large pre-registered study (combined N = 3,249). Importantly, these issues are of current societal interest and scientific groups have either issued official statements of consensus on them, or surveys of scientists and reviews of research have demonstrated *de facto* consensus: The safety of genetically modified foods, the validity of anthropogenic climate change, the benefits of vaccination outweighing its risks, the validity of evolution as an explanation of human origins, the validity of the Big Bang theory as an explanation for the origin of the universe, the lack of efficacy of homeopathic medicine, and the importance of nuclear power as an energy source (see Table 1). Each participant was randomly assigned to answer questions about just one of these seven issues.

Table 1: Scientific issues and consensuses. Studies 1 through 3 examine respondents' attitudes toward seven issues on which scientific consensus has been established. Studies 4 and 5 examine attitudes on COVID vaccination and activities or policies that mitigate the spread of the virus. The consensuses for these issues (and associated citations) are included.

Issue	Consensus	References
Climate Change	Most of the warming of the Earth's average global temperature over the second half of the 20th century has been caused by human activities.	(*5*, *38*)
Genetically Modified Foods	Consuming foods with ingredients derived from genetically modified crops is no riskier than consuming foods modified by conventional plant improvement techniques.	(*39*, *40*)
Nuclear Power	Nuclear power is necessary and should be expanded in order to mitigate climate change.	(*1*, *41*)
Vaccination	The benefits of vaccinations outweigh the risks, and vaccination has zero link to autism.	(*1*, *42*, *43*)
Homeopathic Medicine	There is no reliable evidence that homeopathic medicine is an effective treatment for any health condition.	(*44*, *45*)
The Big Bang	The universe began approximately 14 billion years ago in a hot and dense state, and has expanded and cooled since then.	(*46*)
Evolution	Humans and other living things have evolved over time.	(*47*, *48*)
COVID-19	Measures such as social distancing and wearing a mask successfully reduce the spread of COVID-19.	(*49*, *50*)

In order to measure participants' general and issue-specific objective knowledge, we developed a scale of 34 true-false science questions, containing subscales for each of the seven scientific issues. This allowed us to test the generalizability of the effects both within and across issues. While previous studies have assessed differences in science knowledge between those who oppose versus accept the consensus, we focus on the *degree* of anti-consensus opposition. These studies, therefore, are restricted to participants who do not report complete agreement with the scientific consensus.

Studies 1 and 2 measured the same variables and showed similar results, so we aggregated and analyzed data from the two studies together (see Supplementary Materials for additional analyses). The main regression models separately tested the zero-order association of opposition to the consensus with the following measures:

- Objective knowledge (the full set of 34 items)
- Objective knowledge (each issue's five-item subscale)
- Subjective knowledge
- A within-subject knowledge difference score constructed by subtracting each participant's z-scored subjective knowledge score from their z-scored objective knowledge score

Figure 1 shows the main pattern of results: as opposition to the scientific consensus increases, objective knowledge decreases but subjective knowledge increases (see Table 2 for corresponding regressions). As a result, more opposition is also associated with larger (negative) magnitudes of the knowledge difference score (a proxy for knowledge overconfidence), constructed with either the general or issue-specific objective knowledge measures. These results demonstrate that the most extreme opponents believe their knowledge ranks among the highest, but it is actually among the lowest.

Figure 1: Overall across-issue model predictions of relationships between opposition and objective knowledge, subjective knowledge, and the knowledge difference score, with 95% confidence interval bands. Higher levels of opposition to a scientific consensus are associated with lower levels of actual scientific knowledge, higher self-assessments of knowledge, and more knowledge overconfidence (operationalized here as the increasing negative magnitude of each respondent's knowledge difference score).

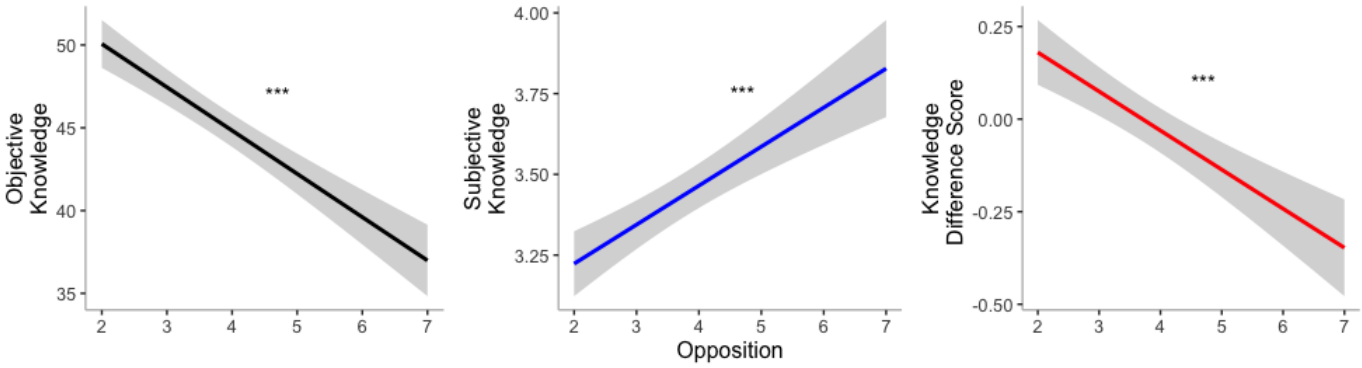


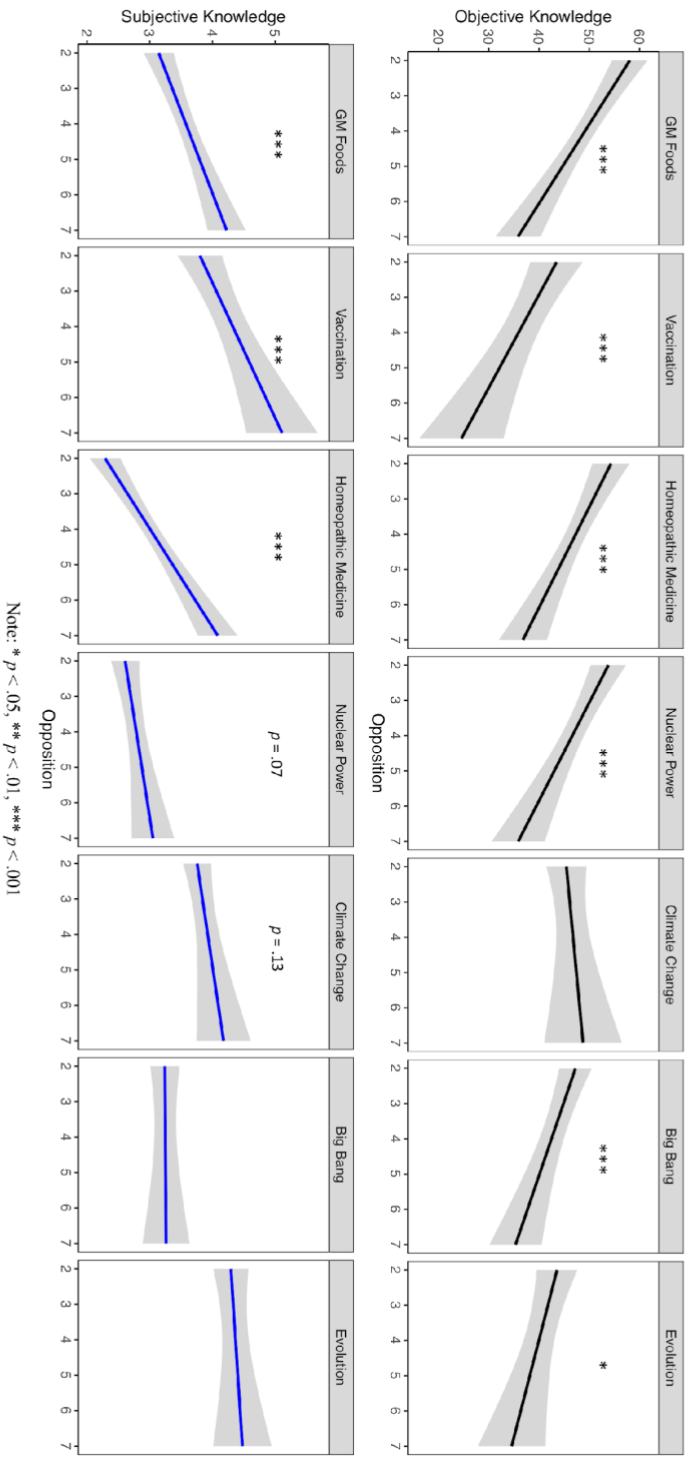
Table 2: Overall across-issue model output. The coefficients and degrees of freedom reported here represent zero-order relationships between opposition to scientific consensus and the five (knowledge) dependent variables in linear mixed models pooling data across all scientific issues in Studies 1 and 2.

	Dependent Variables				
	Objective Knowledge (full set)	Objective Knowledge (subscales)	Subjective Knowledge	Difference Score (using full set of objective knowledge questions)	Difference Score (using objective knowledge subscales)
	(1)	(2)	(3)	(4)	(5)
Opposition	-2.84***	-0.53***	0.15***	-0.11***	-0.09***
dfs	2130.6	2126.8	2126.8	1862.1	1996.2

Notes: $^{***}p < .001$; degrees of freedom estimated with Satterthwaite's method

Next, because across-issue models could potentially obscure differences in associations at the issue level, we tested the same relationships for each issue separately. Regression predictions by issue are shown in Figure 2. The figure shows results using the overall objective knowledge scale, but results are similar for the issue-specific subscales (see Supplementary Materials). The relation between opposition and objective knowledge is negative and significant for all issues except climate change ($\beta_{opposition} = .66$, $t(240) = .67$, $p = .50$). The relation between opposition and subjective knowledge is positive for all issues, but is not statistically significant for climate change, Big Bang, or Evolution ($p = .13$, .94 and .55, respectively). The knowledge difference score analysis replicated the across-issue results (more opposition associated with larger differences) for all issues except climate change.

Figure 2: The relationship between opposition and subjective and objective knowledge for each of the seven scientific issues, with 95% confidence bands. In general, opposition is positively associated with subjective knowledge and negatively associated with objective knowledge, but not for all issues.



Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Because we were interested in the degree to which the polarization of an issue could alter these relationships, we then calculated political polarization and religiosity scores for each of the seven scientific issues (see Methods). For more politically polarized issues, the relation between opposition and objective knowledge is less negative than for less polarized issues ($\beta_{interaction}$ = 6.26, $t(2128.2) = 3.65$, $p < .001$), and the relation between opposition and subjective knowledge is less positive ($\beta_{interaction}$ = -.48, $t(2125.5) = -4.25$, $p < .001$). Higher levels of issue religiosity, however, attenuated only the relation between opposition and subjective knowledge ($\beta_{interaction}$ = -.61, $t(2124.8) = -4.48$, $p < .001$). These findings should be interpreted with caution because scientific issue and polarization scores are perfectly correlated, and the possibility exists that other unmeasured factors represent the true causes of differences between issues. Overall, the positive association between opposition to the scientific consensus and knowledge overconfidence generally holds. However, these relations appear to be weaker for more polarized issues, particularly climate change.

Study 3: Incentivizing Genuine Assessments of Knowledge

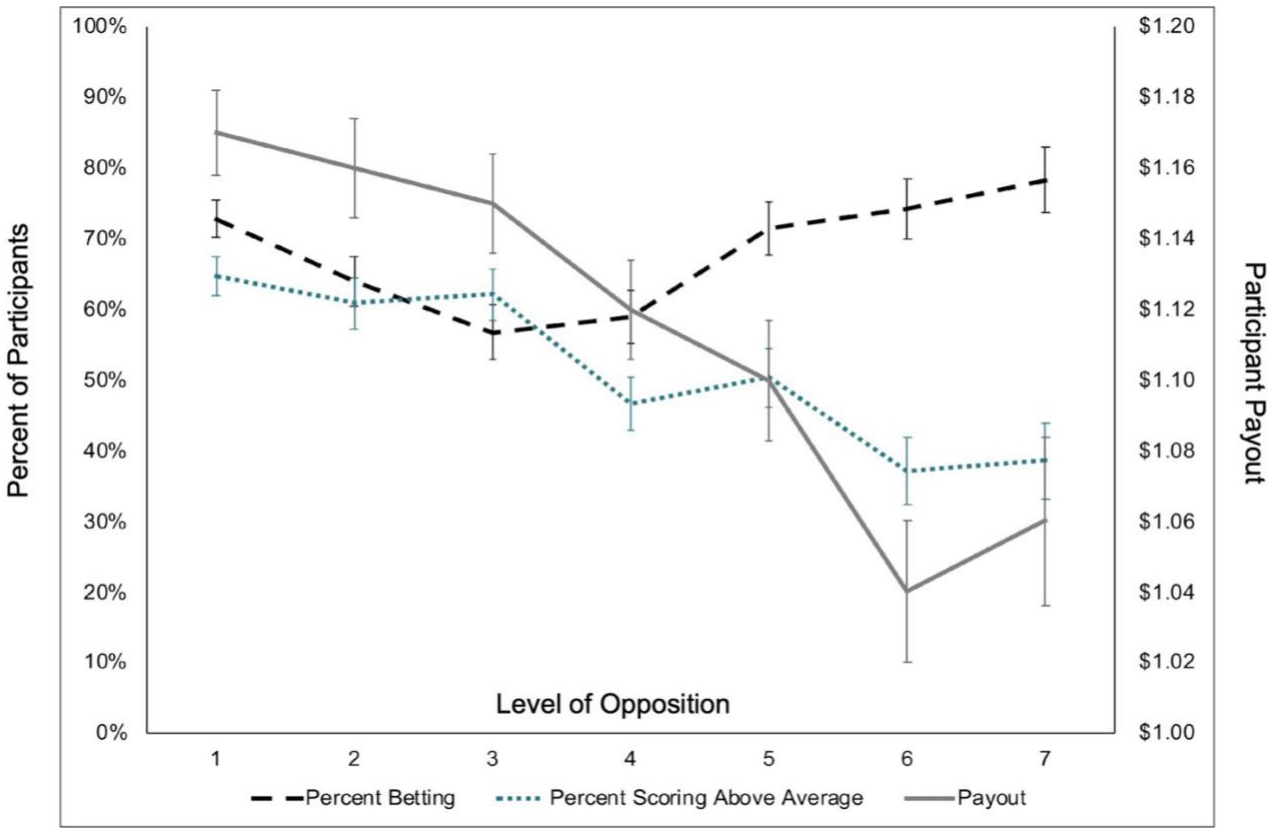
A limitation of Studies 1 and 2 is that participants with different levels of opposition to the consensus may interpret the measure of subjective knowledge differently. For instance, opponents may claim they understand an issue but acknowledge that their understanding does not reflect the same facts as the scientific community. This could explain the disconnect between their subjective knowledge rating and their ability to answer questions based on accepted scientific facts. The goal of Study 3 was thus to remove ambiguity in how the subjective knowledge measure could be interpreted across participants. To accomplish this, we designed a measure of knowledge confidence that incentivized participants to report their genuine beliefs.

Participants were given the opportunity to earn a bonus payment by betting on their ability to score above average on the objective knowledge questions associated with their assigned scientific issue, or take a smaller guaranteed payout. In this paradigm, betting indicates greater knowledge confidence (*51*). We predicted that those with greater opposition to the consensus would earn less due to knowledge overconfidence and that the other effects documented in Studies 1 and 2 would be replicated. Another feature of Study 3 was that participants fully in line with the consensus were not filtered out of the survey, and we analyzed the data both with and without them included in the dataset.

Figure 3 shows the key results. As opposition to the consensus increased, participants were more likely to bet but less likely to score above average on the objective knowledge questions, confirming our predictions. As a consequence, more extreme opponents earned less. Regression analysis revealed that there was a $.03 reduction in overall pay with each one-unit increase in opposition ($t(1169) = -8.47$, $p < .001$). We also replicated the effect that more opposition to the consensus is associated with higher subjective knowledge ($\beta_{opposition} = 1.81$, $t(1171) = 7.18$, $p < .001$) and lower objective knowledge (both overall science literacy and the subscales; overall science literacy model $\beta_{opposition} = -1.36$, $t(1111.6) = -16.28$, $p < .001$; subscales model $\beta_{opposition} = -.19$, $t(1171) = -10.38$, $p < .001$). Finally, participants who chose to bet were significantly more opposed than non-betters ($\beta_{bet} = .24$, $t(1168.7) = 2.09$, $p = .04$), and betting was significantly correlated with subjective knowledge ($r = .28$, $p < .001$), as we would expect if they are related measures. All effects were also significant when excluding people fully in line with the consensus (see Supplementary Materials for analysis). Excluding them weakens the association of opposition with objective knowledge as those fully in line with the consensus scored highly on the objective knowledge questions. However, doing so strengthens the association of opposition with subjective knowledge, as the subjective knowledge distribution is

j-shaped (see Supplementary Materials for visualizations). Like more extreme opponents, those fully in line with the scientific consensus rated subjective knowledge higher than moderate opposers (but lower than extreme opponents). However, whereas the confidence of those in agreement with the established science is substantiated by their actual knowledge, the confidence of extremists appears to be misplaced.

Figure 3: Percentages of participants who bet on their knowledge, scored above average on objective knowledge, and their payout, as a function of opposition, with standard error bars. Higher levels of opposition to the scientific consensus were associated with more betting, lower likelihoods of scoring above average on objective knowledge, and earning less in the incentivized task.



Study 4: Attitudes toward a potential COVID-19 vaccine

The COVID-19 pandemic has caused widespread economic damage, sickness and death (*52*, *53*). Survey responses in the U.S. have consistently revealed a stubborn minority of the population opposed to getting a vaccine against novel coronavirus infection (*36*, *54*). In Study 4, which was conducted in the summer of 2020 (before COVID-19 vaccines were available and before the emergence of more contagious variants), we examine whether the relationships between anti-consensus attitudes and knowledge generalize to U.S. participants' views on receiving a COVID-19 vaccine. Participants in Study 4 answered a battery of general science and issue-specific true-false questions (objective knowledge), and reported their willingness to receive a potential COVID-19 vaccination (opposition) and their self-assessed knowledge of how a COVID-19 vaccine would work (subjective knowledge).

Study 4's findings replicated the main pattern of results from Studies 1-3. As opposition to getting a COVID-19 vaccine increases, both general and COVID-specific objective knowledge decreases, and subjective knowledge of how a COVID-19 vaccine would work increases, (general objective knowledge model $\beta_{opposition}$ = -.96, $t(314)$ = -2.30, p = .02; virus subscale model $\beta_{opposition}$ = -.36, $t(314)$ = -2.53, p = .01; subjective knowledge model $\beta_{opposition}$ = .13, $t(314)$ = 2.90, p = .004). As a result, more opposition to the vaccine is associated with larger (negative) magnitudes of the knowledge difference score (general difference score model $\beta_{opposition}$ = -.15, $t(314)$ = -3.77; p = .02; virus-specific difference score model $\beta_{opposition}$ = -.15, $t(314)$ = -3.88, p = < .001). Lower willingness to receive a potential COVID-19 vaccine was associated with lower objective knowledge about science and COVID-19, but higher levels of subjective knowledge about how the vaccine would work.

Study 5: Attitudes toward COVID-19 mitigation policies and preventive behaviors

In Study 5 we examine support for COVID-19 mitigation policies and self-reported compliance with preventive behaviors recommended by health experts. Data reported here are part of a larger survey on attitudes, behaviors, and information sources about COVID-19, conducted in the fall of 2020 by three researchers who were then independent of those working on Studies 1, 2 and 4.

Study 5 included two different sets of measures of participants' opposition to the consensus: one measuring how opposed they were to COVID-mitigating policies, and one measuring their reported noncompliance with COVID-preventing behaviors. Consistent with the previous studies, as opposition to policies consistent with the scientific consensus increases, objective knowledge decreases ($\beta_{opposition}$ = -.55, $t(692)$ = -17.56, $p < .001$), and subjective knowledge increases ($\beta_{opposition}$ = .14, $t(692)$ = 3.62, $p < .001$). Opposition was also associated with the knowledge difference score ($\beta_{opposition}$ = -.51, $t(692)$ = -15.74, $p < .001$). An identical pattern emerged for noncompliance with preventive behaviors (objective knowledge $\beta_{noncompliance}$ = -.45, $t(692)$ = -13.12, $p < .001$; subjective knowledge $\beta_{noncompliance}$ = .11, $t(692)$ = 2.8, p = .005; knowledge difference score $\beta_{noncompliance}$ = -.41, $t(692)$ = -11.79, $p < .001$).

Study 5 also included a new variable; how much participants think scientists know about COVID-19. To validate the main finding, we split the sample into those who rated their own knowledge higher than scientists' knowledge (28% of the sample) and those who did not. This dichotomous variable was also highly predictive of responses: those who rated their own knowledge higher than scientists' were more opposed to virus mitigation policies (M = 3.66 versus M = 2.66, $t(692)$ = -12, $p < .001$, d = 1.01) and more noncompliant with recommended COVID-mitigating behaviors (M = 3.05 versus M = 2.39, $t(692)$ = -9.08, $p < .001$, d = .72), while scoring lower on the objective knowledge measure (M = .57 versus M = .67, $t(692)$ = 7.74, $p <$

.001, d = .65). For robustness, we replicated these patterns in identical models controlling for political identity, and in models using a subset scale of the objective knowledge questions that conservatives were not more likely to answer incorrectly. All effects remained significant. Together, these results speak against the possibility that the relation between policy attitudes and objective knowledge on COVID is completely explained by political ideology (see Supplementary Materials for all political analyses).

DISCUSSION

Results from five studies show that the people who disagree most with the scientific consensus know less about the relevant issues, but they think they know more. These results suggest that this phenomenon is fairly general, though the relationships were weaker for some more polarized issues, particularly climate change. It is important to note that we document larger mismatches between subjective and objective knowledge among participants who are more opposed to the scientific consensus. Thus, although broadly consistent with the Dunning-Kruger effect and other research on knowledge miscalibration, our findings represent a pattern of relationships that goes beyond overconfidence among the least knowledgeable. However, the data are correlational, and the normal caveats apply.

A strength of these studies is the consistency of the main result across the overall models in Studies 1-3 and specific (but different) instantiations of anti-consensus attitudes about COVID-19 in Studies 4 and 5. Additional strengths are that Study 5 is a conceptual replication of Study 4 (and Studies 1-3 more generally) using different measures and operationalizations of the main constructs, conducted by an initially independent group of researchers (with each group unaware of the research of the other during study development and data collection). The final

two studies were also collected approximately two months apart, in July and September of 2020, respectively. These two collection periods reflect the dynamic nature of the COVID-19 pandemic in the United States, with cases in July trending upward and cases in September flat or trending downward. The consistency of our effects across these two months suggests that the pattern of results is fairly robust.

One possible interpretation of these relationships is that the people who appear to be overconfident in their knowledge and extreme in their opposition to the consensus are actually reporting their sense of understanding for a set of incorrect "alternative facts," not those of the scientific community. After all, non-scientific explanations and theories tend to be much simpler and less mechanistic than scientific ones. As a result, participants could be reporting higher levels of understanding for what are in fact simpler interpretations. However, we believe several elements of this research speak against this interpretation fully explaining the results. First, the battery of objective knowledge questions are sufficiently broad, simple, and removed (at first glance) from the corresponding scientific issues. For example, not knowing that "the skin is the largest organ in the human body" does not suggest that participants hold alternative views about how the human body works; it suggests lack of real knowledge about the body. We also believe that it does not cue participants to the fact that the question is related to vaccination. More important, participants tested using the betting paradigm of Study 3 who indicated high subjective knowledge were explicitly indicating that they think they know what scientists know. Their subjective knowledge was assessed in terms of "the agreed-upon knowledge of…scientists." Thus, the pattern of relationships does not appear to be driven completely by participants' perceived knowledge of incorrect "alternative facts," though this may be part of the story.

Of course, this research also has limitations. The data analyzed here cannot directly speak to why some more polarized issues show weaker associations between different knowledge types and attitudes. The relation between opposition and objective knowledge may cancel out at the high end of the distribution (*21*, *55*), but the case for subjective knowledge is less clear, and there are many potential factors. It is possible, for example, that higher levels of media attention, or even how easy or difficult it is to imagine the harms associated with each scientific issue, could shift how (or whether) people make assessments of their own knowledge. More research is needed before strong conclusions can be drawn on this point.

It is also important to point out that consensus views can emerge around matters of fact (e.g., "the Earth is warming") and around policies that are not purely about facts, but rather require cost-benefit analysis informed by facts (e.g., "vaccine benefits outweigh risks"). In this research we consider both but acknowledge the distinction. We similarly recognize that, of the seven scientific issues in the manuscript (excluding COVID-19), nuclear power has the weakest consensus among scientists. While the consensuses surrounding most of the other issues relate more directly to scientific facts, that of nuclear power (and to some extent vaccination) is more of a cost-benefit analysis. The majority of AAAS scientists (65%) believe that more nuclear power plants should be built, and the Intergovernmental Panel on Climate Change (IPCC) announced that a sharp increase in nuclear energy production is needed to curb global warming and meet the climate goals outlined in the 2015 Paris Agreement. Finally, it should be noted that the samples surveyed in this research tended to be slightly more scientifically literate than the average U.S. respondent. In order to rule out the possibility that the main pattern of relationships was not driven solely by respondents' education levels, we re-analyzed the data controlling for several demographic variables including education. Doing so did not meaningfully change any of the reported relationships (see Supplementary Materials for analyses).

The findings from these five studies have several important implications for science communicators and policymakers. Given that the most extreme opponents of the scientific consensus tend to be those who are most overconfident in their knowledge, fact-based educational interventions are less likely to be effective for this audience. For instance, The Ad Council conducted one of the largest public education campaigns in history in an effort to convince people to get the COVID-19 vaccine (*56*). If individuals who hold strong anti-vaccine beliefs already think they know all there is to know about vaccination and COVID-19, then the campaign is unlikely to persuade them.

Instead of interventions focused on objective knowledge alone, these findings suggest that focusing on changing individuals' perceptions of their own knowledge may be a helpful first step. The challenge then becomes finding appropriate ways to convince anti-consensus individuals that they aren't as knowledgeable as they think they are. One option may be to encourage people to try to explain the mechanisms underlying the complex scientific phenomena at issue. This has been shown to reduce subjective knowledge (*33*, *57*) and increase deference to experts (*58*). Another way to potentially make feelings of ignorance more salient to people is to give them reference points. People feel uncertain about choices they understand less well when considering options together, but not when evaluating them separately (*51*).This finding suggests that people may be led to realize that they know less about vaccination, for example, than about mechanisms they are more familiar with (from their careers or hobbies say), if presented in parallel.

Another strategy for bringing opponents in line with the scientific consensus is to ignore individual knowledge, and focus instead on experts or perceived experts, gaining the allyship of agents of change. A survey on transmission of the coronavirus has found that the major reason people report wearing masks in Japan is not to mitigate risk nor be altruistic but to conform to a

social norm (*59*), and studies in the U.S. have found that perceptions of the extent to which one's social circle engages in preventive behaviors are strongly related to one's own behaviors (*60*, *61*). People tend to do what they think their community expects them to do (*62*). If policymakers and science communicators can convince influential thought leaders from political, religious, or cultural groups with whom people holding anti-consensus beliefs identify, these thought leaders may be able to alter their followers' views. As these novel ideas are adopted by the community, they can create a momentum that would prompt change in the long run (*63*). At a minimum, these agents of change can be brought to the decision-making table, giving them some ownership of outcomes or discouraging them from actively working against consensus goals.

Conforming to the consensus is not always recommended. Plato and Galileo both refused to conform and this helped them to drive society to higher levels of philosophical and scientific understanding, respectively. But if opposition to the consensus is driven by an illusion of understanding, and if that opposition leads to actions that are dangerous to those who do not share in the illusion, it is incumbent on society to try to change minds in favor of the scientific consensus.

MATERIALS AND METHODS

Study 1 and 2 Methods

Methods, predictions, and analysis plans for Studies 1 and 2 were pre-registered on *AsPredicted.org* prior to data collection. The two studies were nearly identical, but with two differences. First, Study 1 participants were recruited from Amazon Mechanical Turk via CloudResearch, whereas Study 2 participants were recruited from Prolific Academic. Second,

the Study 1 sample was a convenience sample of U.S.-based participants, whereas Study 2's was a U.S. nationally representative sample based on age, gender, and ethnicity. What follows in this section describes both studies.

Participants (N = 1,754 in Study 1; N = 1,495 in Study 2) were randomly assigned to one of seven scientific issue conditions: climate change, genetically modified foods, nuclear power, vaccination, evolution, the big bang, and homeopathic medicine. They then answered a one-item attitude measure of opposition to the scientific consensus for their assigned issue ("opposition"; adapted from Fernbach et al. 2019; see Supplementary Materials for wording). Any participants who indicated complete agreement with the scientific consensus were funneled into an unrelated study after answering demographic questions and did not complete this one. This left final sample sizes of 1,137 for Study 1 and 996 for Study 2.

Immediately after answering the opposition question, all Study 2 participants were asked, "What is your political ideology?" (7-point scale, "Very liberal" to "Very conservative") and "How important is religion in your life?" (5-point scale, "Not important at all" to "Very important"). These measures were recorded in order to construct religiosity and political polarization scores for each issue, which we discuss in our analysis of the combined data from studies 1 and 2. Participants were then asked how well they understood their assigned issue, using a 1-7 measure ("subjective knowledge") adapted from Fernbach et al. (2019) and based on one developed by Rozenblit & Keil (2002). They then answered 34 randomly-ordered true-false science questions that we compiled from the National Science Foundation's Science and Engineering Indicators survey, AAAS Benchmarks for Science, and recent work on public understanding of science, or developed by us based on information found on governmental websites such as NASA, the EPA, and the NIH (see Supplementary Materials for all items and sources). For each of these 34 questions, participants recorded their answers on a seven-point

scale ranging from “Definitely true” to “Definitely false.” Responses were coded from -3 to 3 reflecting degree of correctness and summed for each participant (“objective knowledge”). For robustness, we created binarized versions of both this general objective knowledge scale and each subscale by treating scores of 1 to 3 as correct and scores of 0 to -3 as incorrect (see Supplementary Materials for results using these binarized measures). We also divided this measure into issue-specific objective knowledge subscales of five questions each (one medical/biological subscale used for both vaccination and homeopathic medicine, all other issues had their own unique subscales). Finally, participants provided demographic information (age, income, gender, education). They were paid, debriefed, and exited the survey.

Using U.S. nationally representative data from Study 2, we calculated the correlation of opposition with both political ideology (with higher values indicating more conservatism) and religiosity within each scientific issue condition. We then took the absolute value of these correlations as the issue-specific political polarization and religiosity scores to use in our pre-registered polarization interaction models. Thus, higher numbers indicate more polarization of an issue, regardless of whether conservative/liberal or religious/non-religious participants are more likely to oppose the consensus. To test whether political polarization and religiosity scores moderate the reported relationships, we ran regression models separately predicting our two main dependent variables: either objective or subjective knowledge, predicted by opposition, issue-specific political polarization scores, and a political-polarization-by-opposition interaction term. We then ran the same two interaction models again, this time swapping out political polarization for issue-specific religiosity scores.

Study 3 Methods

Participants were 1173 residents of the U.S. recruited through Amazon Mechanical Turk. Base pay was $0.85 with an opportunity to earn up to an additional $0.50 bonus. The procedure was the same as Studies 1 and 2 with four changes. First, we restricted the study to four issues: GM Foods, Vaccination, Nuclear Power and Homeopathic medicine. Second, after answering the subjective knowledge question, participants were given the opportunity to bet on their ability to score above average on the scientific literacy questions associated with their assigned issue, and they were told that the questions were designed using "factual information from top scientists" at well-known scientific organizations (see Supplementary Materials for instructions). If they chose to bet *and* scored higher than the mean on their issue-specific knowledge subscale, they received a $.50 bonus. If they chose not to bet, they received an automatic $.25 bonus. Third, rather than a 7-point scale to measure objective knowledge, we used a trinary scale (true, false, I don't know) and coded wrong and I don't know answers as incorrect, as is customary in science literacy research. Fourth, we did not filter out participants fully in line with the consensus, and we analyzed the data both with and without them included in the dataset.

Study 4 Methods

We recruited a U.S. nationally representative sample of 501 online participants from Prolific Academic (final N = 316 after 7 attention check failures and 178 exclusions based on complete agreement with the scientific consensus) in July, 2020. Participants first answered a COVID-19 vaccination willingness question, which read, "COVID-19 is an illness caused by a coronavirus called SARS-CoV-2 that can spread from person to person. If a COVID-19 vaccine were available to you today, would you get the vaccine?" (7-point scale, "Definitely get the vaccine" to "Definitely not get the vaccine"). After this attitude question, participants answered

the subjective knowledge question, which was worded, “using the scale you just learned about, how would you rate your understanding of how a COVID-19 vaccine would work? (7-point scale, “Vague understanding” to “Thorough understanding”). The study asked how a vaccine would work (as opposed to how it does work), because at the time of the study no vaccine was publicly available in the United States. Participants then answered 23 true-false science literacy questions, including six COVID-specific items in place of the subscale items from Studies 1-3 (i.e., “True or False? COVID-19 is a variant of the Flu.”). The remaining 17 were identical to those from the previous studies. We developed the six COVID-specific items based on facts from official U.S. and international COVID-19 informational websites (see Supplementary Materials), and participants indicated their answers on a 7-point “Definitely true” to “Definitely false” scale. As with the objective knowledge variables in Studies 1 and 2, participants were given scores of -3 to 3 for each true-false item based on degree of correctness, with scores across all items summed within each participant. Finally, participants answered demographic questions before completing the survey and receiving payment.

Study 5 Methods

A strategic sample was recruited by distributing the survey link through paid Facebook and Instagram ads, and by making the survey available to a student research pool at a U.S. research university. The social media ads reached 13,077 users, proportionally distributed across the United States according to population density, and targeted adults 18-65+. The student research pool consisted of students 18-35 years old, who received course credit for their participation. Data collection generated a sample of 695 participants, 452 from social media and

243 from the student subject pool. First, participants answered questions about their exposure to COVID-19, as well as knowledge of deaths among family, friends, communities, and workplaces. Those who had not been diagnosed with COVID-19 were then asked about their perceived risk of contracting it, and answered a battery of questions about their perceived knowledge of COVID-19 and preventive measures. They were then asked to complete two instruments, one assessing their COVID-19 knowledge and one assessing their knowledge about its transmission. Following the knowledge questions, participants were asked about their support for mitigation policy measures and trust in politicians and scientists. The next section recorded their own practices related to COVID-19 prevention, and motivational factors driving these practices. Frequency of consumption of— and trust in—sources of information about COVID-19 were addressed in the next section, followed by a section addressing fear, worries, and coping. The survey finished by asking participants a series of demographic questions.

We collapsed across thirteen policy support questions (α = .92) and six preventive behavior ones (α = .85) to generate separate measures of opposition to COVID-19 mitigation policies and noncompliance with preventive behaviors, respectively. Policy support questions addressed both major policy decisions that had already been taken during the pandemic, such as "Closing K-12 schools and universities" or "Imposing severe restrictions to people coming to the U.S. from overseas," as well as proposed policy measures to be implemented if the number of cases in the U.S. were to increase, such as "State-wide mandate requiring people entering from other states with higher infection rates to quarantine for 10 days," or "State-wide mandate requiring people to wear masks all the time when in public." All policy support items were generated from topics that have received extensive media coverage, and were measured on a 5-point scale ("Strongly against" to "Strongly support"). Preventive behavior items were adapted from a previous study on mitigation behaviors (*55*), and were consistent with the most current

recommendations by the WHO and the CDC. A 5-point scale ("Almost all the time", "Fairly often", "Sometimes", "Not very often", "Almost never") was used to estimate compliance with preventive behaviors. Subjective knowledge was measured with one question, "How would you rate your knowledge about COVID-19?" on a sliding scale from 1 = *Very poor knowledge* to 10 = *Very good knowledge*, with the midpoint labeled *Average knowledge*. Perceptions of scientists' knowledge was measured with one question, "How would you rate (in general) scientists' knowledge about COVID-19?" using the same scale as above. The objective knowledge measure was created by collapsing across twenty-six COVID-19 knowledge questions adapted from Rothmund et al. (2020) or created by the authors based on the current consensus on transmission mechanisms (see Supplementary Materials).

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ACKNOWLEDGEMENTS

Author Contributions

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Methodology: NL, PMF, NR, MVG, SS
Data Analysis:: NL, NR, MVG
Visualizations: NL
Writing—original draft: NL, PMF, NR
Writing—review & editing: NL, PMF, NR, MVG, SS

Funding
Studies 1-4 were funded in part by a grant from Humility & Conviction in Public Life, a project of the University Connecticut sponsored by the John Templeton Foundation. Data collection for Study 5 was funded in part by the Center for Excellence in Health Communication to Underserved Populations (CEHCUP) from the University of Kansas School of Journalism and Mass Communications.

Competing Interests
The authors declare no competing interests.

Data Availability
On publication or request prior to publication, all datasets, surveys, and corresponding syntax for analysis will be made publicly available via OSF. All measures and summary analyses needed to evaluate the conclusions in the paper are present in the paper and/or Supplementary Materials.

Supplementary Materials

Knowledge overconfidence is associated with anti-consensus views on controversial scientific issues

STUDY 1 SURVEY QUESTIONS

Opposition Questions

GM Food
Genetically modified foods are foods created through the manipulation of a plant's or animal's genetic structure using biotechnology. This is done to create foods with certain attributes such as faster growth, resistance to pathogens, or enhanced nutritional value.

Please indicate your level of opposition to genetically modified foods.
(1-7, anchored by "Not opposed at all = 1" and "Extremely opposed = 7")

Climate Change
Climate change is a term used to describe significant variation in either the average state of the climate or its variability, lasting for an extended period of time.

Please indicate your level of belief in human-caused climate change.
(1-7, anchored by "Completely do not believe = 1" and "Completely believe = 7")

Evolution
Evolution is the scientific theory that describes changes in inherited traits of populations though successive generations.

Please indicate your level of belief in Evolution.
(1-7, anchored by "Completely do not believe = 1" and "Completely believe = 7")

Big Bang
The Big Bang Theory is a scientific theory that a massive blast approximately 13.8 billion years ago caused the universe to expand from its pebble-size origin to astronomical scope.

Please indicate your level of belief in the Big Bang Theory.
(1-7, anchored by "Completely do not believe = 1" and "Completely believe = 7")

Vaccination
Vaccination is the act of introducing a vaccine into the body to produce immunity to a specific disease.

Please indicate your level of opposition to vaccination.
(1-7, anchored by "Not opposed at all = 1" and "Extremely opposed = 7")

Homeopathic Medicine
Homeopathic medicine, of "homeopathy," is a medical system based on the idea that a disease can be cured by a substance that produces similar symptoms in healthy people, and the notion that the lower the dose of medication, the greater its effectiveness.

Please indicate your level of belief in the effectiveness of homeopathic medicine.
(1-7, anchored by "Completely do not believe = 1" and "Completely believe = 7")

Nuclear Power
Nuclear power is the use of sustained nuclear reactions to generate heat and electricity.

Please indicate your level of opposition to nuclear power.
(1-7, anchored by "Not opposed at all = 1" and "Extremely opposed = 7")

Subjective Knowledge

Introduction to Subjective Knowledge Question

Next, we will ask you to rate your understanding of [scientific issue] on a seven-point scale. To ensure you understand the scale, this section explains what three (of the seven) levels of understanding mean, using the example of how a crossbow works. Please read each description to get a sense of how to use the scale. As you will see, a 7 implies detailed and deep knowledge, a 1 implies very little knowledge, and a 4 is in the middle.

Level 7 knowledge: A person with level 7 knowledge of crossbows can tell you all about their parts and how they work together. This person could tell you that a crossbow has a stiff, flexible piece of metal as a bow with a wire or strong line; that the bow is permanently mounted on a block of wood or metal; and that the wire is pulled back by something that gives a mechanical advantage—either a lever, a small block and tackle, or a crank wound around a spool that pulls a wire attached to the bow wire. The bow wire is held back by a pin connected to a trigger, and an arrow is set in front of it. The pin is directly connected to the trigger so that when you pull on the trigger, it causes the pin to pivot around a point such that the end moves downwards and releases the bow wire. When the pin releases the string, the bow very quickly un-flexes, rapidly imparting the energy stored in the flexed bow to the arrow.

Level 4 knowledge: A person with level 4 knowledge might know that the crossbow is a fixed bow and arrow arrangement; that it gets more power than a normal bow and arrow because it allows you to pull the string back extra hard and then trap it there, rather than hold it; and that it is then released by a trigger.

Level 1 knowledge: A person with level 1 knowledge might know what a crossbow looks like and what it does (shoots arrows).

Subjective Knowledge Question

Using the scale you just learned about, how would you rate your understanding of [scientific issue]?
(1-7, anchored by "Vague understanding = 1" and "Thorough understanding = 7")

Objective Knowledge Questions

(7-point Likert scale: Definitely false, Probably false, Maybe false, Not sure, Maybe true, Probably true, Definitely true. Indications of correct answers below were included at the end of the survey during debriefing.)

Full Set of 34 Items

1. True or false? The center of the earth is very hot: True
2. True or false? The continents have been moving their location for millions of years and will continue to move. True
3. True or false? The oxygen we breathe comes from plants: True
4. True or false? Antibiotics kills viruses as well as bacteria: False
5. True or false? All insects have eight legs: False
6. True or false? All radioactivity is man made: False
7. True or false? Men and women normally have the same number of chromosomes: True
8. True or false? Lasers work by focusing sound waves: False
9. True or false? Almost all food energy for living organisms comes originally from sunlight: True
10. True or false? Electrons are smaller than atoms: True
11. True or false? All plants and animals have DNA: True
12. True or false? Humans share a majority of their genes with chimpanzees: True
13. True or false? It is the father's genes that decide whether the baby is a boy or a girl: True
14. True or false? Ordinary tomatoes do not have genes, whereas genetically modified tomatoes do: False
15. True or false? Sound moves faster than light. False
16. True or false? The North Pole is a sheet of ice that floats on the Arctic Ocean. True
17. True or false? The ozone layer absorbs most of the sun's UVB radiation, but not UVA radiation. True
18. True or false? Nitrogen makes up most of the earth's atmosphere. True.
19. True or false? Antibodies are proteins produced by the immune system. True
20. True or false? Pathology is the study of the human body. False
21. True or false? The skin is the largest organ of the human body. True
22. True or false? Ligaments connect muscles to bones. False
23. True or false? All mutations to a human's or animal's genes are unhealthy. False

24. True or false? Uranium is an element found in nature. True
25. True or false? Radioactive milk can be made safe by boiling it. False
26. True or false? The process of splitting uranium or plutonium atoms to create energy is called nuclear fission. True
27. True or false? Venus is the closest planet to the sun. False
28. True or false? It takes 24 hours for the earth to orbit the sun: False
29. True or false? A "Red Dwarf" is a kind of planet. False
30. True or false? The universe is expanding. True
31. True or false? Earth is the only place in the solar system where helium can be found. False
32. True or false? Gravity is the theory that serves as the foundation for modern biology. False.
33. True or false? The earliest humans lived at the same time as the dinosaurs. False
34. True or false? "Survival of the fittest" is a phrase used to describe how natural selection works. True

Objective Knowledge Issue-specific Subscales

Climate Change

- Almost all food energy for living organisms comes originally from sunlight.
- The oxygen we breathe comes from plants.
- The North Pole is on a sheet of ice that floats on the Arctic Ocean.
- The ozone layer absorbs most of the sun's UVB radiation, but not UVA radiation.
- Nitrogen makes up most of the Earth's atmosphere.

Vaccination and Homeopathy

- Antibodies are proteins produced by the immune system.
- Pathology is the study of the human body.
- The skin is the largest organ in the human body.
- Ligaments connect human muscles to bones.
- Antibiotics kills viruses as well as bacteria.

GM Foods

- It is the father's genes that decide whether the baby is a boy or a girl.
- Ordinary tomatoes do not have genes, whereas genetically modified tomatoes do.
- All mutations to a human's or animal's genes are unhealthy.
- All plants and animals have DNA.
- Men and women normally have the same number of chromosomes.

Nuclear Power

- All radioactivity is man made.
- Electrons are smaller than atoms.
- Uranium is an element found in nature.
- Radioactive milk can be made safe by boiling it.
- The process of splitting plutonium or uranium atoms to create energy is called nuclear fission.

Big Bang

- Venus is the closest planet to the sun.
- It takes 24 hours for the earth to orbit the sun.
- A “Red Dwarf” is a kind of planet.
- The universe is expanding.
- Earth is the only place in the solar system where helium can be found.

Evolution

- All mutations to a human’s or animal’s genes are unhealthy.
- Humans share a majority of their genes with chimpanzees.
- Gravity is the theory that serves as the foundation for modern biology.
- The earliest human beings lived at the same time as the dinosaurs.
- “Survival of the fittest” is a phrase used to describe how natural selection works.

Demographic Questions

Age: What is your age? Please answer in years, using only numbers.

Gender: What is your gender?

- Male
- Female
- Other / prefer not to answer

Income: What is your individual yearly income level?

- Less than $10,000
- $10,000 - $19,999
- $20,000 - $29,999
- $30,000 - $39,999
- $40,000 - $49,999
- $50,000 - $59,999
- $60,000 - $69,999
- $70,000 - $79,999
- $80,000 - $89,999
- $90,000 - $99,999
- $100,000 - $149,999
- More than $150,000

Political Ideology: What is your political ideology?

- Very liberal
- Mostly liberal
- Somewhat liberal
- Moderate
- Somewhat conservative
- Mostly conservative
- Very conservative

Religiosity: How important is religion in your life?

- Not important at all
- A little important
- Somewhat important
- Important
- Very important

Education: What is the highest level of education you have completed?

- Less than high school degree
- High school degree
- 2-year college degree
- 4-year college degree
- Post-graduate degree

Sources for Objective Knowledge Subscale Items

Many of the objective knowledge items in Studies 1-3 were taken from Fernbach et al. (2019). New items' sources are below.

- The ozone layer absorbs most of the sun's UVB radiation, but not UVA radiation.
  - https://www.epa.gov/sites/production/files/documents/uvradiation.pdf
- Antibodies are proteins produced by the immune system.
  - https://www.genome.gov/genetics-glossary/Antibody
- Pathology is the study of the human body.
  - https://www.rcpath.org/discover-pathology/what-is-pathology.html
- The skin is the largest organ in the human body.
  - https://www.ncbi.nlm.nih.gov/books/NBK470464/
- Ligaments connect human muscles to bones.
  - https://medlineplus.gov/ency/imagepages/19089.htm#:~:text=A%20ligament%20is%20a%20fibrous,together%20and%20keep%20them%20stable.
- All mutations to a human's or animal's genes are unhealthy.
  - https://www.nationalgeographic.co.uk/history-and-civilisation/2017/11/human-evolution-facts
- Uranium is an element found in nature.
  - https://19january2017snapshot.epa.gov/www3/radtown/docs/tribal-uranium-activities.pdf
- The process of splitting plutonium or uranium atoms to create energy is called nuclear fission.
  - https://www.energy.gov/ne/articles/fission-and-fusion-what-difference
- Venus is the closest planet to the sun.
  - https://spaceplace.nasa.gov/all-about-mercury/en/
- It takes 24 hours for the earth to orbit the sun.
  - https://spaceplace.nasa.gov/years-on-other-planets/en/
- A "Red Dwarf" is a kind of planet.

- https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=131744
- The universe is expanding.
  - https://www.nasa.gov/feature/goddard/2016/nasa-s-hubble-finds-universe-is-expanding-faster-than-expected
- Earth is the only place in the solar system where helium can be found.
  - https://solarsystem.nasa.gov/planets/jupiter/in-depth/
- Gravity is the theory that serves as the foundation for modern biology.
  - https://www.nsf.gov/news/special_reports/darwin/
- "Survival of the fittest" is a phrase used to describe how natural selection works.
  - https://www.genome.gov/25520157/online-education-kit-1859-darwin-published-on-the-origin-of-species-proposing-continual-evolution-of-species

STUDY 1 ADDITIONAL ANALYSES

Main Across-Issue Analyses

The effect of opposition on the full set of 34 objective knowledge items variable:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	56.6048	2.4589	15.5052	23.020	2.08e-13	***
opposition	-3.5346	0.4131	1134.0889	-8.557	< 2e-16	***

The effect of opposition on the issue-specific subscale variable:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	7.76140	0.91233	8.15327	8.507	2.49e-05	***
opposition	-0.60650	0.09316	1132.51214	-6.510	1.13e-10	***

The effect of opposition on subjective knowledge:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	3.13	2.760e-01	8.10	11.343	2.98e-06	***
opposition	.15	2.788e-02	1132	5.392	8.47e-08	***

The effect of opposition on the knowledge difference score variable using the full set of 34 objective knowledge items:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	0.47709	0.10977	91.17782	4.346	3.59e-05	***
opposition	-0.11963	0.02545	972.13735	-4.701	2.97e-06	***

The effect of opposition on the knowledge difference score variable using the issue-specific objective knowledge subscales:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	0 .36549	0.11095	116.44476	3.294	0.001307	**
opposition	-0.08958	0.02611	932.40090	-3.430	0.000629	***

Issue-by-Issue Analyses

GM Foods

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-4.37	.92	209	-4.72	< .001
Objective knowledge subscale	-.83	.21	209	-4.02	< .001
Subjective knowledge	.24	.06	209	4.00	< .001
Diff score (with full set)	-.18	.06	209	-2.94	.004
Diff score (with subscale)	-.15	.06	209	-2.53	.01

Climate Change

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-1.01	1.57	123	-.64	.52
Objective knowledge subscale	.03	.28	123	.12	.91
Subjective knowledge	-.09	.09	123	-1.00	.32
Diff score (with full set)	.00	.09	123	.01	.99
Diff score (with subscale)	.11	.10	123	1.04	.30

Vaccination

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-5.40	1.38	76	3.91	< .001

Objective knowledge subscale	-.65	.33	76	-1.98	.05
Subjective knowledge	.36	.09	76	3.90	< .001
Diff score (with full set)	-.24	.08	76	-2.88	.005
Diff score (with subscale)	-.25	.08	76	3.03	.003

Homeopathic Medicine

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-4.53	.99	222	-4.60	< .001
Objective knowledge subscale	-.28	.21	222	-1.33	.18
Subjective knowledge	.36	.07	222	5.41	< .001
Diff score (with full set)	-.31	.06	222	-5.16	< .001
Diff score (with subscale)	-.30	.06	222	-4.69	< .001

Nuclear Power

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-5.22	.10	194	-5.24	< .001
Objective knowledge subscale	-.82	.22	194	-3.78	< .001
Subjective knowledge	.15	.07	194	2.17	.03

Diff score (with full set)	-.10	.07	194	-1.48	.14
Diff score (with subscale)	-.11	.07	194	-1.53	.13

Evolution

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-1.52	1.21	120	-1.27	.21
Objective knowledge subscale	-.88	.27	120	-3.26	.001
Subjective knowledge	.04	.08	120	.48	.63
Diff score (with full set)	-.05	.07	120	-.71	.48
Diff score (with subscale)	.03	.07	120	.36	.72

Big Bang

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-1.89	.98	179	-1.94	.05
Objective knowledge subscale	-.55	.27	179	-2.03	.04
Subjective knowledge	-.08	.07	179	-1.18	.24
Diff score (with full set)	.03	.06	179	.42	.68

Diff score (with subscale)	.06	.06	179	.93	.36

STUDY 2 SURVEY QUESTIONS

(Identical to those in Study 1)

STUDY 2 ADDITIONAL ANALYSES

Main Across-Issue Analyses

The effect of opposition on the full set of 34 objective knowledge items variable:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	53.8366	2.2628	25.1874	23.792	< 2e-16 ***
opposition	-2.0816	0.4494	992.6340	-4.632	4.1e-06 ***

The effect of opposition on the issue-specific subscale variable:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	7.30427	0.85266	8.99901	8.566	1.28e-05 ***
opposition	-0.42558	0.09827	989.37574	-4.331	1.64e-05 ***

The effect of opposition on subjective knowledge:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	2.93183	0.23810	9.57506	12.313	3.47e-07 ***
opposition	0.13698	0.02957	989.57103	4.632	4.10e-06 ***

The effect of opposition on the knowledge difference score variable using the full set of 34 objective knowledge items:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	0.30703	0.11004	994.00000	2.790	0.005369 **
opposition	-0.09582	0.02688	994.00000	-3.564	0.000382 ***

The effect of opposition on the knowledge difference score variable using the issue-specific objective knowledge subscales:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	0.30459	0.11119	994.00000	2.739	0.006267 **
opposition	-0.08967	0.02717	994.00000	-3.301	0.000998 ***

Issue-by-Issue Analyses

GM Foods

Operationalization	**Beta(opposition)**	**Std. Error**	**df**	**t**	**p**

Objective knowledge full set	-4.56	1.01	176	-4.51	< .001
Objective knowledge subscale	-.85	.22	176	-3.79	< .001
Subjective knowledge	.18	.07	176	2.50	.01
Diff score (with full set)	-.04	.06	176	-.62	.53
Diff score (with subscale)	-.07	.06	176	-1.03	.30

Climate Change

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	1.07	1.30	115	.82	.41
Objective knowledge subscale	.14	.24	115	.59	.56
Subjective knowledge	.21	.07	115	3.05	.003
Diff score (with full set)	-.16	.08	115	-2.05	.04
Diff score (with subscale)	-.19	.07	115	-2.48	.01

Vaccination

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-.25	1.92	68	-.13	.90

Objective knowledge subscale	.43	.37	68	1.18	.24
Subjective knowledge	.003	.13	68	.02	.98
Diff score (with full set)	-.19	.11	68	-1.70	.09
Diff score (with subscale)	-.12	.11	68	-1.11	.27

Homeopathic Medicine

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-2.15	1.14	178	-1.89	.06
Objective knowledge subscale	-.46	.23	178	-2.01	.05
Subjective knowledge	.34	.07	178	4.70	< .001
Diff score (with full set)	-.21	.07	178	-3.10	.002
Diff score (with subscale)	-.15	.07	178	-2.16	.03

Nuclear Power

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-1.86	1.13	175	-1.65	.10
Objective knowledge subscale	-.28	.24	175	-1.18	.24
Subjective knowledge	.02	.07	175	.37	.71

Diff score (with full set)	-.03	.07	175	-.38	.71
Diff score (with subscale)	-.02	.07	175	-.24	.81

Evolution

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-2.22	1.34	98	-1.65	.10
Objective knowledge subscale	-.85	.30	98	-2.85	.005
Subjective knowledge	.04	.10	98	.44	.66
Diff score (with full set)	-.04	.09	98	-.41	.68
Diff score (with subscale)	-.04	.09	98	-.50	.62

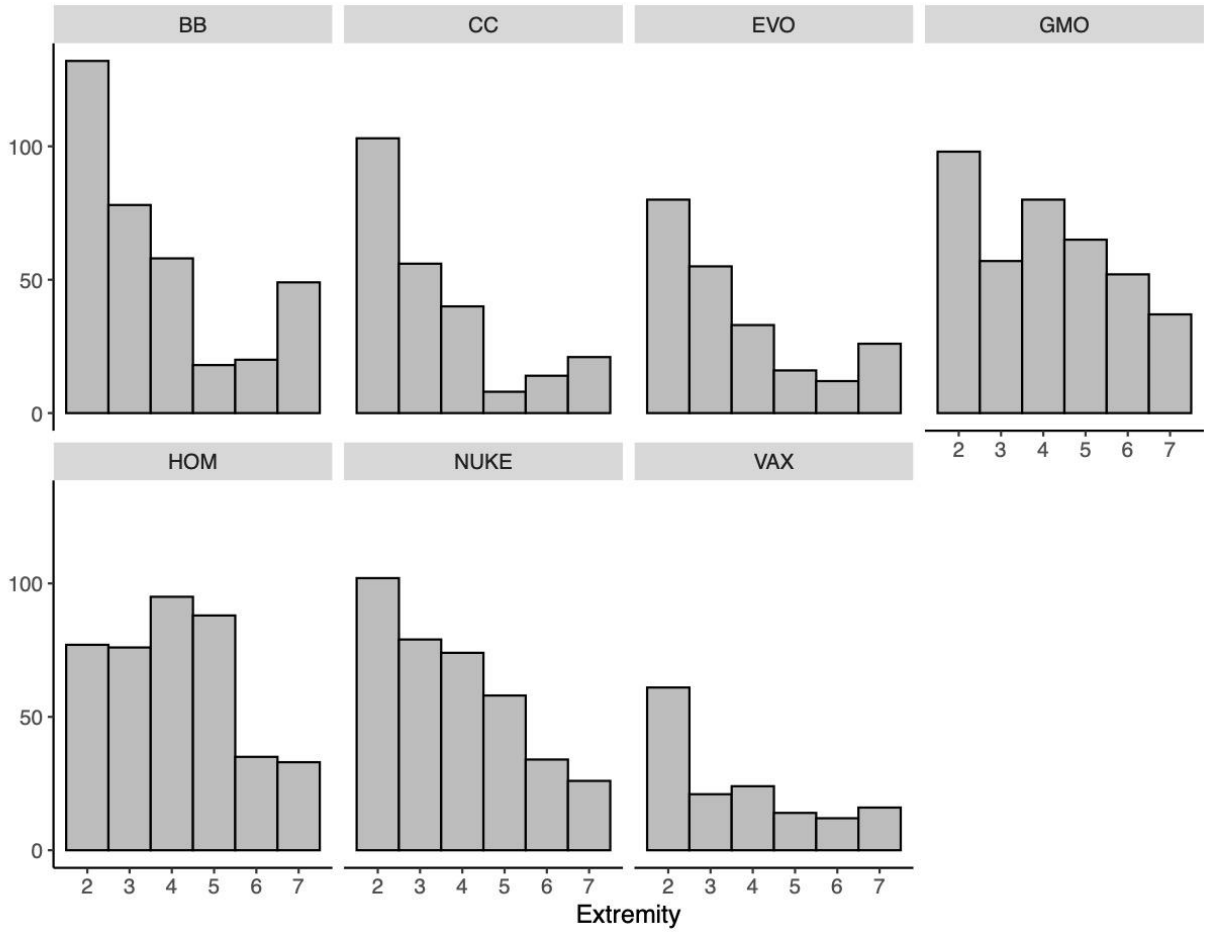
Big Bang

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-2.92	.98	172	-2.97	.003
Objective knowledge subscale	-.59	.26	172	-2.28	.02
Subjective knowledge	.09	.07	172	1.19	.24
Diff score (with full set)	-.09	.06	172	-1.56	.12

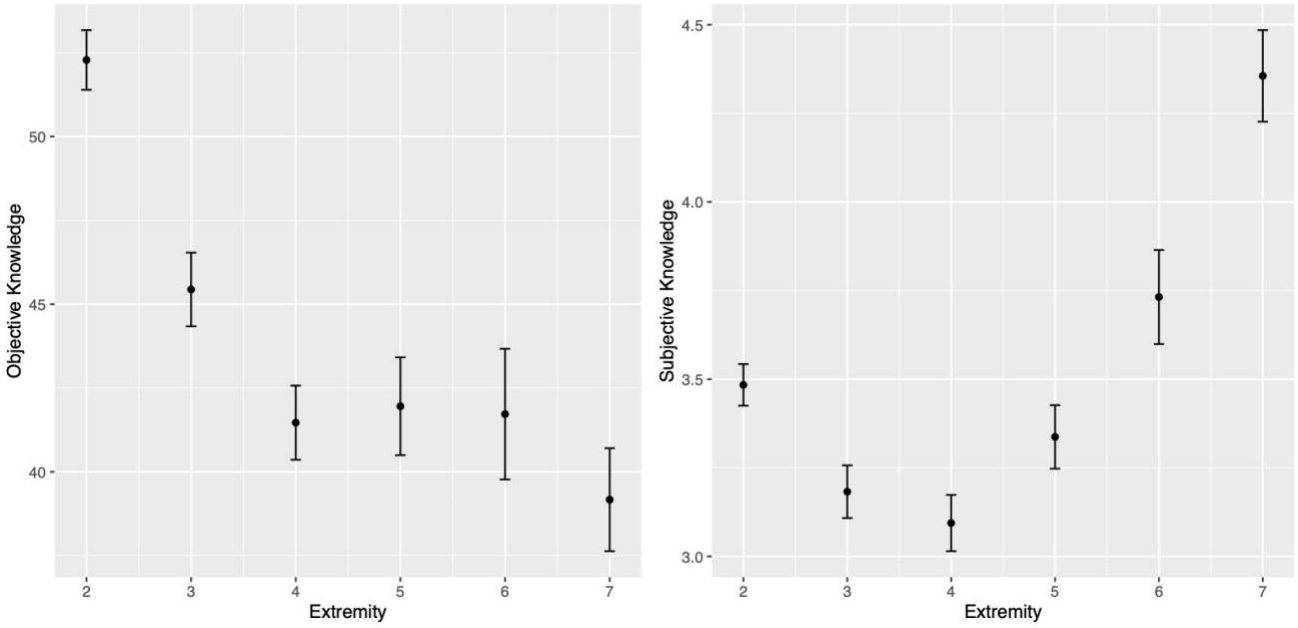
Diff score (with subscale)	-.07	.06	172	-1.31	.19

COMBINED STUDY 1 AND STUDY 2 ADDITIONAL ANALYSES

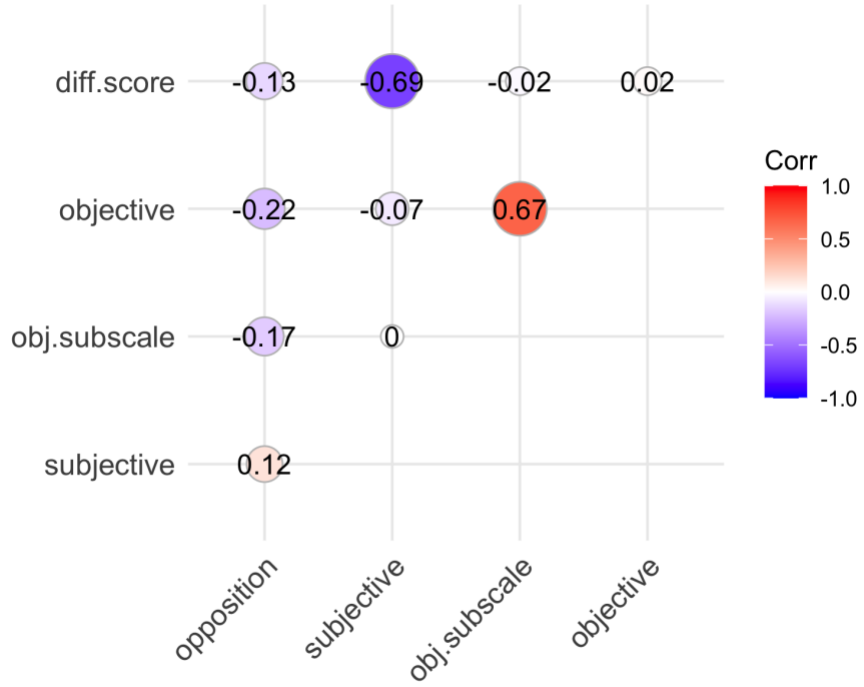
Distributions of Extremity/Opposition by Issue



Subjective and Objective Knowledge Means (with Standard Errors) by Opposition Level



Correlation Table of Main Constructs



Issue-by-Issue Main Analyses

GM Foods

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-4.46	.68	387	-6.55	< .001
Objective knowledge subscale	-.83	.15	387	-5.48	< .001
Subjective knowledge	.22	.05	387	4.72	< .001
Diff score (with full set)	-.12	.04	387	-2.65	.008
Diff score (with subscale)	-.11	.04	387	-2.57	.01

Climate Change

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	.66	.98	240	.67	.50
Objective knowledge subscale	.06	.18	240	.33	.74
Subjective knowledge	.08	.05	240	1.53	.13
Diff score (with full set)	-.09	.06	240	-1.62	.11
Diff score (with subscale)	-.07	.06	240	-1.20	.23

Vaccination

Operationalization	Beta(opposition)	Std. Error	df	t	p

Objective knowledge full set	-3.79	1.11	146	-3.41	< .001
Objective knowledge subscale	-.34	.24	146	-1.42	.16
Subjective knowledge	.26	.08	146	3.47	< .001
Diff score (with full set)	-.20	.07	146	-3.11	.002
Diff score (with subscale)	-.19	.06	146	-2.94	.004

Homeopathic Medicine

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-3.51	.74	402	-4.75	< .001
Objective knowledge subscale	-.37	.15	402	-2.45	< .001
Subjective knowledge	.36	.5	402	7.37	< .001
Diff score (with full set)	-.25	.04	402	-5.66	< .001
Diff score (with subscale)	-.22	.05	402	-4.74	< .001

Nuclear Power

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-3.59	.75	371	-4.76	< .001
Objective knowledge subscale	-.56	.16	371	-3.44	< .001

Subjective knowledge	.09	.05	371	1.83	.07
Diff score (with full set)	-.06	.05	371	-1.31	.19
Diff score (with subscale)	-.06	.05	371	-1.24	.21

Evolution

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-1.81	.89	220	-2.03	.04
Objective knowledge subscale	-.87	.20	220	-4.37	< .001
Subjective knowledge	.04	.06	220	.59	.55
Diff score (with full set)	-.04	.06	220	-.79	.43
Diff score (with subscale)	-.002	.06	220	-.04	.97

Big Bang

Operationalization	Beta(opposition)	Std. Error	df	t	p
Objective knowledge full set	-2.39	.69	353	-3.45	< .001
Objective knowledge subscale	-.57	.19	353	-3.05	.002
Subjective knowledge	.004	.05	353	.07	.94

Diff score (with full set)	-.03	.04	353	-.76	.45
Diff score (with subscale)	-.01	.04	353	-.25	.80

Analyses with Binarized Versions of Objective Knowledge

As reported in the main text, we ran robustness analyses for all models using versions of the objective knowledge variable in which we binarize each objective knowledge question score (1 for correct, 0 for incorrect). Model output using binarized versions of objective knowledge are below.

Across-Issue Binarized Objective Knowledge Analyses (each with random intercepts for issue)

The effect of opposition on the binarized full set of 34 objective knowledge items variable:

```
            Estimate Std. Error          df t value Pr(>|t|)
(Intercept)  25.90592    0.43454  13.11332  59.617   <2e-16 ***
opposition          -0.664790.06842 2130.90896  -9.717   <2e-16 ***
```

The effect of opposition on the binarized issue-specific subscale variable:

```
            Estimate Std. Error          df t value Pr(>|t|)
(Intercept)          0.35981 0.07850  136.26547   4.584 1.02e-05 ***
opposition          -0.093700.01852 1989.60089  -5.059 4.60e-07 ***
```

The effect of opposition on the knowledge difference score variable using the binarized version of the full set of 34 objective knowledge items:

```
                Estimate Std. Error          df t value Pr(>|t|)
(Intercept)          0.39693 0.07607  163.35427   5.218 5.43e-07 ***
opposition          -0.104190.01830 1878.39427  -5.694 1.44e-08 ***
```

The effect of opposition on the knowledge difference score variable using the binarized version of the issue-specific objective knowledge subscales:

```
            Estimate Std. Error          df t value Pr(>|t|)
(Intercept)          0.35981 0.07850  136.26547   4.584 1.02e-05 ***
opposition          -0.093700.01852 1989.60089  -5.059 4.60e-07 ***
```

Issue-by-Issue Binarized Objective Knowledge Analyses

GM Foods

Operationalization	Beta(opposition)	Std. Error	df	t	p

Binarized full set	-1.01	.15	387	-6.56	< .001
Binarized subscale	-.18	.04	387	-5.12	< .001
Binarized full set diff score	-.11	.04	387	-2.62	.009
Binarized subscale diff score	-.11	.04	387	-2.65	.008

Climate Change

Operationalization	Beta(opposition)	Std. Error	df	t	p
Binarized full set	-.06	.22	240	-.26	.80
Binarized subscale	-.03	.05	240	-.73	.47
Binarized full set diff score	-.08	.05	240	-1.58	.12
Binarized subscale diff score	-.08	.06	240	-1.40	.16

Vaccination

Operationalization	Beta(opposition)	Std. Error	df	t	p
Binarized full set	-.89	1.05	146	-3.40	<.001
Binarized subscale	-.06	.06	146	-1.02	.31
Binarized full set diff score	-.19	.07	146	-2.76	.007
Binarized subscale diff score	-.16	.06	146	-2.51	.01

Homeopathic Medicine

Operationalization	Beta(opposition)	Std. Error	df	t	p

Binarized full set	-.74	.72	402	-4.45	<.001
Binarized subscale	-.08	.03	402	-2.26	.02
Binarized full set diff score	-.25	.04	402	-5.61	<.001
Binarized subscale diff score	-.21	.05	402	-4.60	<.001

Nuclear Power

Operationalization	Beta(opposition)	Std. Error	df	t	p
Binarized full set	-.71	.17	371	-4.14	<.001
Binarized subscale	-.11	.04	371	-2.65	.008
Binarized full set diff score	-.05	.05	371	-1.10	.27
Binarized subscale diff score	-.06	.05	371	-1.33	.19

Evolution

Operationalization	Beta(opposition)	Std. Error	df	t	p
Binarized full set	-.46	.21	220	-2.24	.03
Binarized subscale	-.19	.05	220	-4.01	<.001
Binarized full set diff score	-.05	.06	220	-.81	.42
Binarized subscale diff score	-.02	.06	220	-.27	.79

Big Bang

Operationalization	Beta(opposition)	Std. Error	df	t	p

Binarized full set	-.62	.15	353	-4.09	<.001
Binarized subscale	-.13	.04	353	-3.06	.002
Binarized full set diff score	-.05	.04	353	-1.12	.27
Binarized subscale diff score	-.04	.04	353	-.97	.33

Overall Analyses with Political Ideology and Religiosity as Covariates

The following analyses show the main construct relationships, controlling for individual-level political ideology and religiosity. Although more conservatism and higher religiosity are negatively associated with objective knowledge and positively associated with subjective knowledge, including them as covariates in these overall models does not change the pattern of results from those reported in the main text.

Opposition on the full set of objective knowledge items, controlling for political ideology (higher numbers = more conservatism), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	60.3368	2.1027	19.3967	28.695	< 2e-16 ***
opposition	-2.4676	0.3078	2129.0642	-8.016	1.78e-15 ***
polideo	-1.7492	0.3014	2126.0381	-5.803	7.47e-09 ***

Opposition on the objective knowledge subscales, controlling for political ideology (higher numbers = more conservatism), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	8.04254	0.86126	8.04904	9.338	1.36e-05 ***
opposition	-0.49664	0.06871	2126.63227	-7.229	6.77e-13 ***
polideo	-0.15925	0.06730	2127.28938	-2.366	0.0181 *

Opposition on subjective knowledge, controlling for political ideology (higher numbers = more conservatism), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	2.783	2.444e-01	8.323e+00	11.387	2.32e-06 ***
opposition	0.128	2.058e-02	2.127e+03	6.240	5.27e-10 ***
polideo	0.085	2.016e-02	2.128e+03	4.194	2.86e-05 ***

Opposition on the full set of objective knowledge items, controlling for religiosity (higher numbers = more religiosity), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	61.2011	1.9383	17.4964	31.575	< 2e-16 ***
opposition	-2.1860	0.3056	2129.0810	-7.153	1.16e-12 ***
religion	-3.0511	0.3276	2128.1750	-9.313	< 2e-16 ***

Opposition on the objective knowledge subscales, controlling for religiosity (higher numbers = more religiosity), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	8.14035	0.84758	7.66406	9.604	1.53e-05	***
opposition	-0.46907	0.06888	2126.42201	-6.810	1.26e-11	***
religion	-0.28751	0.07385	2126.71203	-3.893	0.000102	***

Opposition on subjective knowledge, controlling for religiosity (higher numbers = more religiosity), with random intercepts by issue:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2.841e+00	2.416e-01	7.868e+00	11.759	2.87e-06	***
opposition	1.256e-01	2.067e-02	2.127e+03	6.077	1.44e-09	***
religion	9.735e-02	2.216e-02	2.127e+03	4.392	1.18e-05	***

Overall Analyses with both Objective and Subjective Knowledge Simultaneously Predicting Opposition

The full set of objective knowledge items variable and subjective knowledge on opposition

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	3.754e+00	1.747e-01	1.326e+01	21.488	1.09e-11	***
subjective	1.705e-01	2.216e-02	2.113e+03	7.698	2.11e-14	***
scilit	-1.436e-02	1.466e-03	2.129e+03	-9.793	< 2e-16	***

Objective knowledge subscale variable and subjective knowledge on opposition

(Intercept)	3.417e+00	1.708e-01	1.056e+01	20.014	9.78e-10	***
subjective	1.741e-01	2.231e-02	2.115e+03	7.804	9.34e-15	***
subscale	-5.625e-02	6.685e-03	2.110e+03	-8.413	< 2e-16	***

Overall Analyses with Demographic Control Variables

Note that the effect of opposition on the dependent variables remains significant and in the same direction as the models reported in the main text.

Predicting Objective Knowledge

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	44.47030	2.65139	45.15641	16.772	< 2e-16	***
opposition	-2.58042	0.30201	2111.89617	-8.544	< 2e-16	***
age	0.03612	0.03400	2107.44415	1.062	0.288	
gender.binary	7.53316	0.98531	2109.47660	7.645	3.14e-14	***
edu	2.62116	0.44912	2106.87258	5.836	6.17e-09	***

Predicting Subjective Knowledge

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2.608e+00	2.721e-01	1.143e+01	9.586	8.35e-07	***
opposition	1.621e-01	2.032e-02	2.108e+03	7.976	2.46e-15	***
age	9.734e-04	2.286e-03	2.106e+03	0.426	0.670265	
gender.binary	4.394e-01	6.626e-02	2.107e+03	6.631	4.21e-11	***
edu	1.070e-01	3.019e-02	2.106e+03	3.544	0.000403	***

STUDY 3 SURVEY QUESTIONS

Betting Question and Scenario

In the next part of the survey we will ask you to answer 30+ true-false scientific questions. Mixed in among them are 5 questions on the science surrounding [issue] specifically. These questions were developed using factual information from top scientists at organizations such as:

-NASA
-The Organisation for Economic Co-operation and Development (OECD)
-The National Science Foundation (NSF)
-The National Institutes of Health (NIH)
-The Environmental Protection Agency (EPA)

We would like to give you the opportunity to bet on your understanding of [issue], as defined by the agreed-upon knowledge of these scientists.

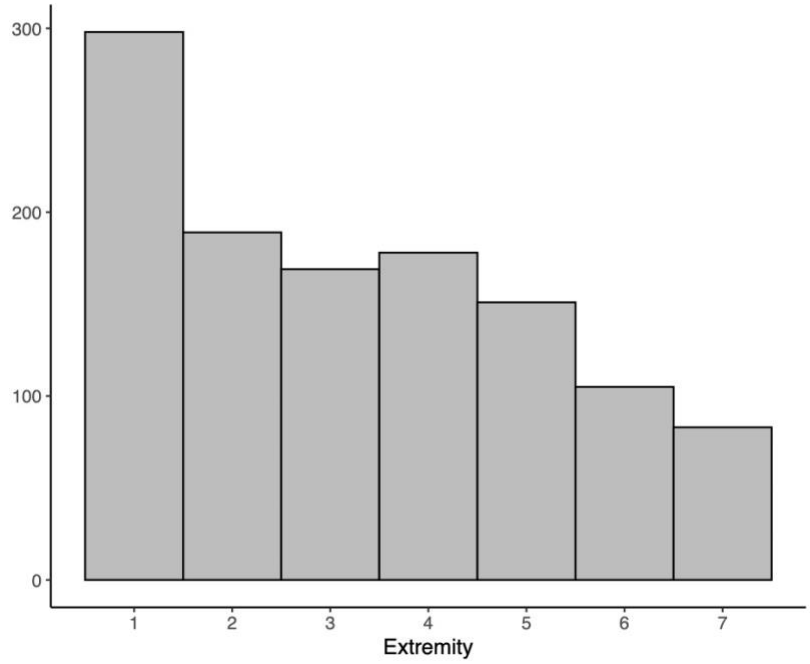
If you decide to bet, you will receive a $.50 bonus if you score better than the average on these five questions. If you do not choose to take the bet, we will give you a one-time bonus of $.25.

Would you like to bet?

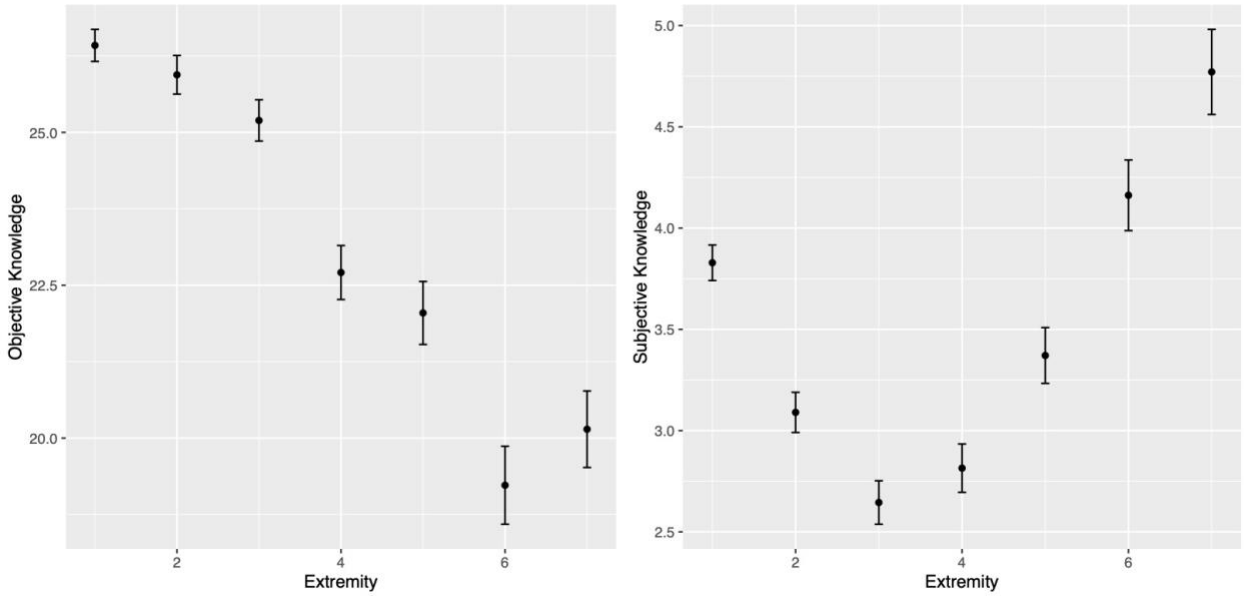
- No, I would **not** like to bet
- Yes, I would like to bet

STUDY 3 ADDITIONAL ANALYSES

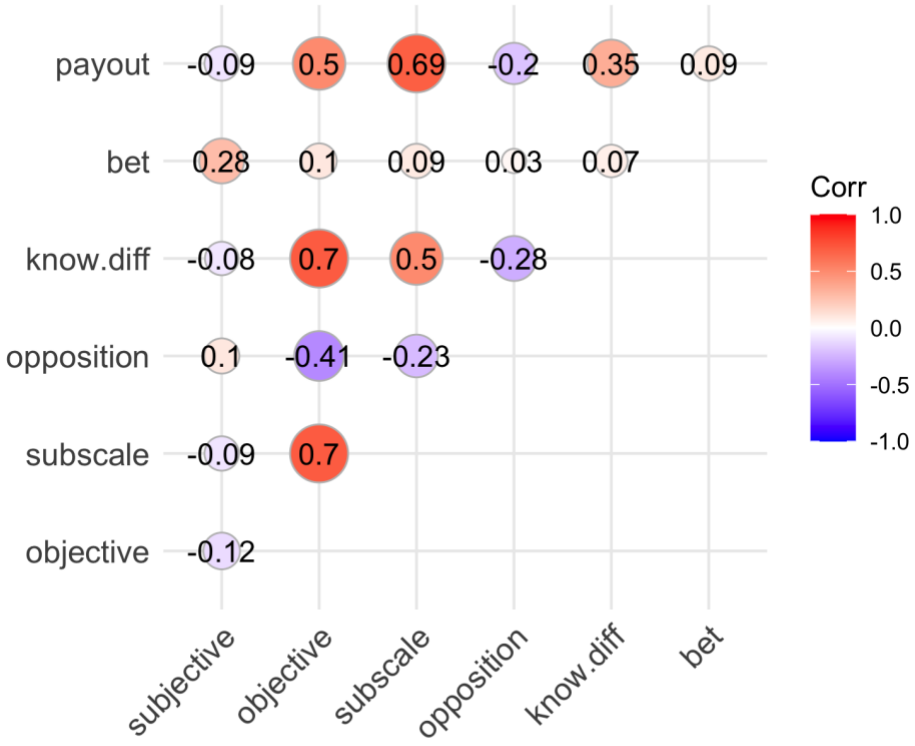
Distribution of Opposition/Extremity



Subjective and Objective Knowledge Means (with Standard Errors) by Opposition/Extremity Level



Correlation Table of Main Constructs



Overall Analyses with Both Objective and Subjective Knowledge Simultaneously Predicting Opposition

The full set of objective knowledge items variable and subjective knowledge on opposition

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	5.799e+00	4.654e-01	5.324e+00	12.459	3.85e-05	***
subjective	1.734e-01	2.966e-02	1.169e+03	5.846	6.52e-09	***
scilit.all	-1.294e-01	8.229e-03	1.167e+03	-15.728	< 2e-16	***

Objective knowledge subscale variable and subjective knowledge on opposition

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	4.0939	0.4916	4.1695	8.327	0.000947	***
subjective	0.2063	0.0312	1169.1032	6.613	5.72e-11	***
subscale	-0.4316	0.0432	1168.7180	-9.990	< 2e-16	***

Main Analyses Excluding Participants Fully in Line with The Scientific Consensus

All of the following models take the same basic form: a dependent variable predicted by opposition, with a random intercept variable for issue.

Opposition on the full set of objective knowledge items variable

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	28.6842	0.6796	9.4912	42.21	4.01e-12	***
opposition	-1.4138	0.1157	870.5430	-12.22	< 2e-16	***

Opposition on the objective knowledge subscale variable

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	4.03849	0.22151	4.66969	18.232	1.61e-05	***
opposition	-0.17005	0.02452	870.22972	-6.935	7.94e-12	***

Opposition on subjective knowledge

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2.07673	0.38141	3.82210	5.445	0.00629	**
opposition	0.33509	0.03277	870.09004	10.227	< 2e-16	***

Opposition on the knowledge difference score variable

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	0.81529	0.14879	21.29919	5.479	1.86e-05	***
opposition	-0.24064	0.02998	871.42539	-8.026	3.24e-15	***

Opposition on the participant payout variable

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	1.20589	0.03202	5.54347	37.661	6.79e-08	***
opposition	-0.02453	0.00410	870.32652	-5.982	3.22e-09	***

Overall Analyses with Demographic Control Variables

Note that the effect of opposition on the dependent variables remains significant and in the same direction as the models reported in the main text.

Predicting Objective Knowledge

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	27.31223	0.90855	31.50271	30.061	< 2e-16	***
opposition	-1.28914	0.09309	919.50554	-13.848	< 2e-16	***
edu	0.51053	0.15675	951.25744	3.257	0.00117	**
age	-0.02281	0.01525	951.82169	-1.496	0.13497	
gender.binary	0.88625	0.33801	951.37837	2.622	0.00888	**

Predicting Subjective Knowledge

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	2.075e+00	4.204e-01	5.857e+00	4.935	0.00280	**
opposition	1.843e-01	2.771e-02	9.538e+02	6.650	4.92e-11	***
edu	1.599e-01	4.639e-02	9.510e+02	3.448	0.00059	***
age	4.895e-03	4.513e-03	9.512e+02	1.085	0.27835	
gender.binary	5.248e-01	1.000e-01	9.511e+02	5.247	1.91e-07	***

STUDY 4 SURVEY QUESTIONS

COVID-19 Vaccination Opposition Question

COVID-19 is an illness caused by a coronavirus called SARS-CoV-2 that can spread from person to person.

If a COVID-19 vaccine were available to you today, would you get the vaccine?

Please indicate your answer on the 7-point scale below.
(7-point scale, “Definitely get the vaccine,” “Probably get it,” “Lean slightly toward getting it,” “Neutral,” “Lean slightly against getting it,” “Probably not get it,” “Definitely get the vaccine”)

Subjective Knowledge

Introduction to Subjective Knowledge Question

(Identical to Studies 1 and 2)

Subjective Knowledge Question

Using the scale you just learned about, how would you rate your understanding of how a COVID-19 vaccine would work?
(1-7, anchored by “Vague understanding = 1” and “Thorough understanding = 7”)

Objective Knowledge Questions

(7-point Likert scale: Definitely false, Probably false, Maybe false, Not sure, Maybe true, Probably true, Definitely true. Indications of correct answers below were included at the end of the survey during debriefing.)

Full Set of 23 Items

1. True or false? The center of the earth is very hot: True
2. True or false? The continents have been moving their location for millions of years and will continue to move. True
3. True or false? The oxygen we breathe comes from plants: True
4. True or false? Antibiotics kills viruses as well as bacteria: False
5. True or false? All insects have eight legs: False
6. True or false? All radioactivity is man made: False
7. True or false? Men and women normally have the same number of chromosomes: True
8. True or false? Lasers work by focusing sound waves: False
9. True or false? Almost all food energy for living organisms comes originally from sunlight: True
10. True or false? Electrons are smaller than atoms: True
11. True or false? All plants and animals have DNA: True
12. True or false? Humans share a majority of their genes with chimpanzees: True
13. True or false? It is the father’s genes that decide whether the baby is a boy or a girl: True
14. True or false? Ordinary tomatoes do not have genes, whereas genetically modified tomatoes do: False
15. True or false? The earth orbits the sun. True
16. True or false? Antibodies are proteins produced by the immune system. True
17. True or false? COVID-19 is a kind of bacteria. False

18. True or false? People younger than 65 cannot contract COVID-19. False
19. True or false? There is no publicly available COVID-19 vaccine. True
20. True or false? There are many different types of Coronavirus. True
21. True or false? COVID-19 can be transmitted through houseflies. False
22. True or false? COVID-19 is a variant of the flu. False
23. True or false? COVID-19 is transmitted mainly via small respiratory droplets through sneezing, coughing, or when people interact in close proximity. True

Objective Knowledge COVID-specific Subscale Items

- COVID-19 is a kind of bacteria.
- People younger than 65 cannot contract COVID-19.
- There is no publicly available COVID-19 vaccine.
- There are many different types of Coronavirus.
- COVID-19 can be transmitted through houseflies.
- COVID-19 is a variant of the flu.
- COVID-19 is transmitted mainly via small respiratory droplets through sneezing, coughing, or when people interact in close proximity.

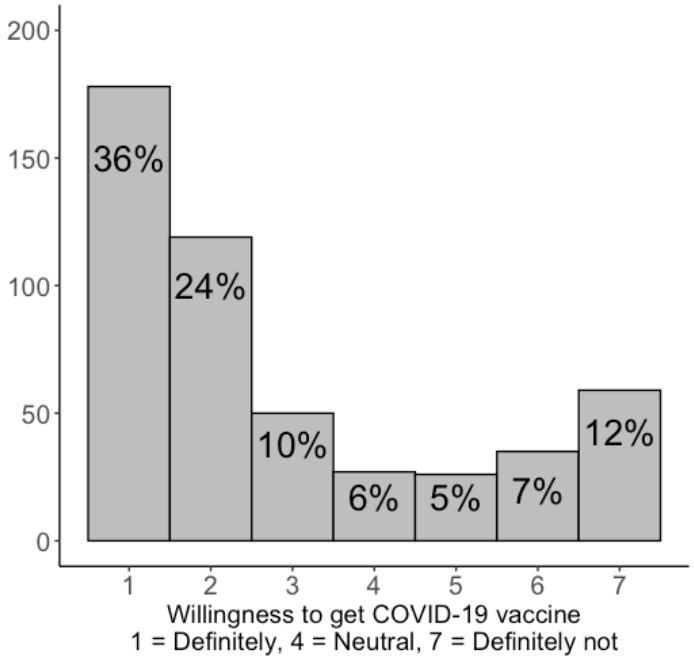
Sources for COVID-specific Subscale Items

COVID-19 subscale items were drawn from facts on the following informational websites:

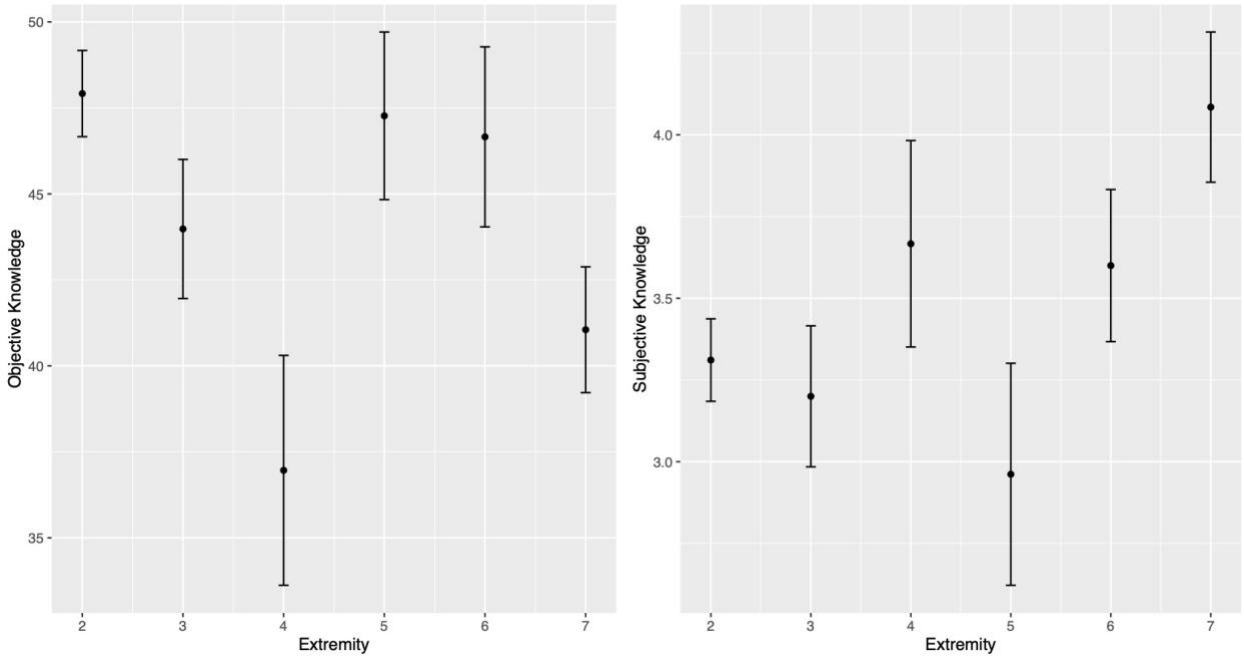
- https://www.cdc.gov/coronavirus/2019-ncov/downloads/2019-ncov-factsheet.pdf
- https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/2019-novel-coronavirus-myth-versus-fact
- https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters
- https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters?gclid=CjwKCAiA8ov_BRAoEiwAOZogwVROv5ZPdF-7tPRUm61EGjmlDvF6oTSjFmB_yfkdPWdJzN6P-DzxBBoCn2IQAvD_BwE#houseflies
- https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19-similarities-and-differences-with-influenza

STUDY 4 ADDITIONAL ANALYSES

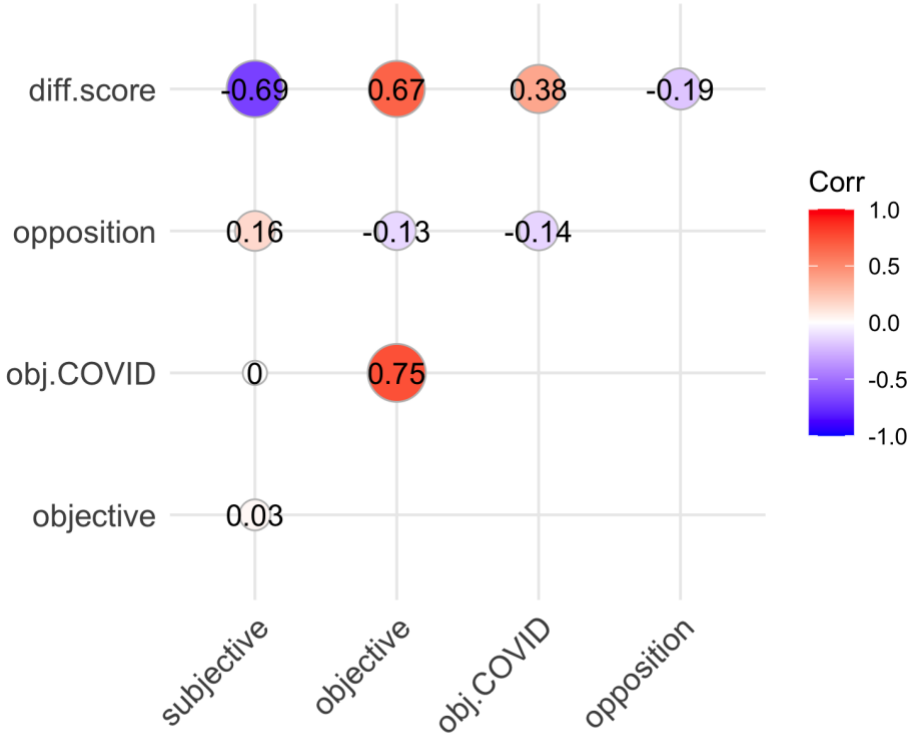
Distribution of participants' reported willingness to receive a COVID-19 vaccine



Subjective and Objective Knowledge Means (with Standard Errors) by Opposition/Extremity Level



Correlation Table of Main Constructs



Binarized Objective Knowledge Analyses

The effect of opposition on the binarized full set of objective knowledge items variable:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	19.77251	0.39047	50.64	<2e-16	***
opposition	-0.22907	0.08845	-2.59	0.01	*

The effect of opposition on the binarized COVID-specific subscale variable:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	6.29784	0.13658	46.112	<2e-16	***
opposition	-0.06495	0.03094	-2.099	0.0366	*

The effect of opposition on the knowledge difference score variable using the binarized version of the full set of objective knowledge items:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.61411	0.17211	3.568	0.000416	***
opposition	-0.15537	0.03898	-3.985	8.38e-05	***

The effect of opposition on the knowledge difference score variable using the binarized version of the issue-specific objective knowledge subscales:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.55998	0.17724	3.159	0.00173	**

opposition -0.14168 0.04015 -3.529 0.00048 ***

Overall Analyses with Political Ideology and Religiosity as Covariates

The following analyses show the main construct relationships, controlling for individual-level political ideology and religiosity. Although more conservatism and higher religiosity are again negatively associated with objective knowledge and positively associated with subjective knowledge, including them as covariates in these overall models does not meaningfully change the pattern of results from those reported in the main text.

Opposition on the full set of objective knowledge items, controlling for political ideology (higher numbers = more conservatism):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	52.4492	2.2043	23.794	< 2e-16	***
opposition	-0.5820	0.4285	-1.358	0.17534	
polideo	-1.4897	0.4948	-3.011	0.00282	**

Opposition on the COVID-specific subscale, controlling for political ideology (higher numbers = more conservatism):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	17.5824	0.7466	23.549	<2e-16	***
opposition	-0.2323	0.1451	-1.600	0.1105	
polideo	-0.4887	0.1676	-2.916	0.0038	**

Opposition on subjective knowledge, controlling for political ideology (higher numbers = more conservatism):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.74545	0.23618	11.624	<2e-16	***
opposition	0.10581	0.04591	2.305	0.0218	*
polideo	0.08709	0.05301	1.643	0.1014	

Opposition on the full set of objective knowledge items, controlling for religiosity (higher numbers = more religiosity):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	53.3661	2.0656	25.836	< 2e-16	***
opposition	-0.6984	0.4073	-1.715	0.0873	.
religion	-2.3394	0.5213	-4.488	1.01e-05	***

Opposition on the objective knowledge subscales, controlling for religiosity (higher numbers = more religiosity):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	17.3470	0.7124	24.350	< 2e-16	***
opposition	-0.2998	0.1405	-2.135	0.03356	*
religion	-0.5009	0.1798	-2.786	0.00566	**

Opposition on subjective knowledge, controlling for religiosity (higher numbers = more religiosity):

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.77073	0.22500	12.315	<2e-16	***
opposition	0.11694	0.04436	2.636	0.0088	**
religion	0.09753	0.05678	1.718	0.0868	.

Analyses with both Objective and Subjective Knowledge Simultaneously Predicting Opposition

The full set of objective knowledge items variable and subjective knowledge on opposition

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	3.795864	0.385981	9.834	< 2e-16	***
scilit	-0.018976	0.009598	-1.977	0.04891	*
subjective	0.208825	0.070126	2.978	0.00313	**

Objective knowledge COVID subscale variable and subjective knowledge on opposition

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	4.08239	0.42166	9.682	< 2e-16	***
COVlit	-0.05617	0.02195	-2.559	0.01096	*
subjective	0.20426	0.06980	2.927	0.00368	**

Overall Analyses with Demographic Control Variables

Note that the effect of opposition on the dependent variables remains significant and in the same direction as the models reported in the main text.

Predicting Objective Knowledge

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	11.17166	1.32075	8.459	1.09e-15	***
opposition	-0.26829	0.14090	-1.904	0.057827	.
edu	0.90502	0.24992	3.621	0.000343	***
gender.binary	0.30269	0.54817	0.552	0.581221	
age	0.04008	0.01796	2.231	0.026373	*

Predicting Subjective Knowledge

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.819912	0.425410	6.629	1.51e-10	***
opposition	0.138616	0.045385	3.054	0.00245	**
edu	-0.020850	0.080499	-0.259	0.79580	
gender.binary	0.248369	0.176565	1.407	0.16053	
age	0.004155	0.005785	0.718	0.47320	

STUDY 5 SURVEY QUESTIONS

Subjective knowledge

Perceptions of people's own knowledge were measured with one question, "How would you rate your knowledge about COVID-19?" Responses were recorded on a sliding scale from 1 = *Very poor knowledge* to 10 = *Very good knowledge*, with the midpoint labeled *Average knowledge*.

Subjective knowledge of scientists

Perceptions of scientists' knowledge were measured with one question, "How would you rate (in general) scientists' knowledge about COVID-19?" using the same scale as above.

Objective knowledge

The objective knowledge items consisted of twenty questions adapted from Rothmund et al. (2020) that tapped into general knowledge of COVID-19 and seven questions generated from the scientific literature by M.V.G. that tapped into knowledge specifically of COVID-19 transmission. One knowledge question ("The numbers of people that have died from COVID-19 are artificially inflated") was excluded from the analysis because the true answer is unknown. Responses were scored correct if participants selected "Yes, probably right" or "Yes, definitely right" for items that are true, and "No, definitely wrong" or "No, probably wrong" for items that are false.

Many claims have been made about COVID-19, some maybe true, others maybe false. In your opinion: 1 = *No, definitely wrong*, 2 = *No, probably wrong*, 3 = *I am not sure*, 4 = *Yes, probably right*, 5 = *Yes, definitely right*	
Keeping distant to other people helps to slow the spread of COVID-19 (1)	True
It usually takes a few days from the moment of infection to the onset of disease (2)	True
Washing one's hands thoroughly kills the novel coronavirus (3)	True
An infection with COVID-19 is only possible once, then the body is immune (4)	False
Taking Ibuprofen or Aspirin can exacerbate COVID-19 (5)	False
The novel coronavirus was unleashed in a laboratory in Wuhan and spread from there (6)[1]	False
With the proper diet, I can protect myself from being infected with COVID-19 (7)	False
The spread of COVID-19 is affected by 5G wireless technology (8)	False

[1] This question was treated as false based on the general understanding of the virus at the time of the study, but recent developments have made the lab leak theory more plausible.

As long as I can hold my breath for 10 seconds without any difficulties, I am not infected with COVID-19 (9)	False
To kill the coronavirus in its initial stage of infection, one should inhale hot air, for example from a hair dryer (10)	False
The drug hydroxychloroquine has been proven to cure COVID-19 (11)	False
To prevent infection, one should gargle with a diluted solution of disinfectant, such as Clorox (12)	False
99 percent of the people infected with COVID-19 do not show any symptoms (13)	False
If a person has no sign of infection, they are not contagious (14)	False
The numbers of people that have died from COVID-19 are artificially inflated (15)	Excluded from the analysis*
Overall, COVID-19 is not deadlier than seasonal flu (16)	False
Young people with no pre-existing conditions can also die from COVID-19 (17)	True
COVID-19 is more dangerous than seasonal flu (18)	True
The United States has the lowest death rate of COVID-19 in the world (19)	False
Black and Hispanic communities have the highest rates of COVID-19 infections (20)	True
What is your opinion about the following statements regarding COVID-19 transmission? 1 = *No, definitely wrong*, 2 = *No, probably wrong*, 3 = *I am not sure*, 4 = *Yes, probably right*, 5 = *Yes, definitely right*	
COVID-19 is transmissible via droplets through coughing, sneezing or intimate contact. (1)	True
COVID-19 is transmissible via feces from an infected person, like when someone flushes the toilet (2)	True

COVID-19 is transmissible via feces from an infected pet. (3)	False
COVID-19 is transmissible via objects that have been contaminated by an infected person. (4)	True
COVID-19 is transmissible through AC tubing from room to room, even with filters in place. (5)	False
COVID-19 lingers in the air six or more hours after an infected person has been in a room (6)	False
Wearing a mask only protects others if I am sick, it does not protect me from being infected (7)	False

* Although this item was in Rothmund et al.'s (2020) battery and appeared in our survey, it does not have a known answer and so was omitted from the aggregate measure of objective knowledge.

Opposition to COVID-19 mitigation policies

Opposition to public health policies was measured by reverse coding thirteen items and calculating participant means across items:

Retrospective: What was your agreement towards some of the major policy decisions that have been taken during this pandemic? 1 = *Strongly against*, 2 = *Against*, 3 = *Neither against or support*, 4 = *Support*, 5 = *Strongly support*
Closing all K-12 schools and universities
Closing all bars and restaurants
Closing all non-essential businesses
Closing all parks
Forbidding all public gatherings (sports and culture)
Forbidding all non-necessary travel
Imposing severe restrictions to people coming to the US from overseas

Prospective: What would be your support towards the following policy measures, if implemented? 1 = *Strongly against*, 2 = *Against*, 3 = *Neither against or support*, 4 = *Support*, 5 = *Strongly support*
State-wide mandate requiring people to wear masks all the time when in public?
State-wide mandate requiring people to get a coronavirus vaccine once one is available?
State-wide mandate requiring businesses to check the temperature of all people upon entering the premises?
State-wide mandate requiring self-reporting of all personal contacts for the last five days if diagnosed with COVID-19?
State-wide mandate requiring people entering from other states with higher infection rates to quarantine for 10 days?
State-wide mandate that makes a special exception allowing houses of worship to remain open?

Noncompliance with recommended preventive behaviors

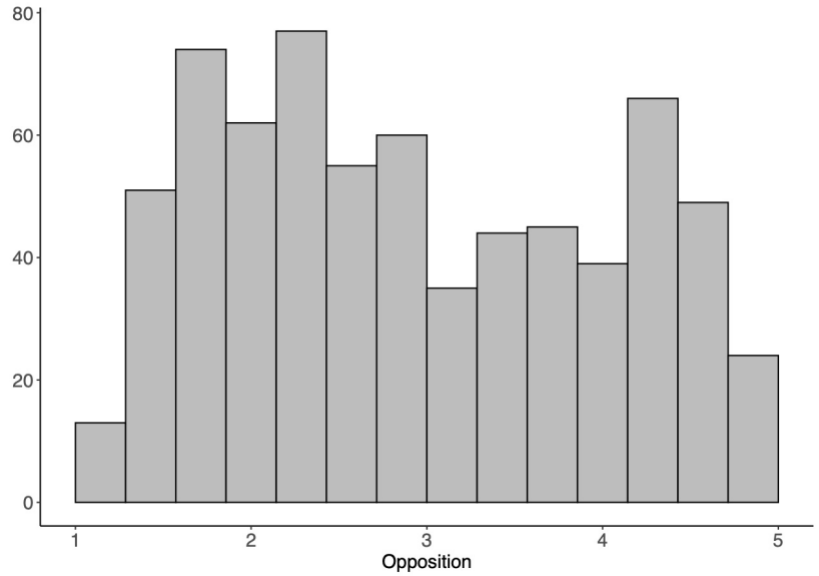
Noncompliance was measured by calculating participant means across six items:

How often have you taken the following measures to prevent infection with COVID-19? 1 = *Almost all the time*, 2 = *Fairly often*, 3 = *Sometimes*, 4 = *Not very often*, 5 = *Almost never*
Hand washing with soap for 20 seconds
Avoiding touching your eyes, nose, and mouth with unwashed hands
Use of disinfectants to clean hands when soap and water is not available for washing hands
Social distancing at 6ft or more from other people
Wiping mail and packages with disinfectant
Using a face mask when going out in public
Wiping groceries and other purchased items with disinfectant

Because Study 4 data was part of a larger investigation (before being integrated into the current manuscript), participants also answered questions about information source trust and use, risk perception, and various demographics.

STUDY 5 ADDITIONAL ANALYSES

Distribution of Opposition



Objective and Subjective Knowledge Means (with Standard Errors) by Level of Opposition

Opposition Bin	Objective Knowledge Mean	SE
1	0.55	0.055
2	0.75	0.008
3	0.68	0.01
4	0.60	0.011
5	0.52	0.011

Opposition Bin	Subjective Knowledge Mean	SE
1	7.25	1.03

2	7.38	0.12
3	6.82	0.12
4	6.76	0.15
5	8.05	0.15

Political ideology

Countless experiments and surveys have found strong effects of political ideology on COVID-19 related behaviors (see Geana, Rabb, & Sloman, under revision). To ensure that the main effects reported here cannot be explained away by partisanship, we ran regressions similar to those reported in the main paper but with individuals' reported ideology (1 = *Very conservative*, 2 = *Moderately conservative*, 3 = *Somewhat conservative*, 4 = *Neither conservative nor liberal*, 5 = *Somewhat liberal*, 6 = *Moderately liberal*, 7 = *Very liberal*) and the relevant interaction included. As the results of these analyses show, political ideology does account for substantial variance in judgments, as we would expect (with the exception of subjective knowledge with noncompliance as a predictor), but the patterns of main effects and directions remain for both independent variables and all three dependent variables.

DV: Objective knowledge

	B	SEM	Standardized β	*t*	Sig.
Policy opposition	-0.056	0.011	-0.385	-4.993	<.001
Political ideology	0.018	0.008	0.232	2.148	.032
Policy opposition x political ideology	0.001	0.003	0.044	0.555	.579

DV: Subjective knowledge

	B	SEM	Standardized β	*t*	Sig.
Policy opposition	0.817	0.161	0.479	5.071	<.001
Political ideology	0.461	0.118	0.516	3.913	<.001
Policy opposition x political ideology	-0.186	0.038	-0.468	-4.896	<.001

DV: Knowledge difference score

	B	SEM	Standardized β	*t*	Sig.

Policy opposition	-0.819	0.100	-0.655	-8.197	<.001
Political ideology	-0.151	0.073	-0.231	-2.068	.039
Policy opposition x political ideology	0.114	0.024	0.391	4.834	<.001

DV: Objective knowledge

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	-0.033	0.007	-0.193	-5.019	<.001
Political ideology	0.043	0.004	0.570	10.585	<.001
Noncompliance x political ideology	-0.006	0.002	-0.184	-3.800	<.001

DV: Subjective knowledge

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	0.195	0.095	0.096	2.049	.041
Political ideology	-0.017	0.059	-0.019	-0.296	.767
Noncompliance x political ideology	-0.045	0.023	-0.113	-1.922	.055

DV: Knowledge difference score

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	-0.318	0.060	-0.215	-5.340	<.001
Political ideology	0.285	0.037	0.435	7.752	<.001
Noncompliance x political ideology	-0.015	0.015	-0.053	-1.051	.293

A different way that political ideology could explain away the results is if the items used to measure objective knowledge were written to lure liberals to agree and conservatives to disagree. Although we excluded one especially charged item (“The numbers of people that have died from COVID-19 are artificially inflated ”) because it has no determinate answer, it is possible that others could have created a demand characteristic that would unfairly suggest differential knowledge. This cannot fully explain the results since they hold when controlling for political ideology, but it could account for some of the variance in judgments. To examine this possibility,

we first calculated correlations between objective knowledge items (correct) and political ideology. Coefficients ranged from -.002 ("Taking Ibuprofen or Aspirin can exacerbate COVID-19") to .58 ("The drug hydroxychloroquine has been proven to cure COVID-19"). We then created a non-politicized objective knowledge measure collapsing across only the items for which the correlation with ideology was small to nonexistent using Cohen's rule of thumb ($r <$ .2). Non-politicized objective knowledge showed the same relationships reported in the main paper: as opposition to policies consistent with the scientific consensus increased, this measure decreased ($\beta_{opposition}$ = -22, t(692) = -5.9, $p < .001$), and noncompliance with preventive behaviors had the same effect ($\beta_{opposition}$ = -.23, $t(692) = -6.18$, $p < .001$).

Excluding participants showing the strongest agreement

Studies 1–4 measured opposition to the scientific consensus with single questions and excluded participants who were in complete agreement with the consensus. Study 5 operationalized opposition using composite measures of multiple scales, so the number of participants showing complete agreement by this criterion (selecting the highest scale point for every question) was small. Still, we may ask whether the results of Study 5 hold up when excluding those who were in near-complete agreement. The analyses below are identical to those reported in the main paper but with all participants whose mean opposition or noncompliance scores were less than 2, i.e. those who responded 1 or 2 on every question. Again, the main effects and directions are the same.

DV: Objective knowledge

	B	SEM	Standardized β	*t*	Sig.
Policy opposition	-0.083	0.007	-0.477	-12.264	<.001

DV: Subjective knowledge

	B	SEM	Standardized β	*t*	Sig.
Policy opposition	0.616	0.092	0.285	6.694	<.001

DV: Knowledge difference score

	B	SEM	Standardized β	*t*	Sig.
Policy opposition	-0.870	0.060	-0.545	-14.610	<.001

DV: Objective knowledge

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	-0.101	0.008	-0.483	-11.982	<.001

DV: Subjective knowledge

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	0.564	0.114	0.222	4.926	<.001

DV: Knowledge difference score

	B	SEM	Standardized β	*t*	Sig.
Noncompliance with preventive measures	-0.952	0.076	-0.502	-12.568	<.001

Overall Analyses with both Objective and Subjective Knowledge Simultaneously Predicting Opposition (Policy Opposition and Noncompliance with Preventive Measures in Separate Models)

DV: Policy opposition

	B	SEM	Standardized β	*t*	Sig.
Objective knowledge	-3.984	.216	-.574	-18.46	<.001
Subjective knowledge	.115	.018	.196	6.313	<.001

DV: Noncompliance with preventive measures

	B	SEM	Standardized β	*t*	Sig.
Objective knowledge	-2.707	.199	-.461	-13.579	<.001
Subjective knowledge	.076	.017	.154	4.533	<.001

Overall Analyses with Demographic Control Variables

Predicting Objective Knowledge

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.725	.027		26.913	.000
	mean_policy_opposition	-.081	.005	-.564	-16.811	.000
	How old are you?	.001	.000	.077	2.117	.035
	gender_dummy_coded_female	-8.363E-5	.010	.000	-.008	.994
	How many years of education have you completed?	.025	.004	.207	5.964	.000

a. Dependent Variable: objective_knowledge

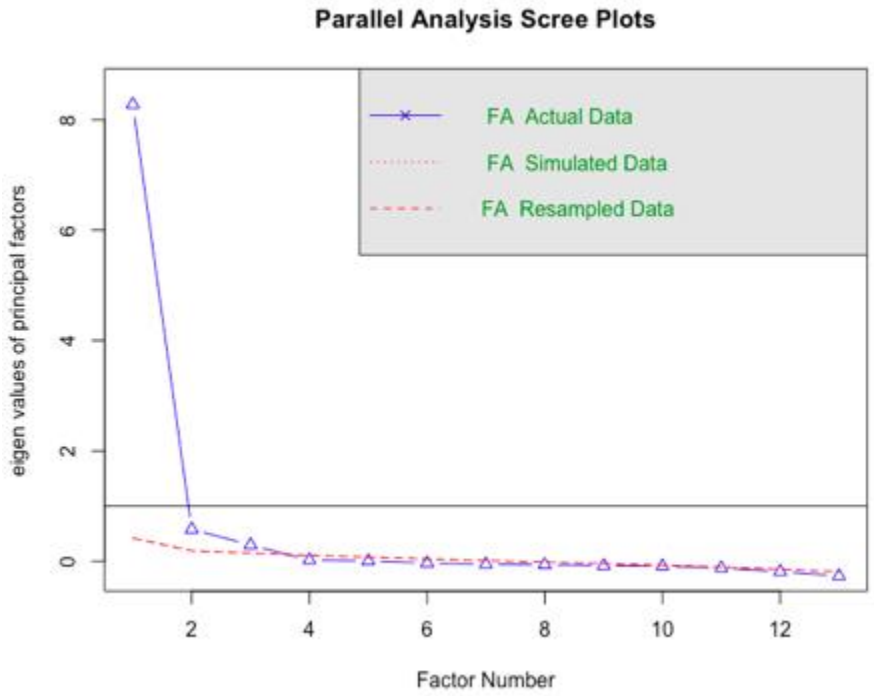
Predicting Subjective Knowledge

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.984	.370		13.459	.000
	mean_policy_opposition	.101	.066	.059	1.528	.127
	How old are you?	.025	.003	.322	7.617	.000
	gender_dummy_coded_female	.014	.141	.004	.098	.922
	How many years of education have you completed?	.144	.059	.099	2.465	.014

a. Dependent Variable: How would you rate your knowledge about COVID-19? - Knowledge about COVID-19

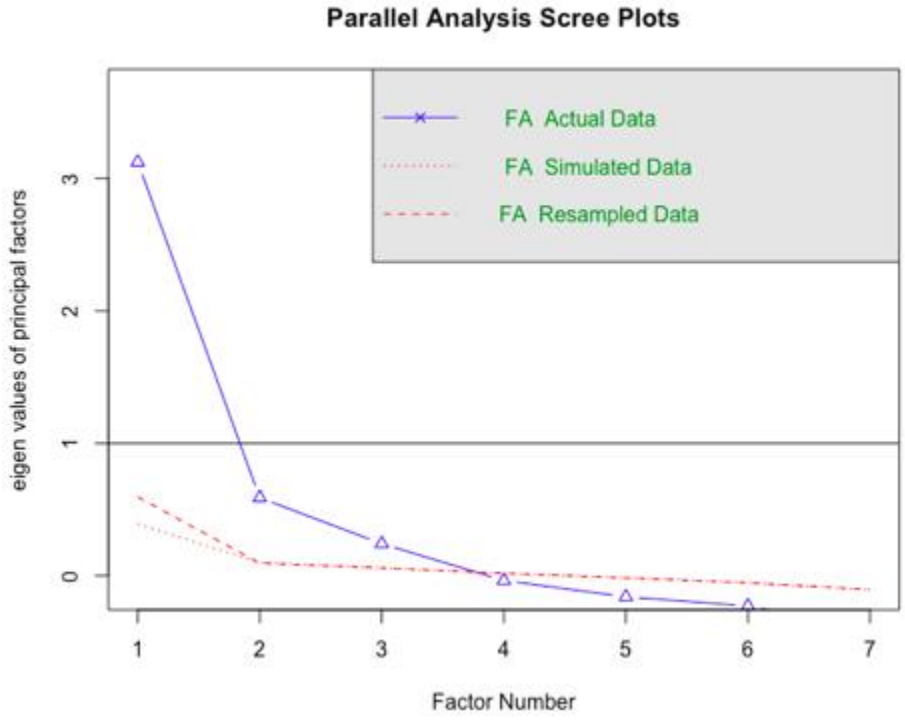
Support for Policies and Preventive Measures Factor Analyses

Policy Support Scree Plot



Policy Support Scree Plot Eigenvalues
8.28, 0.58, 0.29, 0.02, 0.00, -0.03, -0.05, -0.06, -0.08, -0.09, -0.12, -0.19, -0.27

Preventive Measures Scree Plot



Preventive Measures Scree Plot Eigenvalues
3.12, 0.59, 0.24, -0.04, -0.16, -0.23, -0.41

Policy Support EFA Two-Factor Solution Output

```
Factor Analysis using method =  minres
Call: fa(r = dfpolicy, nfactors = 2, rotate = "oblimin", fm = "minres")
Standardized loadings (pattern matrix) based upon correlation matrix
         MR1   MR2   h2   u2 com
Q115_1  0.98 -0.09 0.82 0.18 1.0
Q115_2  0.88  0.08 0.88 0.12 1.0
Q115_3  0.95 -0.02 0.87 0.13 1.0
Q115_4  0.75  0.07 0.64 0.36 1.0
Q115_5  0.88  0.07 0.88 0.12 1.0
Q115_6  0.86  0.04 0.79 0.21 1.0
Q115_7  0.39 -0.02 0.14 0.86 1.0
Q121_1  0.29  0.67 0.85 0.15 1.4
Q121_2 -0.04  0.83 0.63 0.37 1.0
Q121_3 -0.10  0.95 0.76 0.24 1.0
Q121_4  0.13  0.78 0.79 0.21 1.1
Q121_5  0.29  0.55 0.64 0.36 1.5
Q121_6 -0.54 -0.04 0.32 0.68 1.0

                       MR1  MR2
SS loadings           5.68 3.33
Proportion Var        0.44 0.26
Cumulative Var        0.44 0.69
Proportion Explained  0.63 0.37
Cumulative Proportion 0.63 1.00

 With factor correlations of
    MR1 MR2
MR1 1.0 0.8
MR2 0.8 1.0

Mean item complexity =  1.1
Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  78  and the objective function
was  13.23 with Chi Square of  9110.85
The degrees of freedom for the model are 53  and the objective function was
0.51

The root mean square of the residuals (RMSR) is  0.03
The df corrected root mean square of the residuals is  0.04

The harmonic number of observations is  688 with the empirical chi square
123.3  with prob <  1.6e-07
The total number of observations was  695  with Likelihood Chi Square =
349.61  with prob <  2.8e-45

Tucker Lewis Index of factoring reliability =  0.952
RMSEA index =  0.09  and the 90 % confidence intervals are  0.081 0.099
BIC =  2.78
Fit based upon off diagonal values = 1
Measures of factor score adequacy
                                                MR1  MR2
Correlation of (regression) scores with factors   0.99 0.97
Multiple R square of scores with factors          0.97 0.94
Minimum correlation of possible factor scores     0.95 0.87
```

Preventive Measures EFA Two-Factor Solution Output

```
Factor Analysis using method =  minres
Call: fa(r = dfpreventive, nfactors = 2, rotate = "oblimin", fm = "minres")
Standardized loadings (pattern matrix) based upon correlation matrix
        MR1   MR2   h2     u2 com
Q30_1  0.75 -0.07 0.51 0.4886 1.0
Q30_2  0.69  0.00 0.47 0.5259 1.0
Q30_3  0.83 -0.02 0.67 0.3303 1.0
Q30_4  0.54  0.14 0.39 0.6124 1.1
Q30_5  0.10  0.79 0.72 0.2838 1.0
Q30_6  0.59  0.14 0.44 0.5558 1.1
Q30_7 -0.04  1.02 1.00 0.0046 1.0

                       MR1  MR2
SS loadings           2.43 1.77
Proportion Var        0.35 0.25
Cumulative Var        0.35 0.60
Proportion Explained  0.58 0.42
Cumulative Proportion 0.58 1.00

 With factor correlations of
     MR1  MR2
MR1 1.00 0.51
MR2 0.51 1.00

Mean item complexity =  1
Test of the hypothesis that 2 factors are sufficient.

The degrees of freedom for the null model are  21  and the objective function
was  3.41 with Chi Square of  2356.68
The degrees of freedom for the model are 8  and the objective function was
0.22

The root mean square of the residuals (RMSR) is  0.06
The df corrected root mean square of the residuals is  0.09

The harmonic number of observations is  692 with the empirical chi square
88.22  with prob <  1.1e-15
The total number of observations was  695  with Likelihood Chi Square =
153.33  with prob <  4e-29

Tucker Lewis Index of factoring reliability =  0.836
RMSEA index =  0.162  and the 90 % confidence intervals are  0.14 0.185
BIC =  100.98
Fit based upon off diagonal values = 0.99
Measures of factor score adequacy
                                                 MR1  MR2
Correlation of (regression) scores with factors 0.92 1.00
Multiple R square of scores with factors        0.85 1.00
Minimum correlation of possible factor scores   0.69 0.99
```

Main Policy Support Analyses Using Two Factors. Note that these are not reverse-coded (as they are in the main text). As a result, a positive coefficient represents a positive correlation between support for anti-COVID policies and the dependent variables. These analyses replicate the findings reported in the main text.

```
Policy factor 1 on objective Knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.86680    0.13805  -13.52   <2e-16 ***
policy.F1    0.64739    0.04428   14.62   <2e-16 ***


Policy factor 2 on objective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.85441    0.11488  -16.14   <2e-16 ***
policy.F2    0.60050    0.03374   17.80   <2e-16 ***


Policy factor 1 on subjective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  7.72106    0.20137  38.342  < 2e-16 ***
policy.F1   -0.16962    0.06472  -2.621  0.00897 **


Policy factor 2 on subjective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  8.00600    0.17471  45.825  < 2e-16 ***
policy.F2   -0.25034    0.05156  -4.856 1.49e-06 ***
```

Main Preventive Measures Analyses Using Two Factors. Note that these are reverse-coded (as they are in the main text). As a result, a positive coefficient represents a positive correlation between noncompliance with preventive measures and the dependent variables. These analyses replicate the findings reported in the main text.

```
Preventive factor 1 on objective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.47422    0.11870   12.42   <2e-16 ***
prevent.F1  -0.70724    0.05302  -13.34   <2e-16 ***


Preventive factor 2 on objective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.88794    0.17164   5.173 3.08e-07 ***
prevent.F2  -0.22216    0.04217  -5.268 1.88e-07 ***


Preventive factor 1 on subjective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.79667    0.16709  40.676  < 2e-16 ***
prevent.F1   0.20861    0.07394   2.821  0.00492 **


Preventive factor 2 on subjective knowledge
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
```

```
(Intercept)  6.86130    0.22391  30.643   <2e-16 ***
prevent.F2   0.09372    0.05475   1.712   0.0874 .
```