When Experts Matter:
Variations in consensus messaging for vaccine and GMO safety

April 17, 2023

Abstract

Does consensus messaging about contested science issues influence perceptions of consensus and/or personal beliefs? This question remains open, particularly for topics other than climate change and samples outside the U.S. In a Spanish national sample (N=5,087), we use preregistered survey experiments to examine differential efficacy of variations in consensus messaging for vaccines and genetically modified organisms (GMOs). We find that no variation of consensus messaging influences vaccine beliefs. For GMOs, about which misperceptions are particularly prevalent in our sample, we find that scientific consensus messaging increases perception of consensus and personal belief that GMOs are safe, and decreases support for a ban. Increasing degree of consensus did not have consistent effects. Although individual differences (e.g., a conspiratorial worldview) predict these GMO beliefs, they do not undercut consensus message effects. While we observe relatively modest effect sizes, consensus messaging may be able to improve the accuracy of beliefs about some contentious topics.

Keywords: consensus, norms, misperceptions, vaccines, GMO

Misperceptions about humans' contribution to climate change (Egan & Mullin, 2017), the fallacious link between the measles, mumps, and rubella (MMR) vaccine and autism (Motta et al., 2018), and the risk of consuming genetically modified (GM) foods (Hasell & Stroud, 2020) remain widespread. These misperceptions can delay climate action, reduce vaccination rates, and lead to the prohibition of bioengineered foods (DeStefano & Shimabukuro, 2019; Egan & Mullin, 2017; Wunderlich & Gatto, 2015). These misperceptions exist despite clear scientific consensus on these claims: global warming is anthropogenic, vaccines do not cause autism, and consuming GMOs is safe (Landrum et al., 2019; Cook et al., 2016; National Academies of Sciences, Engineering, and Medicine, 2016; Funk et al., 2015b; Gust et al., 2008). The result is a "consensus gap" (Cook et al., 2018). In part, the discrepancy between the scientific community and the public has been attributed to an awareness issue — many members of the public simply do not know that scientists agree on these issues (Funk et al., 2015b; Deryugina & Shurchkov, 2016).

If misperceptions on these important issues are largely an information deficit problem, communicating scientific consensus on contested issues should improve the accuracy of beliefs on these topics. Such messages would convey descriptive norms about the actual level of agreement among experts (van der Linden, Clarke, & Maibach, 2015). While descriptive norms as traditionally conceived convey information about social groups' normative beliefs and behaviors (Lapinski & Rimal, 2005), messages communicating scientific consensus further imply an appeal to authority, as the norms described come from *experts* (Landrum & Slater, 2020). Ultimately, though, the literature on consensus messaging remains unsettled (Bayes et al., 2020; Landrum & Slater, 2020). Among other outstanding questions, we do not know the degree of expert consensus citizens require to see an issue as solved, and we do not know how much more effective expert consensus is as opposed to consensus among the general public.

Accordingly, we respond to calls in the field to understand the conditions under which consensus messages are and are not effective (Bayes et al., 2020). We contribute to this knowledge base by testing consensus message variations regarding GMOs and vaccines in a national Spanish sample. We find regardless of variations in source or degree of consensus, consensus messages are much more influential for GMO beliefs and attitudes than for vaccines. Based on descriptive data from our representative sample, we suggest that consensus messages are more likely to be effective for issues that have generated widespread misperceptions, and low awareness of the scientific community's views, but are nonetheless not subject to political or social division.

The Consensus Messaging Debate

Whether communicating scientific consensus surrounding an issue can effectively sway the public is a contested issue (Landrum & Slater, 2020). Proponents of the Gateway Belief Model (GBM) argue that perceptions of scientific consensus serve as a "gateway belief" that indirectly affects personal beliefs and policy preferences (van der Linden, Leiserowitz, et al., 2015). In a number of follow-up studies, van der Linden and colleagues have replicated this basic finding, typically focusing on climate change (van der Linden et al., 2019; M. H. Goldberg et al., 2019; Van der Linden et al., 2014), but also extending to vaccines (van der Linden, Clarke, & Maibach, 2015).

There are a variety of critiques to this model, however. Some have challenged the methodological choices made by these authors in specifying path models across studies (Kahan, 2016; Landrum & Slater, 2020), and disagree about how best to interpret the models' results. Importantly, consensus messages generally appear not to have direct effects on attitudes or policy preferences (Bolsen & Druckman, 2018; Chinn et al., 2018; Landrum et al., 2019; G. Dixon, 2016; Deryugina & Shurchkov, 2016; Kerr & Wilson, 2018a). Though proponents of the GBM emphasize the role of indirect effects, outlining a two-stage sequential mediational process, it is worth noting recent critiques of this form of analysis (Imai et al., 2011; Green et al., 2010; Bullock & Ha, 2011; Rohrer et al., 2021; Bayes et al., 2020; McGrath, n.d.).

Others' tests of this general model have failed to replicate its findings (Landrum et al., 2019; Deryugina & Shurchkov, 2016; Kerr & Wilson, 2018b; Cook & Lewandowsky, 2016). Some have also noted that differential acceptance and reactance to persuasion attempts undermine consensus messaging, particularly for polarized issues such as climate change (Ma et al., 2019; Cook & Lewandowsky, 2016; G. Dixon, 2016; Chinn & Hart, 2021a), casting doubt on the ultimate worth of the strategy. They instead argue that targeted messaging strategies are needed to appeal to hesitant subgroups (Hasell et al., 2020; G. Dixon et al., 2017). GBM proponents argue climate consensus messaging is as effective or more effective among conservatives in the U.S. (van der Linden et al., 2019).

Variations in Consensus Messaging

Consensus messages can be constructed in a number of ways that might moderate their efficacy. One way they can vary is in the conceptualization of consensus itself. Though the majority of studies rely on numerical or summary statements (Landrum & Slater, 2020), others highlight the process of achieving consensus (Landrum et al., 2019; Bolsen & Druckman, 2018) (e.g., describing how a panel of scientists reviewed hundreds of scientific studies to arrive at their conclusion), and some have tested metaphor and pie charts (Van der Linden et al., 2014). Another variation is in the level of consensus depicted. Some work shows that when presented with varying degrees of scientific consensus on apolitical issues in the U.S. — the gravitational pull of the moon's effects on earthquakes, repeated motions' effects on bone damage, or artificial sweeteners' effect on the composition of gut microbiota — respondents shift their perceptions of the science's certainty to match. However, as Chinn and colleagues showed, any consensus below 65% decreased perceptions of certainty (Chinn et al., 2018). The authors also detected indirect effects on personal agreement and funding support, in line with the GWB. Similarly, Kerr and Wilson (2018a) find that both high (97%) and low (63%) consensus messages increased perceived consensus on GMO safety in the U.S. Another study (Kobayashi, 2019) tested the effects of highly divergent scientific and public consensus levels on GMO safety in Japan. Respondents were either informed that 88% of scientists agreed GMOs were safe, or that 5% of the general public agreed, or they both. Only those exposed to both treatments had increased safety beliefs. More work is needed to understand tipping points in numerical consensus messages for other issues and in other contexts.

Additionally, the source of consensus can be varied. The primary sources tested in the literature are scientific (Landrum & Slater, 2020). However, some scholars have examined the effects of scientific consensus when conveyed by partisan elected officials (Benegal & Scruggs, 2018), with interest in the group dynamics of source credibility in this arena. Others, like Kobayashi (2019), have examined the potential for *social*, rather than scientific consensus to influence the public. This can skirt around issues that arise when the public is skeptical of experts (Funk et al., 2019; Pasek, 2018; B. A. Lyons et al., 2020), especially if the public is unaware of widespread endorsement of topics such as anthropogenic climate change (Mildenberger et al., 2017). This research on social consensus borrows from research on descriptive norms even more directly, rather than merging such normative information with an implicit appeal to authority. These consensus messages aim then to correct beliefs about beliefs, or second-order beliefs. Individuals display ego-centric bias in forming second-order beliefs about, for instance, the percent of Americans who believe in anthropogenic climate change: individuals' second-order beliefs are conditioned on their personal beliefs. When second-order beliefs are updated, support for climate policy increases as well (Mildenberger et al., 2017). Thus social consensus may be especially effective at influencing behavioral outcomes (Jachimowicz et al., 2018).

Looking Beyond Climate Change

Some studies have tested consensus messaging effects for issues outside climate change, but results are likewise mixed. Van der Linden and colleagues find support for the GBM in the case of vaccines (van der Linden, Clarke, & Maibach, 2015). Others find a much more conditional model: In these studies, consensus messages appear to be influential only among people who already hold favorable views toward science and scientists, failing to move those most often targeted in vaccine communication (G. N. Dixon et al., 2015; Clarke et al., 2015)

A handful of studies have also applied consensus messaging about GMO safety in the United States, with mixed results. Dixon presents a pair of studies (G. Dixon, 2016) that find consensus messaging increases perception of consensus but only indirectly influences personal beliefs, and are less effective for those with negative prior views toward GMOs. Others show that GMO consensus can increase both perceived consensus and personal safety beliefs, the latter both directly and indirectly (Kerr & Wilson, 2018a). On the other hand, process-based consensus messages as employed in recent work appear to influence neither consensus perception nor GMO concern (Landrum et al., 2019).

Ultimately, consensus messages are likely to be most effective when issue-knowledge is low and misperceptions of scientific consensus are widespread (Li & Wagner, 2020), but attitudes on the given issue are not held with great conviction or tied to identity (Flynn et al., 2017). Such conditions not only change across issues but across the cultural contexts of the public(s) in question.

Pre-registered Hypotheses

We extend the research on consensus messaging by testing variations for GMO and vaccination in a national sample from Spain. For vaccination, we vary whether the consensus is derived from scientists or the public, and whether the level of consensus is 75% or 90%. For GMOs, we focus on scientific consensus only, but vary the degree from 60% to 95% at 5% intervals. We pre-registered our design, hypotheses, and analyses using the Open Science Framework: `https://osf.io/d9s3w?view_only=14e16a7bb168442a94540d16de5ee338` [blinded for peer review].

We make two primary hypotheses. First, we pose a *corrections hypothesis*: Any treatment condition will lead to a significant reduction in "negative" beliefs or attitudes[1] compared to the control condition (where participants receive no consensus information). Second, we pose a *norms hypothesis*: Higher levels of descriptive norms (i.e., 90% compared to 75% consensus) will lead to a larger reduction in negative beliefs or attitudes than lower levels of descriptive norms. Both of these hypotheses are tested for both vaccination and GMOs, although the range of variation in descriptive norms we test varies. We do not have a hypothesis of whether scientific or social consensus will be most effective in reducing negative beliefs or attitudes in the case of vaccine items, and so this test is exploratory.

[1] Our wording here targets negative beliefs or attitudes for the sake of brevity; our analysis covers perceived consensus, personal beliefs, and behavioral intent or policy attitudes.

Methods

Sample

The online survey firm YouGov collected survey responses (in Spanish) from a national sample in Spain in May-June 2020. YouGov recruits a large panel of opt-in respondents and then uses a weighting and matching algorithm to create a sample that mirrors the demographics of the Spanish public. (YouGov determines the specific eligibility and exclusion criteria for their panel). Participation in the study was voluntary and participants received YouGov points for their participation. We obtained a total sample of 5087 participants (2592 men, 2495 women, 26% university educated, $M_{\text{age}} = 45.11$, $SD_{\text{age}} = 14.45$), including an oversample of participants residing in Cataluña.[2] Our descriptive results that follow use the weights supplied by YouGov to match the demographics of the Spanish population, though our experimental models do not employ these weights per Franco et al. (2017) and Miratrix et al. (2018).

Design

We specifically target two claims in our consensus treatments: the unsupported claim that the MMR vaccine causes autism, and the claim the GMO foods are not as as safe to consume as conventional foods. Virtually no experts support the first claim; over 90% of U.S. physicians agree that adults and children should receive all recommended vaccines (let alone MMR), for instance (Gust et al., 2008; van der Linden, 2016). Likewise, 88% of the American Association for the Advancement of Science (AAAS) members agreed that GMO foods were safe to eat (Funk et al., 2015a), and the National Academies of Sciences, Engineering and Medicine (NASEM) concluded in a 2016 consensus statement that there is "no substantiated evidence of a difference in risks to human health between currently commercialized genetically engineered (GE) crops and conventionally bred crops," and further,"no conclusive cause-and-effect evidence of environmental problems from the GE crops."

[2] As this large survey included other orthogonal studies, one focusing on attitudes about the independence movement, we oversample of participants residing in Cataluña.

(Landrum et al., 2019). Still, it should be noted that this is not an uncontested position, as other groups (e.g., the European Network of Scientists for Social and Environmental Responsibility) have questioned the consensus on GMO safety, emphasizing the uncertainty of such calculations (Landrum et al., 2019). Regardless, both the MMR vaccine and GMO foods have been broadly endorsed by relevant experts. In addition to looking at the effects of communicating such consensus on directly related beliefs, we further examine potential spillover effects on other vaccine and GMO-related attitudes.

Accordingly, we conducted two experiments that vary slightly in the specifics of the design. Participants were randomly assigned to the GMO experiment or the vaccination experiment. The vaccination experiment (n = 3,539) employed a 2 (scientific vs. social consensus) x 2 (90% vs. 75%) between subjects factorial design, with an additional control condition exposed to no vaccination information(the 4 treatment groups ranged from 613 to 633, with control group n = 1,031). The message in this experiment targeted the MMR-autism misperception, with messages presented as follows: "More than [75/90] out of 100 [medical scientists/people] agree that the MMR vaccine does not cause autism."

The GMO experiment (n = 3587) employed a between-subjects design with one factor (percentage of scientific norm) and 8 levels (60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%), as well as a control condition (no message on GMOs) (the 8 treatment groups ranged from 284-349, with control group n = 1,008). Messages were presented as follows: "More than [X] out of 100 food scientists agree that genetically modified food is safe to eat." In the case of GMOs, which historically have been more distrusted in Europe than in the U.S. (Ceccoli & Hixon, 2012; Wunderlich & Gatto, 2015), we do not test parallel social consensus conditions as such messages may lack external validity and raise participant suspicion (this is in part borne out in our descriptive results below, which show high levels of negative beliefs about GMOs in the control group).

In other words, the two experiments differ somewhat in the specific variations in consensus treatment conditions due to the underlying nature of the two issues. Vaccines are more broadly popular and more positively perceived than GMOs in our sample (and elsewhere), and so it is more appropriate to test the effects of social consensus in this case. Similarly, the potential uncertainty in GMO effects asserted in some expert statements (Landrum et al., 2019) allowed us to test a wider range of consensus degrees going as low as 60 percent consensus. This variation may make it more difficult to directly compare the effects of consensus messaging across issues.

About 20% of the participants who were assigned to the GMO [vaccination] experiment were randomly assigned to answer the outcome variables of the vaccination [GMO] experiment. These participants acted as our control group for the vaccination [GMO] experiment. For this reason, the final n is about 3,500 for each experiment (Table C1).

Following the treatment, respondents provided responses on a number of outcome measures. Our main focus follows prior consensus message work: perception of consensus, personal belief, and relevant outcome (policy attitude or behavioral intent). Another important test for any intervention is whether it produces unintended spillover effects (good or bad). The literature on fact-checking for instance often shows not only effects of corrections on targeted beliefs, but other relevant beliefs or attitudes (B. Lyons et al., 2019; B. A. Lyons et al., 2020; Khanna & Sood, 2018; Carey et al., 2022). We follow this logic in our experiments by testing a number of potential spillover effects of interest. Specifically, in the GMO experiment, we look at effects on conspiracy beliefs concerning GMOs, an outcome that to our knowledge has not been examined in the consensus messaging literature. Consensus messaging might have a general "halo effect" (Ahluwalia, 2000) that improves responses toward GMOs regardless of the thrust of the claim, thereby reducing conspiracy beliefs. In the vaccine experiment, we look at a number of potential attitude or belief spillovers – in addition to conspiracy beliefs about vaccines, we look at general vaccine hesitancy, and beliefs about vaccines other than the MMR (flu, and HPV). Again, we test whether positive consensus messaging about the MMR vaccine has spillover effects on these untargeted outcomes. To our knowledge, these have likewise not been tested in a consensus messaging framework.

In sum, for GMOs, we look at the targeted consensus belief regarding consumption, the targeted personal belief, and potential spillover outcomes (perception of consensus on environmental harm, personal belief on environmental harm, policy attitude, and related conspiracy beliefs about

GMOs). As per our pre-registered analysis plan, in our primary analysis we scale together both consensus perceptions, both personal beliefs, and both conspiracy beliefs, as these respective outcomes are highly correlated. For vaccines, we similarly look at the targeted consensus perception and personal belief as well as numerous potential spillover outcomes, which we likewise group according to the pre-registered analysis plan. All respondents were debriefed at the conclusion of the survey (see supplemental materials).

Measures

Respondents first provided demographic information and completed a series of batteries measuring predispositions that we employ as moderators (moderator measures and tests are reported in Appendix B). They were then exposed to one of the experimental treatments, and subsequently completed the outcome measures. We describe our measures below in the order in which they appeared to participants (note that we provide the English translation of the items here). All items included a "don't know" response option unless specified otherwise.

Covariates

We measure a set of standard demographics for use as covariates in our models in order to increase precision around our estimates. In addition to standard demographics (age, gender, and university education), we measure religiosity using the item: "Lots of things come up that keep people from attending religious services even if they want to. Thinking about your life these days, how often do you go to religious services?"on a scale the ranged from *never* (1) to *once a week or more* (7) (M = 2.39, SD = 1.71). Religiosity was included based on prior work showing its association with scientific attitudes and beliefs in the region Rutjens et al. (2018); Pasek (2018)

In order to examine potential political differences, we also measure left-right ideology with the following measure: "When it comes to politics, people speak of "the left" and "the right." What is your position? Please place yourself on a scale from 0 to 10, where 0 indicates "extremely left" and 10 indicates "extremely right." What number best describes your position?" (M = 4.65, SD

= 2.17). To measure partisanship, asked "To which of the following political parties do you feel closest to?" and most were given the following options: Partido Popular (PP), Partido Socialista Obrero Espanol (PSOE), Podemos, Vox, Ciudadanos â Partido de la Ciudadania (Cs), Other, None, or "I don't know." The subset of participants residing in Cataluña were given the alternative options of: PP, PSOE, Podemos, Vox, En Comu Podem, Esquerra Republicana de Catalunya/Izquierda Republicana de Cataluna, Junts Per Catalunya/Juntos por Cataluna, Other, None, or "I don't know." In our analyses, we use indicators for PP, Podemos, Vox, Ciudadanos, other party (collecting some of the minor parties listed above), and no party (including none and don't know), with PSOE, currently the largest party, as the reference group. Finally, we ask about attention to politics as follows: "Some people seem to follow what's going on in government and public affairs most of the time, whether there's an election going on or not. Others aren't that interested. Would you say you follow what's going on in government and public affairs" on a scale ranging from *hardly at all* (1) to *most of the time* (4) (M = 2.92, SD = .86)

Outcome measures

We then asked participants to use a 5-point Likert scale to indicate their agreement with a series of questions that reflect perceived consensus, personal beliefs, and behavioral or policy intent. Full question wording (and response distributions) are available in Table C2.

Per our pre-registration, we group GMO items into four measures (Chronbach's alpha and Spearman's rho reported where appropriate): personal beliefs about GMO safety, coded with perceived safety high (items 1 and 2; item 1 reverse coded; $\alpha = .57, \rho = .40$), perceived consensus on GMO safety, coded with safety high (items 3 and 4; $\alpha = .73, \rho = .56$), support for a ban (item 5), and GMO conspiracy beliefs (items 6 and 7; $\alpha = .62, \rho = .44$). (Note that we group items as detailed here due to their anticipated correlations, though we reiterate that only the consumption-safety items (personal belief and perceived consensus) were technically targeted by the consensus message, while others are measured for potential spillover effects.)

While the focus of the vaccine consensus message deals with the fallacious MMR-autism link, we also test for potential spillover effects on human papilomavirus (HPV), influenza, and general vaccine beliefs or attitudes. Per our pre-registration, we group vaccine items into seven measures: general vaccine hesitancy (items 1 and 2; $\alpha = .59, \rho = .43$), autism misperceptions (items 3 and 4; $\alpha = .88, \rho = .77$), HPV misperceptions (items 5, 6, and 7; item 6 reverse coded; α = .53), flu vaccine misperception (item 8), vaccination intention (item 9), vaccine conspiracy beliefs (items 10 and 11; $\alpha = .74, \rho = .58$), and finally misperception of expert consensus, which again uses items 4 and 7 ($\alpha, = .76, \rho = .64$). (Again, we note that the autism items were targeted in the consensus messages, while other items are measured for potential spillover effects.)

We also report results for each experiment using latent variables revealed through (pre-registered) exploratory factor analysis as outcome measures in Table B1. Finally, we report results for all outcome measures individually (Tables B2-B3).

Results

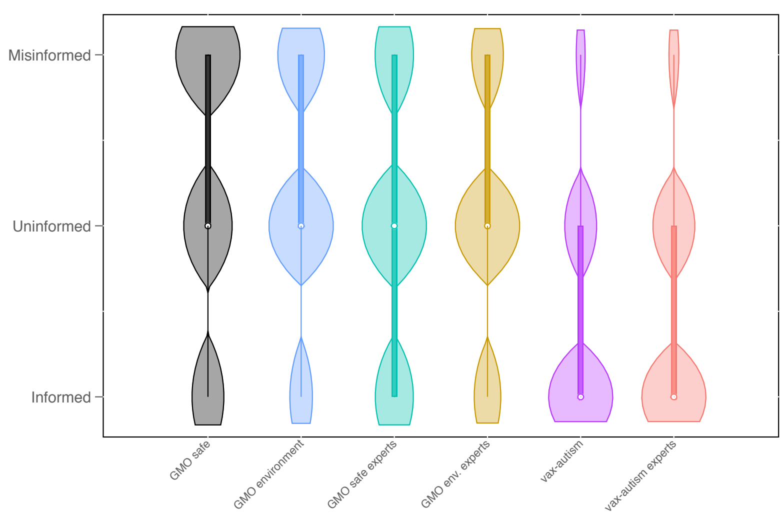
Descriptive Results

Prevalence of beliefs and misperceptions

First we provide descriptive statistics about the prevalence of consensus awareness and personal beliefs about GMOs and vaccines in our national sample (Table A1). These items are those most directly targeted in our consensus message treatments (though note that the GMO-environmental harm items are not directly targeted, but presented for context). These findings come from the control conditions and employ survey weights. We also distinguish between being *mis*informed and *un*informed (Kuklinski et al., 2000), as this may be important in corrective efforts (Li & Wagner, 2020). To emphasize this distinction, we include several additional columns that indicate the proportion that are "misinformed" (their belief is inconsistent with scientific evidence), "informed" (their belief is consistent with scientific evidence), and those who are "uninformed" (neither agreeing nor disagreeing or indicating that they do not know the answer). Although the nature of scientific consensus is inherently open to ongoing contestation, for simplicity we refer here to agreement with the vaccine and GMO consensus references mentioned above (Gust et al., 2008; Landrum et al., 2019). Finally, we estimate the ratio of misinformed to informed responses.

Negative perceptions of GMOs are common: 43.5% believe GMOs are unsafe to eat and 36.2% believe they harm the environment. Only 20.4 and 16.7% are informed on these questions, respectively. The public is also misinformed regarding the scientific consensus on the questions of safe consumption and environmental harm (27% and 25%, respectively). Likewise, the proportion of the public uninformed is also large for personal GMO beliefs (e.g., 47.1% for are categorized as uninformed regarding the personal safety item), and even larger regarding scientific consensus (e.g., 53% are categorized as uninformed regarding scientists' views on environmental harm), suggesting many citizens could be responsive to corrective efforts (Li & Wagner, 2020). Misperceptions about vaccines are less prevalent. Only 8.8% believe vaccines cause autism, while 60.9% are informed on the question, and similar numbers are misinformed/informed regarding scientists' views.

Figure 1: Misinformed and uninformed proportions for GMO and vaccine questions



Note: Violin plot illustrating kernel probability density (i.e., width is representative of the proportion of responses located at that value on the Y-axis). White dots are medians and dark bars are the interquartile range. Unweighted data from control conditions. Categories are defined as follows: "misinformed" (belief inconsistent with scientific evidence); "informed" (belief consistent with scientific evidence); "uninformed" (neither agreeing nor disagreeing or indicating that they do not know the answer).

Political and social division

Next, we present a pre-registered test of whether self-reported ideology is associated with GMO or vaccine beliefs.[3] These regression models look only at respondents in the control condition who received no information about the relevant issue (therefore model *n*s are between 853 and 961). We use survey weights and include standard co-variates of age, sex, and education, as well as religiosity and attention to politics as these may be associated with outcomes and unequally distributed across political preferences (Rutjens et al., 2018; Pasek, 2018). These tests show no association of ideology with any of the beliefs or attitudes relating to GMOs or vaccines (Tables A2 and A3 and Figure 2). Our models also show little to no significant differences in GMO beliefs based on other common predictors of social divisions of education or religiosity. However, education is associated with lesser agreement with most vaccine misperception measures, while religiosity is associated with greater agreement on most measures. Those who follow politics more often also exhibit greater levels of vaccine misperceptions.

Based on these model specifications but replacing ideology with party affiliation, we likewise show no polarization based around political parties for GMO beliefs (Figure A1). For vaccine beliefs (Figure A2), we likewise see little polarization, but note that Vox party affiliates, those affiliating with other minor parties, and those affiliated with no party are more likely to say they would skip vaccination than the reference party (Partido Socialista Obrero Español (PSOE), the current largest party in Spain), and other minor party and no-party respondents displayed greater endorsement of some other vaccine-hesitant items relative to PSOE (we report on party polarization surrounding these beliefs for this sample in greater detail in Authors, 20XX).

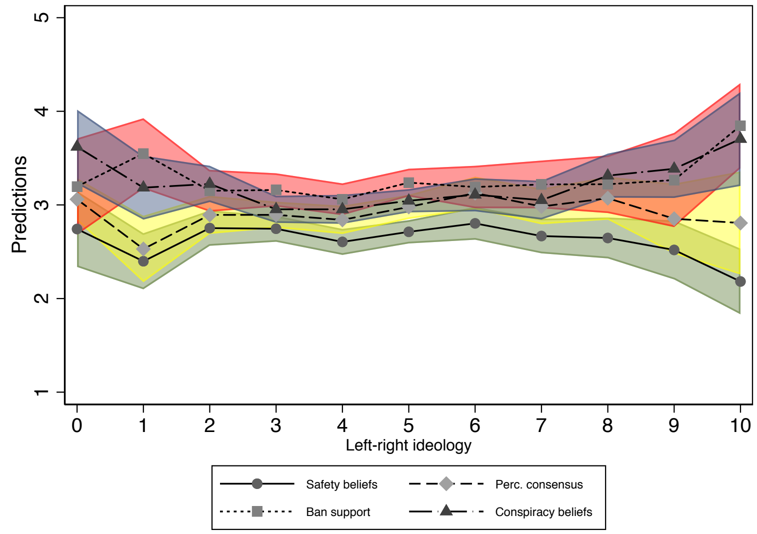
Lastly, we conducted exploratory analyses to determine if there were significant regional differences in these beliefs. We find no regional differences in GMO outcomes, but those in the Northeast (e.g, Cataluña) exhibit greater vaccine misperceptions than those in other regions including Madrid, the North, and the Northwest (see Tables A6 and A7). Note that this should not be because of the

[3] We expected that left-leaning political preferences (i.e., ideology and party affiliation) would be related to GMO beliefs. For vaccine beliefs, we did not predict an association with political preferences.

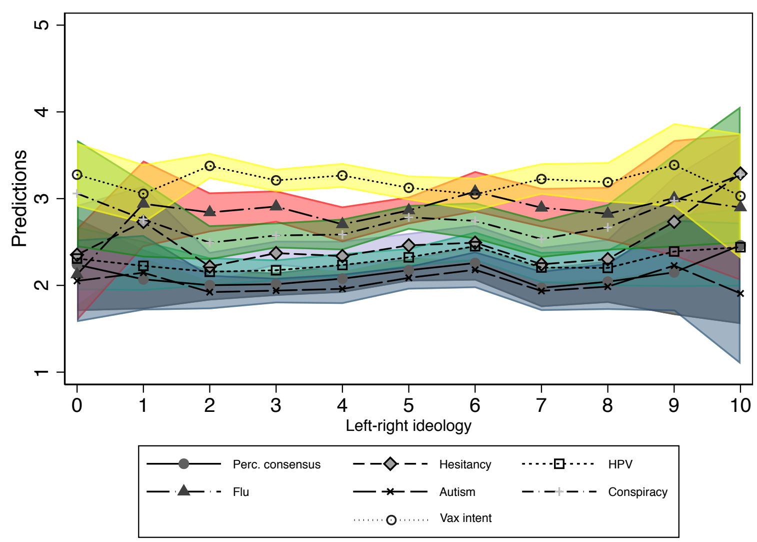
over-sample of the Northeast, as this should merely give us a more precise estimate with smaller confidence intervals; as it is the largest regional subgroup, we set this as the reference category. As this was exploratory, we do not speculate about the cause of any such regional differences.

Figure 2: Predicted values of outcome measures across ideology

(a) GMO outcomes across ideology



(b) Vaccine outcomes across ideology



Notes: Predicted values based on linear regression. Shaded areas are 95% confidence intervals. All outcomes measured on 5-pt. scales. All models include age, education, gender, religiosity, and attention to politics as covariates set at means and use survey weights. Data come from the control conditions.

Hypothesis Tests

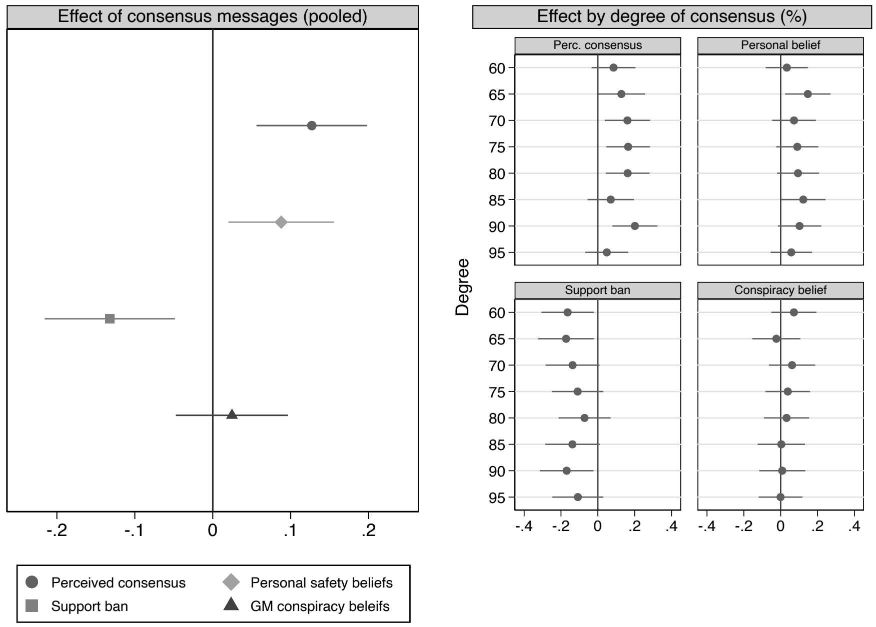
Next we test the effects of consensus. Due to recently highlighted difficulty of satisfying the strong assumptions required in mediation analysis (Imai et al., 2011; Green et al., 2010; Bullock & Ha, 2011; Rohrer et al., 2021), we follow those who focus on direct effects on consensus messages (Deryugina & Shurchkov, 2016; Benegal & Scruggs, 2018). (As Bayes et al. (2020) write in their review of this literature, "for reasons explained by McGrath (n.d.), the mediational evidence presented to-date is insufficient to definitively show an indirect causal path from consensus messages to consensus belief to policy support, as it requires experimental manipulation of the mediators to conclusively establish causality.") For both GMOs and vaccination, we model message effects on our various outcomes of interest separately. All models include a set of standard co-variates (age, sex, education, and religiosity) to improve precision (Angrist & Pischke, 2009).

Does scientific consensus affect GMO beliefs?

To examine the correction hypothesis for GMOs, we pool all consensus conditions and compare against the control condition. The left hand panel in Figure 3 (full results in Table A8) shows the effect of exposure to any consensus message on perceived consensus, personal safety beliefs, support for a ban on GMOs, and belief in GMO conspiracy theories. Consensus messages increased perceived consensus ($b = .13$, $SE = .04$, $p < .005$), and to a lesser extent personal safety beliefs as well ($b = .09$, $SE = .03$, $p < .05$). In contrast to other scholars' findings, our consensus messages also had a significant negative direct effect on support for a ban ($b = -.13$, $SE = .04$, $p < .005$). There was no effect on conspiracy beliefs.

An alternative visualization of scientific consensus effects is shown in Figure 4. Here, we refer back to the "misinformed, uninformed, and informed" categorizations that we reported in our descriptive findings. To show effects across these categories, we use multinomial logistic regression (e.g. Nadeau & Niemi, 1995; Mondak, 2000). Our models use the same co-variates as the previous models, but differ in that "don't know" response are now included (in the "uninformed" outcome category) and test effects on each item individually, as averaging the two consensus be-

Figure 3: Effects of scientific consensus messages on GMO outcomes



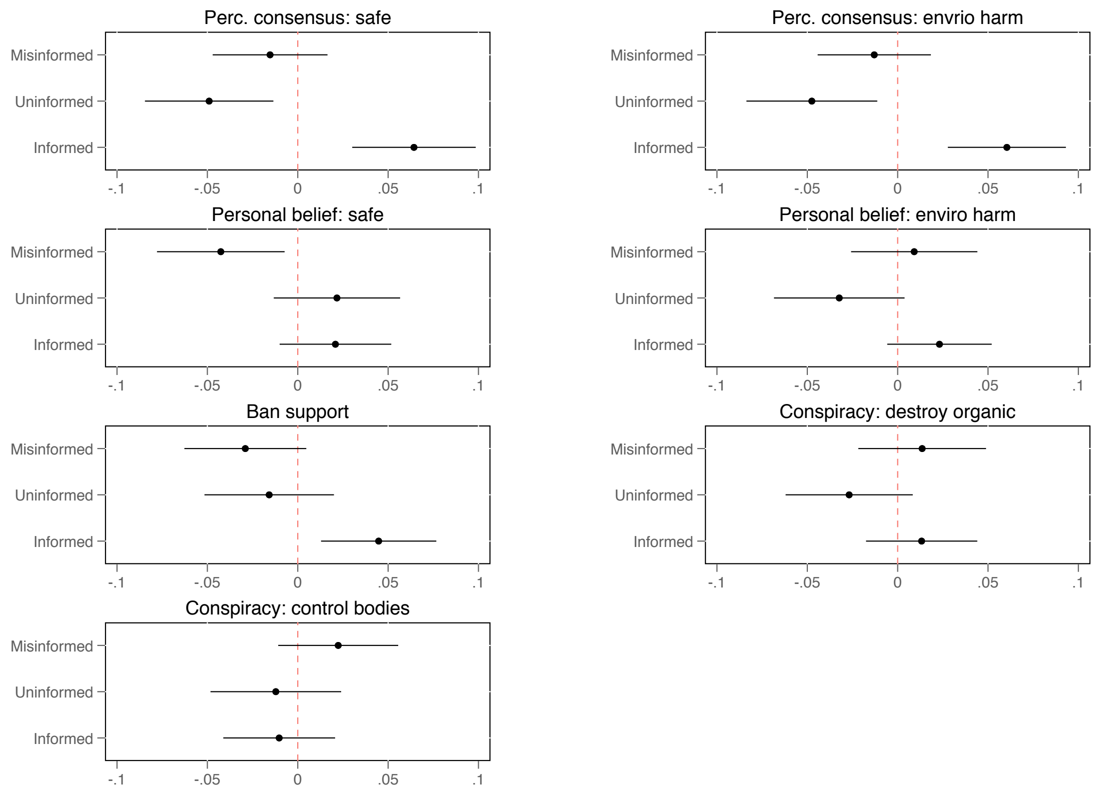
Notes: OLS regression coefficients. Error bars are 95% confidence intervals. All outcomes measured on 5-pt. scales. Models in the left panel pool all consensus messages compared against a control. All models include age, sex, education, and religiosity as co-variates. Model *n* ranges from 3217 to 3372.

liefs, for example, would not allow for discrete categorization. (Note also that for simplicity we use the same categorization scheme for policy attitude, though such an attitude cannot be deemed to be informed or misinformed). Results suggest messages increased the probability of informed responses on either consensus belief by about 6% (*ps* < .001), with about a 5% decrease in probability of uninformed responses (*ps* < .01). For personal safety belief, messages reduced the probability of misinformed responses by about 4% ($p < .05$). Messages increased the probability of opposing a GMO ban by about 4% ($p < .01$).

Does the degree of scientific consensus matter?

To test the norms hypothesis for GMOs, we create an indicator variable for each of the eight levels of consensus, with the control serving as the reference category. When looking at perceived consensus, there is a suggestion of a linear effect — 60–65% messages have no effect, while 70–80% messages have significant effects, with 90% consensus having the strongest effect ($b = .20$, $SE = .06$, $p <$

Figure 4: Effects of scientific consensus message on GMO outcomes: Predicted change in "misinformed/uninformed/informed" by item



Notes: Multinomial logistic regression outcomes. Point estimates are average marginal effects. Error bars are 95% confidence intervals. "Informed" refers to agree/strong agree responses for scientifically supported statements or disagree/strong disagree for unsupported statements; "misinformed" refers to the reverse; "uninformed" refers to neither agree or disagree or DK responses. Models pool all consensus messages compared against a control. All models include age, sex, education, and religiosity as co-variates set at means. Model *n* ranges from 3572 to 3575.

.005). However, neither 85% nor 95% consensus messages have significant effects on perceived consensus. Further, linear comparisons of these effects showed that only significant difference among messages was between 90 and 95% (b = .15, SE = .07, p = .041). The results for personal safety beliefs and ban support are even less consistent regarding the degree of consensus (see the right hand panel in Figure 3 and Table A9).

Are the effects of scientific consensus on GMO beliefs conditional?

Finally, we examined whether the GMO consensus message effects were conditional on a series of predispositions. We provide theoretical background on differential acceptance, measurement detail, and full results for these pre-registered (though exploratory) analyses in Appendix B. Although many of these measures are associated with GMO beliefs, there is limited evidence of any consistent moderation effects. In fact, we find that consensus messages result in *larger* decreases in support for a GMO ban among the most conspiratorial, those most reliant on intuition, and those lowest in general trust. We report these models in full in the Tables B4 through B7.

Does consensus affect vaccine beliefs?

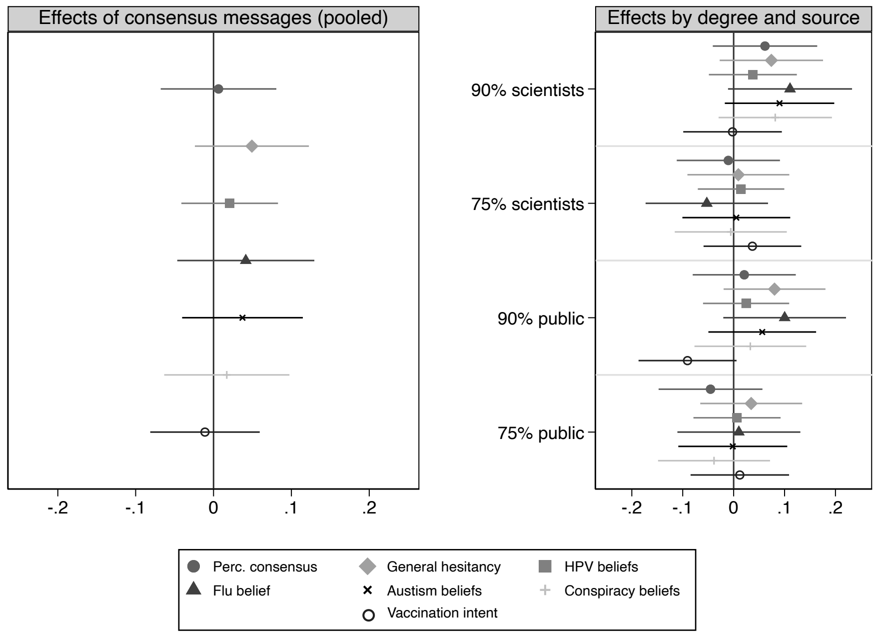
To examine the correction hypothesis for vaccinations, we likewise pool all consensus conditions and compare against the control condition as we did for the GMO experiment. We find no effect on autism beliefs (the target of the consensus message), nor on any related vaccine beliefs about the influenza vaccine, HPV vaccine, general vaccine hesitancy, vaccine conspiracy beliefs, misperceptions of consensus, or behavioral intentions (left hand panel of Figure 5 and Table A10). We also model the effects of the four conditions each entered separately as an indicator variable. Neither scientific nor social consensus influence these beliefs, at either 75 or 90% levels (right hand panel of Figure 5 and Table A11). In other words, there was no effect on vaccine beliefs regardless of source or degree of consensus.

Discussion

When does communicating scientific consensus influence the public? In a large national Spanish sample we find that consensus messages produced direct increases on not only perceived consensus on GMO safety, but also personal beliefs, while decreasing support for a ban on such crops. These direct effects on personal beliefs and policy preferences are surprising, and come in contrast to a literature that typically finds indirect effects (van der Linden, Leiserowitz, et al., 2015) at best (Bolsen & Druckman, 2018; Landrum et al., 2019; G. Dixon, 2016; Deryugina & Shurchkov, 2016; Kerr & Wilson, 2018a).[4] These effects are not undercut by either GMO concern or a host of psychological traits that sometimes lead to the rejection of expertise or official accounts (e.g, G. N. Dixon et al.,

[4] It is noteworthy that the only other study to find direct effects on personal beliefs was also focused on GMOs (Kerr & Wilson, 2018a).

Figure 5: Effects of consensus messages on vaccine outcomes



Notes: OLS regression coefficients. Error bars are 95% confidence intervals. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). Models in the left panel pool all consensus messages compared against a control. All models include age, sex, education, and religiosity as co-variates. Model *n* ranges from 2816 to 3392.

2015). On the other hand, we find no effects on vaccine beliefs or attitudes regardless of source or level of consensus.

Considering the proportion of the public holding relevant misperceptions and knowledge of expert consensus on these topics might help explain why we observe these differences. As stated, up to 43.5% of the sample believed GMOs are unsafe, while only about 9% reported belief that vaccines cause autism. Likewise, consensus awareness was substantially lower for GMO items (about a quarter of respondents) than for vaccine-autism (over half of respondents). Further, GMO beliefs may not be tied to the elements of social identity that anti-vaccinations beliefs have taken on in and of themselves (Attwell & Smith, 2017; Attwell et al., 2018). There is also no ideological association across GMO or vaccine beliefs among our sample (in contrast to climate change in the U.S.), and further, no association of GMO beliefs with party affiliation, religiosity, or national region, limiting differential acceptance. As such, it may be easier for respondents to let new knowledge of expert consensus shape their personal beliefs. It is also worth reflecting on work testing climate consensus effects across samples (M. Goldberg et al., 2019) that found larger effect sizes among more representative samples (as many convenience samples skew younger and more educated and thus more informed on the issue *a priori*); our sample quality may have contributed to our ability to detect effects on GMO outcomes.

On the other hand, our findings point to some additional limits to consider for consensus effects. Interestingly, our results did not show that increasing degrees of consensus necessarily results in larger effects on beliefs. While the pattern of treatment effects for perceived consensus mostly follow the expected pattern, personal belief and policy support did not. This is not necessarily surprising in retrospect as these outcomes are less closely tied to the degree of consensus *per se*; rather, the existence of any form of consensus could represent a tipping point for influencing these outcomes (Andrighetto & Vriens, 2022). Taken together, these results care largely convergent with those of Chinn et al., 2018, who found increasing degree of consensus increases perception of scientific certainty (and indeed, does so non-linearly, but not funding support across multiple issues. Lastly, although updated consensus beliefs may have "spilled over" to personal beliefs about GMO safety, and policy preference, there appears to be a limit to such halo effects, as conspiracy beliefs were not affected (Carey et al., 2022; Ahluwalia, 2000). Overall, our findings suggest a number of possible boundary conditions for consensus effects, helping to address calls from the field to do so (Bayes et al., 2020).

The boundary conditions outlined above should be examined in different cultural and political contexts, however. Most research on consensus effects has been conducted in the U.S., with some exceptions for work conducted in Australia, New Zealand, and Japan (Cook & Lewandowsky, 2016; Kerr & Wilson, 2018a,b; Kobayashi, 2019, 2018). We further the evidentiary base on consensus messaging by examining effects across issues and examining potential spillover effects in a large national sample in Spain, but more work is needed. Indeed, one of the key limitations of our study is that we look at only one (novel) national case. To better understand the conditions under which these messages are successful, future work would ideally consist of cross-national, multi-issue comparisons. Additionally, longitudinal designs could tell us how quickly such effects might decay.

Ultimately, we test single, brief messages and detect small effects. These effects are in line with the expectations derived from prior work, and exceed those in terms of direct effects, but it is important not to over-promise large increases in public understanding and acceptance of contested science (for discussions of small effect sizes in climate attitude research, see Rode et al. (2021); Chinn & Hart (2021b)). On the other hand, it is worth reflecting on the spillover effect we detected: Although the GMO consensus message targeted the safety of consuming GMO foods, this message nonetheless influenced perceptions of experts' views about these crops' environmental impact as well (though this is likewise supported in the 2016 NASEM statement). If such halo effects (Feeley, 2002) are common in consensus message processing, organizations should take care in how they craft statements on nuanced issues.

Our conclusions are also relevant to the contextual efficacy of corrections more generally. That is, understanding the contours of consensus efficacy — which may be driven by proportions of misperceptions, awareness of scientific evidence, and polarization surrounding an issue in a given population and context — can also inform corrective strategies that do not center on consensus messaging. These lessons can be useful when examining the role of information and persuasion on contested factual issues writ large.

Data availability statement

The data underlying this article and code required to reproduce the analyses are available at the Open Science Framework, at https://osf.io/7n9kt/?view_only=4c1b6457ea8746e5bdfbbcd6d9cd [blinded for peer review].

References

Ackah, M., Ameyaw, L., Gazali Salifu, M., Afi Asubonteng, D. P., Osei Yeboah, C., Narkotey Annor, E., … Boakye, H. (2022). Covid-19 vaccine acceptance among health care workers in africa: A systematic review and meta-analysis. *PLoS One*, *17*(5), e0268711.

Ahluwalia, R. (2000). Examination of psychological processes underlying resistance to persuasion. *Journal of Consumer Research*, *27*(2), 217–232.

Andrighetto, G., & Vriens, E. (2022). A research agenda for the study of social norm change. *Philosophical Transactions of the Royal Society A*, *380*(2227), 20200411.

Angrist, J. D., & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.

Anson, I. G. (2022). Epistemic confidence conditions the effectiveness of corrective cues against political misperceptions. *Research & Politics*, *9*(2), 20531680221107869.

Anspach, N. M., Jennings, J. T., & Arceneaux, K. (2019). A little bit of knowledge: Facebookâs news feed and self-perceptions of knowledge. *Research & Politics*, *6*(1), 2053168018816189.

Attwell, K., & Smith, D. T. (2017). Parenting as politics: social identity theory and vaccine hesitant communities. *International Journal of Health Governance*.

Attwell, K., Smith, D. T., & Ward, P. R. (2018). 'the unhealthy other': How vaccine rejecting parents construct the vaccinating mainstream. *Vaccine*, *36*(12), 1621–1626.

Bayes, R., Bolsen, T., & Druckman, J. N. (2020). A research agenda for climate change communication and public opinion: The role of scientific consensus messaging and beyond. *Environmental Communication*, 1–19.

Benegal, S. D., & Scruggs, L. A. (2018). Correcting misinformation about climate change: The impact of partisanship in an experimental setting. *Climatic change*, *148*(1-2), 61–80.

Bolsen, T., & Druckman, J. N. (2018). Do partisanship and politicization undermine the impact of a scientific consensus message about climate change? *Group Processes & Intergroup Relations*, *21*(3), 389–402.

Bullock, J. G., & Ha, S. E. (2011). 35. mediation analysis is harder than it looks. *Cambridge handbook of experimental political science*, 959.

Carey, J. M., Guess, A. M., Loewen, P. J., Merkley, E., Nyhan, B., Phillips, J. B., & Reifler, J. (2022). The ephemeral effects of fact-checks on covid-19 misperceptions in the united states, great britain and canada. *Nature Human Behaviour*, *6*(2), 236–243.

Ceccoli, S., & Hixon, W. (2012). Explaining attitudes toward genetically modified foods in the european union. *International Political Science Review*, *33*(3), 301–319.

Chinn, S., & Hart, P. S. (2021a). Climate change consensus messages cause reactance. *Environmental Communication*, 1–9.

Chinn, S., & Hart, P. S. (2021b). Effects of consensus messages and political ideology on climate change attitudes: inconsistent findings and the effect of a pretest. *Climatic change*, *167*(3-4), 47.

Chinn, S., Lane, D. S., & Hart, P. S. (2018). In consensus we trust? persuasive effects of scientific consensus communication. *Public Understanding of Science*, *27*(7), 807–823.

Clarke, C. E., Weberling McKeever, B., Holton, A., & Dixon, G. N. (2015). The influence of weight-of-evidence messages on (vaccine) attitudes: a sequential mediation model. *Journal of Health Communication*, *20*(11), 1302–1309.

Cook, J., & Lewandowsky, S. (2016). Rational irrationality: Modeling climate change belief polarization using bayesian networks. *Topics in cognitive science*, *8*(1), 160–179.

Cook, J., Oreskes, N., Doran, P. T., Anderegg, W. R., Verheggen, B., Maibach, E. W., … others (2016). Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters*, *11*(4), 048002.

Cook, J., van der Linden, S., Maibach, E., & Lewandowsky, S. (2018). *The consensus handbook: Why the scientific consensus on climate change is important.* Retrieved from www.climatechangecommunication.org/all/consensus-handbook

Deryugina, T., & Shurchkov, O. (2016). The effect of information provision on public consensus about climate change. *PloS one*, *11*(4), e0151469.

DeStefano, F., & Shimabukuro, T. T. (2019). The mmr vaccine and autism. *Annual review of virology*.

Dixon, G. (2016). Applying the gateway belief model to genetically modified food perceptions: New insights and additional questions. *Journal of Communication*, *66*(6), 888–908.

Dixon, G., Hmielowski, J., & Ma, Y. (2017). Improving climate change acceptance among us conservatives through value-based message targeting. *Science Communication*, *39*(4), 520–534.

Dixon, G., Hmielowski, J., & Ma, Y. (2019). More evidence of psychological reactance to consensus messaging: A response to van der linden, maibach, and leiserowitz (2019). *Environmental Communication*, 1–7.

Dixon, G. N., McKeever, B. W., Holton, A. E., Clarke, C., & Eosco, G. (2015). The power of a picture: Overcoming scientific misinformation by communicating weight-of-evidence information with visual exemplars. *Journal of Communication*, *65*(4), 639–659.

Egan, P. J., & Mullin, M. (2017). Climate change: Us public opinion. *Annual Review of Political Science*, *20*, 209–227.

Feeley, T. H. (2002). Comment on halo effects in rating and evaluation research. *Human Communication Research*, *28*(4), 578–586.

Fernbach, P. M., Light, N., Scott, S. E., Inbar, Y., & Rozin, P. (2019). Extreme opponents of genetically modified foods know the least but think they know the most. *Nature Human Behaviour*, *3*(3), 251.

Flynn, D., Nyhan, B., & Reifler, J. (2017). The nature and origins of misperceptions: Understanding false and unsupported beliefs about politics. *Political Psychology*, *38*(S1), 127–150. doi: 10.1111/pops.12394

Franco, A., Malhotra, N., Simonovits, G., & Zigerell, L. (2017). Developing standards for post-hoc weighting in population-based survey experiments. *Journal of Experimental Political Science*, *4*(2), 161–172.

Funk, C., Hefferon, M., Kennedy, B., & Johnson, C. (2019). Trust and mistrust in americansâ views of scientific experts. *Pew Research Center*.

Funk, C., Rainie, L., & Page, D. (2015a). Americans, politics and science issues. *Pew Research Center*, *175*.

Funk, C., Rainie, L., & Page, D. (2015b). Public and scientistsâ views on science and society. *Pew Research Center*, *29*.

Garrett, R. K., & Weeks, B. E. (2017). Epistemic beliefsâ role in promoting misperceptions and conspiracist ideation. *PloS one*, *12*(9), e0184733.

Goldberg, M., van der Linden, S., Ballew, M. T., Rosenthal, S. A., & Leiserowitz, A. (2019). Convenient but biased? the reliability of convenience samples in research about attitudes toward climate change.

Goldberg, M. H., van der Linden, S., Ballew, M. T., Rosenthal, S. A., Gustafson, A., & Leiserowitz, A. (2019). The experience of consensus: video as an effective medium to communicate scientific agreement on climate change. *Science Communication*, *41*(5), 659–673.

Green, D. P., Ha, S. E., & Bullock, J. G. (2010). Enough already about âblack boxâ experiments: Studying mediation is more difficult than most scholars suppose. *The Annals of the American Academy of Political and Social Science*, *628*(1), 200–208.

Gust, D., Weber, D., Weintraub, E., Kennedy, A., Soud, F., & Burns, A. (2008). Physicians who do and do not recommend children get all vaccinations. *Journal of health communication*, *13*(6), 573–582.

Han, H., Blackburn, A. M., Jeftić, A., Tran, T. P., Stöckli, S., Reifler, J., & Vestergren, S. (2022). Validity testing of the conspiratorial thinking and anti-expert sentiment scales during the covid-19 pandemic across 24 languages from a large-scale global dataset. *Epidemiology & Infection*, *150*, e167.

Hasell, A., Lyons, B. A., Tallapragada, M., & Jamieson, K. H. (2020). Improving gm consensus acceptance through reduced reactance and climate change-based message targeting. *Environmental Communication*, 1–17.

Hasell, A., & Stroud, N. J. (2020). The differential effects of knowledge on perceptions of genetically modified food safety. *International Journal of Public Opinion Research*, *32*(1), 111–131.

Imai, K., Keele, L., Tingley, D., & Yamamoto, T. (2011). Unpacking the black box of causality: Learning about causal mechanisms from experimental and observational studies. *American Political Science Review*, 765–789.

Imhoff, R., & Lamberty, P. K. (2017). Too special to be duped: Need for uniqueness motivates conspiracy beliefs. *European Journal of Social Psychology*, *47*(6), 724–734.

Jachimowicz, J. M., Hauser, O. P., OâBrien, J. D., Sherman, E., & Galinsky, A. D. (2018). The critical role of second-order normative beliefs in predicting energy conservation. *Nature Human Behaviour*, *2*(10), 757–764.

Kahan, D. M. (2016). The'gateway belief'illusion: Reanalyzing the results of a scientific-consensus messaging study. *Journal of Science Communication*, *16*(5), 1–20.

Kerr, J. R., & Wilson, M. S. (2018a). Changes in perceived scientific consensus shift beliefs about climate change and gm food safety. *PloS one*, *13*(7), e0200295.

Kerr, J. R., & Wilson, M. S. (2018b). Perceptions of scientific consensus do not predict later beliefs about the reality of climate change: A test of the gateway belief model using cross-lagged panel analysis. *Journal of Environmental Psychology*, *59*, 107–110.

Khanna, K., & Sood, G. (2018). Motivated responding in studies of factual learning. *Political Behavior*, *40*, 79–101.

Klofstad, C. A., Uscinski, J. E., Connolly, J. M., & West, J. P. (2019). What drives people to believe in zika conspiracy theories? *Palgrave Communications*, *5*(1), 1–8.

Kobayashi, K. (2018). The impact of perceived scientific and social consensus on scientific beliefs. *Science Communication*, *40*(1), 63–88.

Kobayashi, K. (2019). Communicating highly divergent levels of scientific and social consensus: its effects on peopleâs scientific beliefs. *Social Influence*, *14*(3-4), 65–76.

Kuklinski, J. H., Quirk, P. J., Jerit, J., Schwieder, D., & Rich, R. F. (2000). Misinformation and the currency of democratic citizenship. *Journal of Politics*, *62*(3), 790–816.

Landrum, A. R., Hallman, W. K., & Jamieson, K. H. (2019). Examining the impact of expert voices: communicating the scientific consensus on genetically-modified organisms. *Environmental Communication*, *13*(1), 51–70.

Landrum, A. R., & Slater, M. H. (2020). Open questions in scientific consensus messaging research.

Lapinski, M. K., & Rimal, R. N. (2005). An explication of social norms. *Communication theory*, *15*(2), 127–147.

Lewandowsky, S., Gignac, G. E., & Oberauer, K. (2013). The role of conspiracist ideation and worldviews in predicting rejection of science. *PloS one*, *8*(10), e75637.

Li, J., & Wagner, M. W. (2020). The value of not knowing: Partisan cue-taking and belief updating of the uninformed, the ambiguous, and the misinformed. *Journal of Communication*, *70*(5), 646–669.

Lynn, M., & Harris, J. (1997). Individual differences in the pursuit of self-uniqueness through consumption. *Journal of Applied Social Psychology*, *27*(21), 1861–1883. doi: 10.1111/j.1559-1816.1997.tb01629.x

Lyons, B., Merola, V., & Reifler, J. (2019). Not just asking questions: Effects of implicit and explicit conspiracy information about vaccines and genetic modification. *Health Communication*, *34*(14), 1741–1750.

Lyons, B. A., Merola, V., & Reifler, J. (2020). Shifting medical guidelines: Compliance and spillover effects for revised antibiotic recommendations. *Social Science & Medicine*, *255*, 112943.

Ma, Y., Dixon, G., & Hmielowski, J. D. (2019). Psychological reactance from reading basic facts on climate change: The role of prior views and political identification. *Environmental Communication*, *13*(1), 71–86.

Maio, G. R., & Esses, V. M. (2001). The need for affect: Individual differences in the motivation to approach or avoid emotions. *Journal of personality*, *69*(4), 583–614.

Martel, C., Pennycook, G., & Rand, D. (2019). Reliance on emotion promotes belief in fake news. Retrieved from https://psyarxiv.com/a2ydw/

McGrath, M. C. (n.d.). Experiments on problems of climate change. *Advances in experimental political science.*, 1–19.

Mildenberger, M., Tingley, D., et al. (2017). Beliefs about climate beliefs: the importance of second-order opinions for climate politics. *British Journal of Political Science*, *49*(4), 1279–307.

Miratrix, L. W., Sekhon, J. S., Theodoridis, A. G., & Campos, L. F. (2018). Worth weighting? how to think about and use weights in survey experiments. *Political Analysis*, *26*(3), 275–291.

Mondak, J. J. (2000). Reconsidering the measurement of political knowledge. *Political analysis*, 57–82.

Motta, M., Callaghan, T., & Sylvester, S. (2018). Knowing less but presuming more: Dunning-kruger effects and the endorsement of anti-vaccine policy attitudes. *Social Science & Medicine*, *211*, 274–281.

Nadeau, R., & Niemi, R. G. (1995). Educated guesses: The process of answering factual knowledge questions in surveys. *Public Opinion Quarterly*, *59*(3), 323–346.

National Academies of Sciences, Engineering, and Medicine. (2016). *Genetically engineered crops: experiences and prospects*. National Academies Press.

Pasek, J. (2018). It's not my consensus: Motivated reasoning and the sources of scientific illiteracy. *Public Understanding of Science*, *27*(7), 787–806.

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., Fugelsang, J. A., et al. (2015). On the reception and detection of pseudo-profound bullshit. *Judgment and Decision making*, *10*(6), 549–563.

Rode, J. B., Dent, A. L., Benedict, C. N., Brosnahan, D. B., Martinez, R. L., & Ditto, P. H. (2021). Influencing climate change attitudes in the united states: A systematic review and meta-analysis. *Journal of Environmental Psychology*, *76*, 101623.

Rohrer, J. M., Hunermund, P., Arslan, R. C., & Elson, M. (2021). *Thatâs a lot to process! pitfalls of popular path models.* PsyArXiv. Retrieved from psyarxiv.com/paeb7 doi: 10.31234/osf.io/paeb7

Rutjens, B. T., Sutton, R. M., & van der Lee, R. (2018). Not all skepticism is equal: Exploring the ideological antecedents of science acceptance and rejection. *Personality and Social Psychology Bulletin*, *44*(3), 384–405.

Thomson, K. S., & Oppenheimer, D. M. (2016). Investigating an alternate form of the cognitive reflection test. *Judgment and Decision Making*, *11*(1), 99–113.

Uscinski, J. E., Klofstad, C., & Atkinson, M. D. (2016). What drives conspiratorial beliefs? The role of informational cues and predispositions. *Political Research Quarterly*, *69*(1), 57–71. doi: doi.org/10.1177/1065912915621621

van der Linden, S. (2016). *Why doctors should convey the medical consensus on vaccine safety* (Vol. 21) (No. 3). Royal Society of Medicine.

van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology*, *62*, 49–58.

van der Linden, S. L., Clarke, C. E., & Maibach, E. W. (2015). Highlighting consensus among medical scientists increases public support for vaccines: evidence from a randomized experiment. *BMC public health*, *15*(1), 1–5.

Van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: plain facts, pie charts or metaphors? *Climatic Change*, *126*(1-2), 255–262.

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PloS one*, *10*(2), e0118489.

Wunderlich, S., & Gatto, K. A. (2015). Consumer perception of genetically modified organisms and sources of information. *Advances in Nutrition*, *6*(6), 842–851.

Appendix A: Main text full results

Descriptive results

Table A1: Proportion of the population holding misperceptions by item

Question wording	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know	Mis-informed	Informed	Uninformed	Ratio
I believe that genetically modified food harms the environment.	10.93%	25.26%	29.95%	13.16%	3.55%	17.15%	36.19%	16.71%	47.10%	2.17
I believe genetically modified foods are as safe to eat as conventional foods.	5.39%	15.00%	26.97%	28.57%	14.96%	9.12%	43.52%	20.39%	36.08%	2.13
Most scientists think that ... GMOs are as safe to eat as conventional foods	5.47%	20.16%	29.83%	18.67%	8.40%	17.46%	27.07%	25.63%	47.29%	1.06
Most scientists think that genetically modified food does no harm to the environment	3.05%	18.94%	34.00%	17.27%	7.33%	19.41%	24.6%	21.99%	53.41%	1.12
I believe some vaccines cause autism in healthy children.	2.57%	6.18%	14.48%	24.74%	36.17%	15.86%	8.75%	60.91%	30.34%	0.14
Most experts believe some vaccines cause autism in healthy children	1.53%	7.32%	17.95%	25.93%	30.71%	16.56%	8.85%	56.64%	34.51%	0.16

Note: Reported ratios estimate the ratio of misinformed to informed responses. Weighted data from control conditions. Categories are defined as follows: "misinformed" (belief inconsistent with scientific evidence); "informed" (belief consistent with scientific evidence); "uninformed" (neither agreeing nor disagreeing or indicating that they do not know the answer).

Table A2: GMO outcomes by ideology

	Perc. consensus	Personal safety beliefs	Ban support	Conspiracy beliefs
Ideology (R)	0.0239	-0.0087	0.0182	0.0195
	(0.0143)	(0.0117)	(0.0188)	(0.0159)
Age	-0.0058**	-0.0038*	0.0139***	0.0080***
	(0.0022)	(0.0016)	(0.0024)	(0.0023)
Education	0.0220	0.0170	-0.0410*	-0.0158
	(0.0140)	(0.0096)	(0.0171)	(0.0147)
Female	-0.1758***	-0.1027*	0.2380***	-0.0569
	(0.0607)	(0.0448)	(0.0724)	(0.0647)
Religiosity	0.0168	0.0150	-0.0059	0.0116
	(0.0183)	(0.0141)	(0.0233)	(0.0200)
Attention to politics	-0.0720*	-0.0694*	0.0149	0.0496
	(0.0366)	(0.0270)	(0.0438)	(0.0382)
Constant	3.1411***	3.1904***	2.6140***	2.6399***
	(0.1905)	(0.1296)	(0.2139)	(0.1945)
R^2	0.03	0.02	0.05	0.02
N	854	915	893	899

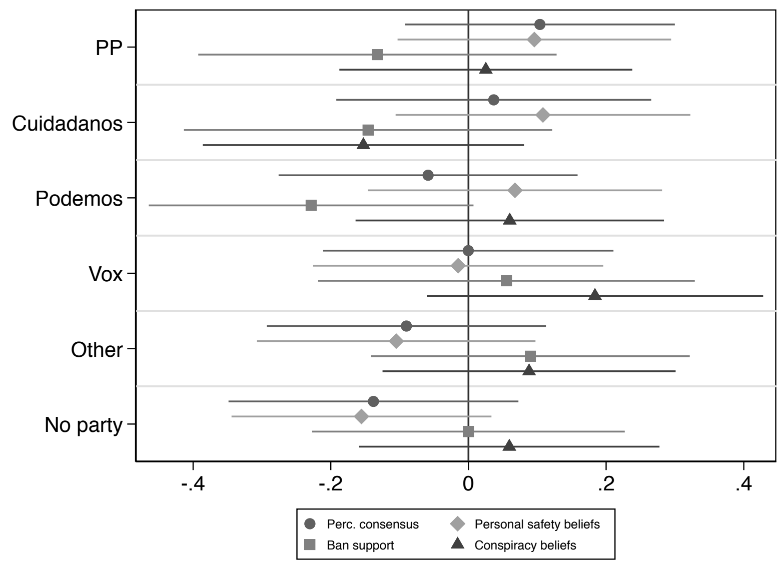
Notes: * $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. Data come from the control condition. Models use survey weights.

Table A3: Vaccine outcomes by ideology

	Perc. consensus	Hesitancy	HPV	Flu	Autism	Conspiracy	Vacc. intent
Ideology (R)	0.0102	0.0144	0.0174	0.0245	0.0107	0.0163	-0.0159
	(0.0176)	(0.0170)	(0.0139)	(0.0210)	(0.0186)	(0.0194)	(0.0151)
Age	-0.0017	-0.0014	0.0002	0.0036	-0.0048*	-0.0026	-0.0068***
	(0.0022)	(0.0024)	(0.0021)	(0.0029)	(0.0022)	(0.0026)	(0.0022)
Education	-0.0213	-0.0470***	-0.0456***	-0.0540***	-0.0091	-0.0680***	-0.0157
	(0.0156)	(0.0154)	(0.0133)	(0.0190)	(0.0170)	(0.0163)	(0.0147)
Female	-0.2134***	-0.3328***	-0.3365***	0.1830*	-0.2350***	-0.1109	0.2119***
	(0.0645)	(0.0662)	(0.0547)	(0.0826)	(0.0695)	(0.0709)	(0.0609)
Religiosity	0.1000***	0.0600***	0.0762***	0.0345	0.0915***	0.0626**	-0.0375
	(0.0214)	(0.0208)	(0.0172)	(0.0235)	(0.0219)	(0.0222)	(0.0201)
Attention to politics	0.1015*	0.1224**	0.0431	0.1243*	0.1126*	0.1622***	-0.1484***
	(0.0441)	(0.0435)	(0.0370)	(0.0521)	(0.0452)	(0.0487)	(0.0384)
Constant	1.9038***	2.4421***	2.3381***	2.4869***	1.9033***	2.6945***	3.9691***
	(0.2006)	(0.2159)	(0.1853)	(0.2555)	(0.2124)	(0.2319)	(0.1848)
R^2	0.06	0.06	0.09	0.03	0.05	0.05	0.04
N	865	961	853	938	882	944	940

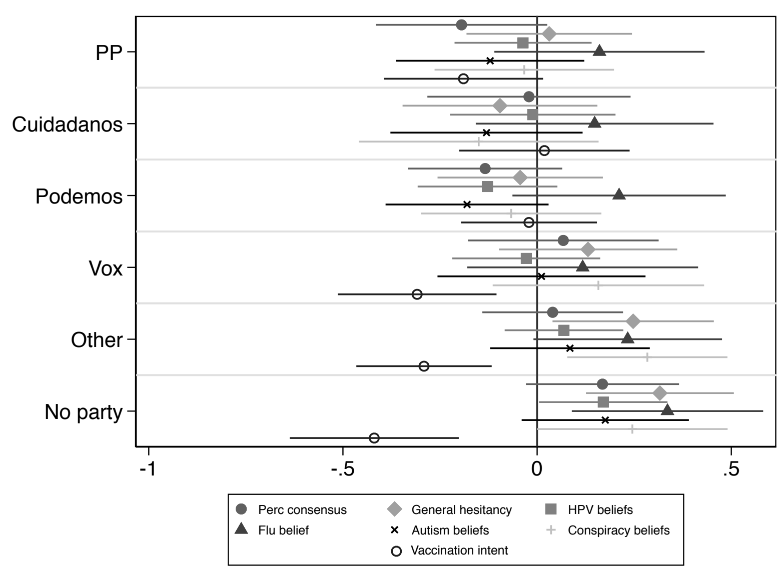
Notes: * $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). Data come from the control condition. Models use survey weights.

Figure A1: GMO outcomes and party affiliation



Notes: OLS regression coefficients for each party across GMO outcome measures with PSOE, the current largest party in Spain, as the reference category. Error bars are 95% confidence intervals. All outcomes measured on 5-pt. scales. All models include age, education, gender, religiosity, and attention to politics as covariates and use survey weights. Data come from the control condition; n ranges from 876 to 940.

Figure A2: Vaccine outcomes and party affiliation



Notes: OLS regression coefficients for each party across vaccine outcome measures with PSOE, the current largest party in Spain, as the reference category. Error bars are 95% confidence intervals. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). All models include age, education, gender, religiosity, and attention to politics as covariates and use survey weights. Data come from the control condition. n ranges from 880 to 994.

Table A4: GMO party models

	Perc. consensus	Personal safety beliefs	Ban support	Conspiracy beliefs
PP	0.0957	0.1038	-0.1322	0.0252
	(0.1011)	(0.0998)	(0.1325)	(0.1083)
Cuidadanos	0.1083	0.0367	-0.1459	-0.1526
	(0.1090)	(0.1164)	(0.1362)	(0.1188)
Podemos	0.0676	-0.0586	-0.2286	0.0600
	(0.1088)	(0.1106)	(0.1201)	(0.1140)
Vox	-0.0149	-0.0002	0.0552	0.1838
	(0.1073)	(0.1074)	(0.1393)	(0.1244)
Other	-0.1049	-0.0901	0.0900	0.0881
	(0.1030)	(0.1032)	(0.1179)	(0.1084)
No party	-0.1554	-0.1380	-0.0000	0.0594
	(0.0961)	(0.1072)	(0.1156)	(0.1110)
Constant	2.7627***	2.9782***	2.8619***	3.0069***
	(0.1807)	(0.1832)	(0.2209)	(0.1986)
Controls	✓	✓	✓	✓
R^2	0.05	0.03	0.05	0.03
N	940	876	919	925

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. PSOE is the reference category. All models include age, sex, education, and religiosity as co-variates and use survey weights. Data come from the control conditions.

Table A5: Vaccine party models

	Consensus	Hesitancy	HPV	Flu	Autism	Conspiracy	Vax intent
PP	-0.1945	0.0312	-0.0361	0.1606	-0.1209	-0.0331	-0.1897
	(0.1124)	(0.1084)	(0.0898)	(0.1378)	(0.1234)	(0.1176)	(0.1044)
Cuidadanos	-0.0210	-0.0956	-0.0112	0.1481	-0.1303	-0.1504	0.0188
	(0.1332)	(0.1277)	(0.1084)	(0.1558)	(0.1260)	(0.1572)	(0.1117)
Podemos	-0.1338	-0.0436	-0.1277	0.2111	-0.1804	-0.0667	-0.0210
	(0.1010)	(0.1084)	(0.0916)	(0.1398)	(0.1068)	(0.1182)	(0.0891)
Vox	0.0674	0.1311	-0.0279	0.1173	0.0113	0.1578	-0.3089***
	(0.1250)	(0.1169)	(0.0969)	(0.1513)	(0.1363)	(0.1386)	(0.1040)
Other	0.0400	0.2474*	0.0692	0.2333	0.0846	0.2839**	-0.2912***
	(0.0922)	(0.1057)	(0.0777)	(0.1236)	(0.1046)	(0.1050)	(0.0887)
No party	0.1683	0.3161***	0.1702*	0.3357**	0.1755	0.2453	-0.4194***
	(0.1003)	(0.0969)	(0.0842)	(0.1254)	(0.1096)	(0.1249)	(0.1108)
Constant	2.1625***	2.7470***	2.4898***	2.7489***	2.2280***	3.1273***	3.6358***
	(0.1638)	(0.1761)	(0.1439)	(0.2004)	(0.1799)	(0.1785)	(0.1656)
Controls	✓	✓	✓	✓	✓	✓	✓
R^2	0.07	0.07	0.10	0.04	0.06	0.06	0.06
N	890	994	880	968	909	972	968

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). PSOE is the reference category. All models include age, sex, education, and religiosity as co-variates and use survey weights. Data come from the control conditions.

Table A6: Regional differences across GMO measures

	Perc. consensus	Personal safety beliefs	Ban support	Conspiracy beliefs
East	-0.0044	0.0346	-0.0978	-0.1262
	(0.1143)	(0.0823)	(0.1245)	(0.1020)
South	0.0137	-0.0670	-0.0094	-0.0541
	(0.0846)	(0.0631)	(0.1118)	(0.0937)
Madrid	-0.0112	0.0262	-0.0858	-0.2084
	(0.1017)	(0.0763)	(0.1192)	(0.1223)
North	0.0094	0.0520	0.0894	-0.0323
	(0.1127)	(0.1016)	(0.1555)	(0.1280)
Northwest	-0.1069	-0.0038	0.0396	-0.0028
	(0.1768)	(0.1311)	(0.2181)	(0.1414)
Center	0.0754	-0.0395	-0.1564	-0.0361
	(0.0961)	(0.0729)	(0.1091)	(0.1111)
Constant	3.1304***	3.2142***	2.6558***	2.6937***
	(0.1958)	(0.1382)	(0.2245)	(0.2014)
Controls	✓	✓	✓	✓
R^2	0.03	0.03	0.05	0.03
N	854	915	893	899

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. Northeast region is the reference category. All models include age, sex, education, and religiosity as co-variates and use survey weights. Data come from the control conditions.

Table A7: Regional differences across vaccine measures

	Consensus	Hesitancy	HPV	Flu	Autism	Conspiracy	Vax intent
East	0.0013	-0.1300	-0.1000	0.0515	-0.0173	-0.1742	0.1194
	(0.1195)	(0.1177)	(0.0984)	(0.1413)	(0.1153)	(0.1151)	(0.0968)
South	-0.0195	-0.0815	-0.1254	-0.0829	-0.0742	-0.2079*	0.0659
	(0.0938)	(0.0932)	(0.0798)	(0.1323)	(0.1003)	(0.0998)	(0.0958)
Madrid	0.0060	-0.2968***	-0.0985	-0.1996	-0.0452	-0.2559*	0.2452**
	(0.0996)	(0.1035)	(0.0811)	(0.1197)	(0.1083)	(0.1132)	(0.0903)
North	-0.1059	-0.1993	-0.0227	-0.2159	-0.1815	-0.3582*	0.3409***
	(0.1241)	(0.1332)	(0.1026)	(0.1514)	(0.1315)	(0.1434)	(0.1070)
Northwest	-0.1437	-0.3545*	-0.2105	-0.2028	-0.1619	-0.4953***	0.1754
	(0.1287)	(0.1436)	(0.1348)	(0.1637)	(0.1457)	(0.1349)	(0.1473)
Center	-0.1549	-0.1497	-0.3408***	-0.1201	-0.1228	-0.1674	0.0818
	(0.1097)	(0.1202)	(0.0946)	(0.1578)	(0.1170)	(0.1148)	(0.1123)
Constant	1.9436***	2.5451***	2.4449***	2.5719***	1.9630***	2.8487***	3.8788***
	(0.2007)	(0.2127)	(0.1881)	(0.2592)	(0.2136)	(0.2310)	(0.1880)
Controls	✓	✓	✓	✓	✓	✓	✓
R^2	0.06	0.07	0.11	0.04	0.05	0.07	0.06
N	865	961	853	938	882	944	940

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). Northeast region is the reference category. All models include age, sex, education, and religiosity as co-variates and use survey weights. Data come from the control conditions.

Hypothesis test results: GMO study

Table A8: Scientific consensus message vs control on GMO beliefs

	Perc. consensus	Personal safety beliefs	Ban support	Conspiracy beliefs
Consensus treatment	0.1271***	0.0878*	-0.1321***	0.0247
	(0.0362)	(0.0345)	(0.0426)	(0.0367)
Constant	2.9256***	2.6207***	3.0273***	3.1080***
	(0.0811)	(0.0780)	(0.0965)	(0.0829)
Controls	✓	✓	✓	✓
R^2	0.03	0.03	0.04	0.01
N	3217	3372	3303	3307

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. Models pool all consensus messages compared against a control. All models include age, sex, education, and religiosity as co-variates.

Table A9: Effects scientific consensus on GMO beliefs from 60-95%

	Perc. consensus	Personal safety beliefs	Ban support	Conspiracy beliefs
60%	0.0851	0.0332	-0.1640*	0.0717
	(0.0607)	(0.0583)	(0.0724)	(0.0624)
65%	0.1279	0.1471*	-0.1724*	-0.0237
	(0.0653)	(0.0628)	(0.0771)	(0.0665)
70%	0.1605*	0.0723	-0.1369	0.0614
	(0.0626)	(0.0604)	(0.0747)	(0.0641)
75%	0.1644**	0.0900	-0.1095	0.0383
	(0.0606)	(0.0582)	(0.0711)	(0.0617)
80%	0.1618**	0.0937	-0.0721	0.0318
	(0.0605)	(0.0583)	(0.0718)	(0.0624)
85%	0.0700	0.1226*	-0.1378	0.0034
	(0.0643)	(0.0617)	(0.0755)	(0.0655)
90%	0.2012***	0.1024	-0.1692*	0.0085
	(0.0623)	(0.0600)	(0.0742)	(0.0638)
95%	0.0488	0.0574	-0.1083	-0.0008
	(0.0596)	(0.0572)	(0.0705)	(0.0606)
Constant	2.9228***	2.6208***	3.0272***	3.1069***
	(0.0811)	(0.0781)	(0.0966)	(0.0829)
Controls	✓	✓	✓	✓
R^2	0.03	0.03	0.04	0.01
N	3217	3372	3303	3307

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Hypothesis test results: vaccine study

Table A10: Effects of vaccine consensus vs. control

	Consensus	Hesitancy	HPV	Flu	Autism	Conspiracy	Vax intent
Consensus treatment	0.0064	0.0493	0.0207	0.0415	0.0372	0.0170	-0.0110
	(0.0379)	(0.0373)	(0.0316)	(0.0449)	(0.0395)	(0.0410)	(0.0359)
Constant	2.3763***	2.7321***	2.4394***	3.0727***	2.4193***	3.0572***	3.3035***
	(0.0863)	(0.0858)	(0.0723)	(0.1037)	(0.0907)	(0.0942)	(0.0824)
Controls	✓	✓	✓	✓	✓	✓	✓
R^2	0.05	0.04	0.08	0.02	0.04	0.04	0.02
N	3036	3392	2966	3276	3071	3320	3294

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). Models pool all consensus messages compared against a control. All models include age, sex, education, and religiosity as co-variates.

Table A11: Scientific and social consensus effects on vaccine beliefs

	Consensus	Hesitancy	HPV	Flu	Autism	Conspiracy	Vax intent
Scientists: 90%	0.0616	0.0741	0.0378	0.1108	0.0902	0.0817	-0.0022
	(0.0523)	(0.0518)	(0.0441)	(0.0621)	(0.0548)	(0.0568)	(0.0494)
Scientists: 75%	-0.0104	0.0093	0.0146	-0.0527	0.0052	-0.0056	0.0369
	(0.0517)	(0.0510)	(0.0433)	(0.0613)	(0.0540)	(0.0561)	(0.0489)
Public: 90%	0.0209	0.0803	0.0245	0.1002	0.0562	0.0328	-0.0906
	(0.0516)	(0.0510)	(0.0431)	(0.0615)	(0.0540)	(0.0560)	(0.0491)
Public: 75%	-0.0454	0.0345	0.0067	0.0103	-0.0017	-0.0385	0.0121
	(0.0520)	(0.0510)	(0.0436)	(0.0616)	(0.0546)	(0.0561)	(0.0493)
Constant	2.3782***	2.7327***	2.4399***	3.0759***	2.4203***	3.0597***	3.3018***
	(0.0863)	(0.0858)	(0.0724)	(0.1036)	(0.0907)	(0.0942)	(0.0823)
Controls	✓	✓	✓	✓	✓	✓	✓
R^2	0.05	0.05	0.08	0.02	0.04	0.04	0.02
N	3036	3392	2966	3276	3071	3320	3294

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All outcomes coded with misperceptions as higher scores except vaccination intent (intent is higher). All models include age, sex, education, and religiosity as co-variates.

Appendix B: Additional results

Latent variable and single item variable models

In this section we report results of additional models in which our outcome measures are latent variables revealed by factor analysis. Using principal-component factor analysis with orthogonal rotation revealed that GMO items loaded onto two factors: personal beliefs (items 1 and 2 in Table C2) and consensus beliefs (items 3 and 4) loaded onto the first factor, while ban support (item 5) and conspiracy beliefs (items 6 and 7) loaded onto a second. The same method revealed that vaccine items loaded onto two factors: All items with negative valence regarding vaccines loaded onto the first factor, while the two positive-valenced items (items 6 and 9; HPV vaccine protects against cancer and intent to vaccinate) loaded onto a second. We then report consensus effects for each outcome item individually.

Table B1: Latent variable models

	GMO 1	GMO 2	GMO 1	GMO 2	Vax 1	Vax 2	Vax 1	Vax 2
GMO consensus	0.1254***	0.0276						
	(0.0340)	(0.0316)						
Scientists: 60%			0.0991	0.0010				
			(0.0574)	(0.0536)				
Scientists: 65%			0.1449*	0.0906				
			(0.0618)	(0.0575)				
Scientists: 70%			0.1418*	0.0101				
			(0.0595)	(0.0552)				
Scientists: 75%			0.1466*	0.0140				
			(0.0570)	(0.0530)				
Scientists: 80%			0.1648***	-0.0063				
			(0.0574)	(0.0537)				
Scientists: 85%			0.0867	0.0477				
			(0.0604)	(0.0564)				
Scientists: 90%			0.1599**	0.0451				
			(0.0589)	(0.0548)				
Scientists: 95%			0.0647	0.0311				
			(0.0564)	(0.0525)				
Vax consensus					-0.0427	0.0349		
					(0.0304)	(0.0308)		
Scientists: 90%							0.0965*	0.0106
							(0.0420)	(0.0425)
Scientists: 70%							-0.0016	-0.0093
							(0.0415)	(0.0420)
Public: 90%							0.0598	-0.0952*
							(0.0415)	(0.0422)
Public: 70%							0.0182	-0.0447
							(0.0415)	(0.0422)
Constant	2.7727***	2.8926***	2.7712***	2.8932***	2.7254***	3.1508***	2.6842***	3.1869***
	(0.0770)	(0.0715)	(0.0770)	(0.0715)	(0.0668)	(0.0680)	(0.0697)	(0.0709)
Controls	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.04	0.02	0.04	0.02	0.06	0.03	0.06	0.03
N	3390	3430	3390	3430	3489	3406	3489	3406

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Table B2: GMO outcome single item models

	Enviro harm	Safe	Enviro exp.	Safe exp.	Ban	Conspiracy 1	Conspiracy 2
Consensus	0.0528	0.1081*	0.1213***	0.1050*	-0.1321***	-0.0028	-0.0417
	(0.0416)	(0.0422)	(0.0409)	(0.0419)	(0.0426)	(0.0442)	(0.0426)
Constant	2.6399***	2.6243***	2.8801***	2.9942***	3.0273***	2.8726***	2.8652***
	(0.0938)	(0.0954)	(0.0920)	(0.0937)	(0.0965)	(0.0994)	(0.0962)
R^2	0.01	0.04	0.02	0.02	0.04	0.01	0.01
N	3118	3306	3017	3128	3303	3177	3088

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Table B3: Vaccine outcome single item models

	Judged	Immunity	Autism	Autism exp.	HPV sex	HPV cancer	HPV sex exp.	Flu	Intent	Consp. 1	Consp. 2
Consensus	0.0742	0.0191	0.0621	-0.0009	0.0011	-0.0812	0.0051	0.0415	-0.0110	0.0204	0.0127
	(0.0450)	(0.0441)	(0.0434)	(0.0434)	(0.0428)	(0.0462)	(0.0431)	(0.0449)	(0.0359)	(0.0467)	(0.0468)
Constant	2.6785***	2.7760***	2.3027***	2.5361***	2.2477***	3.0567***	2.2630***	3.0727***	3.3035***	3.2231***	2.7995***
	(0.1042)	(0.1014)	(0.0996)	(0.0991)	(0.0975)	(0.1065)	(0.0986)	(0.1037)	(0.0824)	(0.1070)	(0.1068)
R^2	0.03	0.04	0.04	0.04	0.07	0.03	0.07	0.02	0.02	0.02	0.05
N	3113	3328	2935	2885	2725	2538	2631	3276	3294	3250	2907

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Differential acceptance

Importantly, consensus messages are likely to be less accepted by some members of the public than others. Prior attitudes have been shown to moderate message effects for vaccines and GMOs (G. N. Dixon et al., 2015; G. Dixon, 2016; Clarke et al., 2015). When examining climate change in the U.S., as many of these studies have, political identities are an obvious factor (Ma et al., 2019; G. Dixon et al., 2019; Bolsen & Druckman, 2018; Benegal & Scruggs, 2018). Moving outside this context and examining issues without ideological polarization, a number of psychological traits may condition the acceptance of information handed down from scientific experts: epistemic overconfidence (Motta et al., 2018; Fernbach et al., 2019; B. A. Lyons et al., 2020), conspiracy predispositions (Lewandowsky et al., 2013; Klofstad et al., 2019), need for affect and reliance on intuition (Martel et al., 2019; Garrett & Weeks, 2017; Anspach et al., 2019), lower cognitive reflection (Pennycook et al., 2015), need for uniqueness (Imhoff & Lamberty, 2017), and lower general social trust. These traits have not been examined in consensus message research to date, so we offer an initial test of differential acceptance based around these here.

Pre-registered expectations

It is important to stress that we did not forward formal hypotheses on these questions. Due to the number of moderators we examine, and because these differential effects are not the primary concern of the study, we indicated tests would be reported as exploratory. Still, there is reason to believe consensus treatments will be less effective for participants who are high in epistemic overconfidence, high in anti-expert sentiments, low in cognitive reflection, high in in need for uniqueness, and high in conspiracy theory mindset, since each of these predispositions often manifests in rejection of mainstream sources and acceptance of dubious claims (Klofstad et al., 2019; Han et al., 2022; Martel et al., 2019). Similarly, reliance on intuition and need for affect may be negatively associated with uptake of consensus information (as found with corrections more generally (Anson, 2022; Anspach et al., 2019)). Meanwhile, general social trust might increase acceptance of official guidelines or the prevailing views of the general public (Ackah et al., 2022). Finally, we might expect that those holding warmer views toward scientists also to be more amenable to scientific consensus (G. N. Dixon et al., 2015).

Moderators

Epistemic overconfidence was measured using a scale developed for this survey, with the following items on a 5-point Likert scale from *strongly disagree* to *strongly agree*: "I am more confident in my opinion than other people's facts," "Most of the time I know just as much as experts," "Experts really don't know that much," "I am very knowledgeable about many different topics," "I feel that I have a pretty good understanding of what is true and what is false," and "I consider myself well-qualified on most issues" (M = 2.94, SD = 0.67, $\alpha = .76$).

Conspiratorial worldview (Uscinski et al., 2016) was measured using the following items on a 5-point Likert scale from *strongly disagree* to *strongly agree*: "Much of our lives are being controlled by plots hatched in secret places," "Even though we live in a democracy, a few people will always run things anyway," "The people who really 'run' the country are not known to the voter," and "Big events like wars, recessions, and the outcomes of elections are controlled by small groups of people who are working in secret against the rest of us," (M = 3.65, SD = 0.82, $\alpha = .77$).

General social trust was measured using the following item: "Generally speaking would you say that most people can be trusted or that you need to be very careful in dealing with people? Please use this scale from 1 (You can't be too careful) to 5 (Most people can be trusted) to tell us what you think," (M = 2.91, SD = 1.03).

Need for affect (Maio & Esses, 2001) was measured with the following items on a 7-pt. Likert scale from *strongly disagree* to *strongly agree*: "I feel that I need to experience strong emotions regularly," "Emotions help people to get along in life," "It is important for me to be in touch with my feelings," and "It is important for me to know how others are feeling," (M = 2.96, SD = 1.17, $\alpha = .69$).

Need for uniqueness (Lynn & Harris, 1997) was measured with the following items on a 5-pt. Likert scale from *strongly disagree* to *strongly agree*: "Being distinctive is important to me," "I have a need for uniqueness," and "I prefer being different from other people," (M = 3.24, SD = .83, $\alpha = .77$).

Reliance on intuition (Garrett & Weeks, 2017) was measured using the following items on a 5-point Likert scale from *strongly disagree* to *strongly agree*: "I trust my gut to tell me what's true and what's not," "I trust my initial feelings about the facts," and "I can usually feel when a claim is true or false even if I can't explain how I know," (M = 3.67, SD = .70, $\alpha = .75$).

A cognitive reflection test (CRT) (Thomson & Oppenheimer, 2016) was administered using the average of two items, in multiple choice format: "If you are running a race and you pass the person in second place, what place are you in?"(Second) and "In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake, in days?" (47 days) (M correct = .50, SD = .33).

Finally, respondents rated their feelings toward scientists in general from 0 (Coldly) to 100 (Warmly) (M = 84.73, SD = 18.93), and issue concern was measured with the following items on a 5-pt. Likert scale from *strongly disagree* to *strongly agree*: "I am concerned about serious negative effects of GMOs," M = 3.73, SD = 1.08) and "I am concerned about serious negative side effects of vaccines," (3.03, SD = 1.32).

Are the effects of scientific consensus on GMO beliefs conditional?

As referenced in the main text, we examined whether the GMO consensus message effects were conditional on a series of predispositions, as GMO but not vaccine consensus messages yielded main effects. Although many of these measures are associated with GMO beliefs, there is limited evidence of any consistent moderation effects. In fact, we find that consensus messages result in larger decreases in support for a GMO ban among the most conspiratorial, those most reliant on intuition, and those lowest in general trust. We report these models in full in the Tables B4 through B7.

Table B4: GMO consensus perception interaction models

	Subjective knowledge	Conspiracy	Sci. feel	Concern	Trust	NFA	Intuition	NFU	CRT
Consensus treatment	0.1681	0.1507	0.2298	0.2251	0.0701	-0.1004	0.2490	-0.1002	0.0011
	(0.1659)	(0.1690)	(0.1655)	(0.1220)	(0.1095)	(0.1452)	(0.2877)	(0.2038)	(0.0960)
Consensus X Subj. know	0.0135								
	(0.0548)								
Subj. know	0.0890***								
	(0.0284)								
Consensus X Conspiracy		0.0064							
		(0.0451)							
Conspiracy		-0.0819***							
		(0.0235)							
Consensus X Sci. feel			0.0012						
			(0.0019)						
Sci feel			-0.0006						
			(0.0010)						
Consensus X Concern				0.0252					
				(0.0315)					
Concern				-0.2696***					
				(0.0168)					
Consensus X Trust					-0.0199				
					(0.0356)				
Trust					0.0816***				
					(0.0187)				
Consensus X NFA						-0.0748			
						(0.0445)			
NFA						0.0200			
						(0.0228)			
Consensus X Intuition							0.0332		
							(0.0769)		
Intuition							0.0112		
							(0.0383)		
Consensus X NFU								-0.0700	
								(0.0608)	
NFU								0.0518	
								(0.0330)	
Consensus X CRT									-0.2534
									(0.1633)
CRT									0.1733*
									(0.0826)
Constant	2.6403***	3.2030***	2.8679***	3.7240***	2.8071***	3.1954***	2.8681***	2.9856***	3.0573***
	(0.1596)	(0.1629)	(0.1588)	(0.1224)	(0.1161)	(0.1656)	(0.2647)	(0.2004)	(0.1331)
R^2	0.03	0.03	0.03	0.12	0.03	0.03	0.03	0.02	0.03
N	3214	3213	3178	3192	3197	1608	1606	1602	1608

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Table B5: GMO safety belief interaction models

	Subjective knowledge	Conspiracy	Sci. feel	Concern	Trust	NFA	Intuition	NFU	CRT
Consensus treatment	-0.0067	0.0039	0.3033	0.1031	0.2203*	-0.1098	0.1109	0.0731	0.0307
	(0.1583)	(0.1570)	(0.1589)	(0.1090)	(0.1052)	(0.1388)	(0.2723)	(0.1991)	(0.0921)
Consensus X Subj. know	-0.0318								
	(0.0524)								
Subj. know	-0.0554*								
	(0.0275)								
Consensus X Conspiracy		-0.0208							
		(0.0419)							
Conspiracy		-0.2287***							
		(0.0221)							
Consensus X Sci. feel			0.0026						
			(0.0018)						
Sci. feel			-0.0003						
			(0.0010)						
Consensus X Concern				0.0023					
				(0.0282)					
Concern				-0.4045***					
				(0.0151)					
Consensus X Trust					0.0453				
					(0.0341)				
Trust					0.0558***				
					(0.0181)				
Consensus X NFA						-0.0780			
						(0.0428)			
NFA						0.0544*			
						(0.0224)			
Consensus X Intuition							-0.0031		
							(0.0728)		
Intuition							-0.0971**		
							(0.0373)		
Consensus X NFU								-0.0016	
								(0.0595)	
NFU								-0.0606	
								(0.0324)	
Consensus X CRT									-0.1772
									(0.1574)
CRT									0.3430***
									(0.0809)
Constant	2.8677***	3.5353***	2.4232***	3.9592***	2.3855***	2.7372***	3.0376***	2.8841***	2.5766***
	(0.1521)	(0.1514)	(0.1521)	(0.1092)	(0.1113)	(0.1598)	(0.2499)	(0.1966)	(0.1277)
R^2	0.04	0.08	0.03	0.25	0.04	0.04	0.04	0.03	0.04
N	3370	3369	3334	3343	3349	1681	1680	1682	1682

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Table B6: GMO ban support interaction models

	Subjective knowledge	Conspiracy	Sci. feel	Concern	Trust	NFA	Intuition	NFU	CRT
Consensus treatment	0.1849	0.2559	-0.0212	-0.2017	-0.3720***	-0.1544	0.6595*	-0.1382	-0.1148
	(0.1932)	(0.1921)	(0.1954)	(0.1354)	(0.1296)	(0.1716)	(0.3297)	(0.2418)	(0.1126)
Consensus X Subj. know	0.1072								
	(0.0640)								
Subj. know	0.2173***								
	(0.0337)								
Consensus X Conspiracy		0.1030*							
		(0.0513)							
Conspiracy		0.3200***							
		(0.0269)							
Consensus X Sci. feel			0.0014						
			(0.0023)						
Sci. feel			-0.0029*						
			(0.0012)						
Consensus X Concern				-0.0183					
				(0.0349)					
Concern				0.4828***					
				(0.0187)					
Consensus X Trust					-0.0824*				
					(0.0420)				
Trust					-0.0734***				
					(0.0223)				
Consensus X NFA						0.0134			
						(0.0529)			
NFA						-0.0569*			
						(0.0274)			
Consensus X Intuition							0.2307**		
							(0.0881)		
Intuition							0.1889***		
							(0.0452)		
Consensus X NFU								-0.0107	
								(0.0724)	
NFU								0.1100**	
								(0.0395)	
Consensus X CRT									0.1377
									(0.1925)
CRT									-0.5099***
									(0.0982)
Constant	2.1088***	1.4728***	3.1608***	1.4762***	3.4080***	3.0737***	1.4189***	2.5153***	3.1335***
	(0.1855)	(0.1855)	(0.1874)	(0.1363)	(0.1375)	(0.1972)	(0.3020)	(0.2389)	(0.1571)
R^2	0.06	0.10	0.04	0.24	0.04	0.04	0.07	0.04	0.06
N	3301	3299	3262	3278	3283	1649	1648	1642	1650

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Table B7: GMO conspiracy belief interaction models

	Subjective knowledge	Conspiracy	Sci. feel	Concern	Trust	NFA	Intuition	NFU	CRT
Consensus treatment	0.3410*	0.2782	-0.2776	-0.0555	-0.0922	0.1852	0.3087	-0.1752	-0.0291
	(0.1634)	(0.1587)	(0.1682)	(0.1234)	(0.1115)	(0.1480)	(0.2824)	(0.2028)	(0.0977)
Consensus X Subj. know	0.1067*								
	(0.0541)								
Subj. know	0.2921***								
	(0.0286)								
Consensus X Conspiracy		0.0672							
		(0.0425)							
Conspiracy		0.3984***							
		(0.0225)							
Consensus X Sci. feel			-0.0036						
			(0.0019)						
Sci. feel			-0.0029***						
			(0.0010)						
Consensus X Concern				-0.0215					
				(0.0319)					
Concern				0.3000***					
				(0.0171)					
Consensus X Trust					-0.0403				
					(0.0361)				
Trust					-0.0624***				
					(0.0193)				
Consensus X NFA						0.0670			
						(0.0455)			
NFA						-0.0731***			
						(0.0236)			
Consensus X Intuition							0.0886		
							(0.0757)		
Intuition							0.2563***		
							(0.0388)		
Consensus X NFU								-0.0550	
								(0.0607)	
NFU								0.1569***	
								(0.0333)	
Consensus X CRT									-0.0435
									(0.1664)
CRT									-0.3576***
									(0.0850)
Constant	1.9865***	1.3945***	3.6316***	2.1723***	3.3547***	3.1934***	1.9131***	2.7927***	3.3610***
	(0.1567)	(0.1529)	(0.1611)	(0.1240)	(0.1183)	(0.1700)	(0.2593)	(0.1998)	(0.1359)
R^2	0.06	0.14	0.02	0.12	0.02	0.02	0.05	0.03	0.03
N	3305	3303	3266	3285	3284	1656	1655	1635	1657

* $p < .05$, ** $p < .01$, *** $p < .005$ (two-sided). Cell entries are OLS coefficients. All outcomes measured on 5-pt. scales. All models include age, sex, education, and religiosity as co-variates.

Appendix C: Additional method detail

Table C1: GMO and vaccine treatment groups

GMO treatment	N	Vaccine treatment	N
Control	1008	Control	1031
Scientists: 60%	337	Scientists: 75%	613
Scientists: 65%	284	Scientists: 90%	630
Scientists: 70%	307	Public: 75%	632
Scientists: 75%	349	Public: 90%	633
Scientists: 80%	341		
Scientists: 85%	297		
Scientists: 90%	316		
Scientists: 95%	348		
Total	3587		3539

Table C2: GMO and vaccine outcome variable items

Item		M	SD
1	I believe that genetically modified food harms the environment	3.24	1.05
2	I believe genetically modified foods are as safe to eat as conventional foods	2.72	1.11
3	Most scientists think that genetically modified foods (sometimes known as GMOs) are as safe to eat as conventional foods	3.05	1.05
4	Most scientists think that genetically modified food does no harm to the environment	2.99	1.01
5	Growing genetically modified crops should be banned	2.99	1.01
6	Giant multinational corporations that produce GM seeds want to destroy organic or ecological agriculture to protect their benefits	3.23	1.12
7	The real aim of agrochemical and pharmaceutical companies is to use what goes into our bodies as a way to control us	3.03	1.07
1	I feel that I can't share my doubts about vaccines with doctors	2.64	1.16
2	I believe it is better for kids to be exposed to germs and develop natural immunity than to receive vaccines	2.27	1.18
3	I believe some vaccines cause autism in healthy children	2.02	1.09
4	Most experts believe some vaccines cause autism in healthy children	2.09	1.08
5	I believe HPV vaccination at age 12 promotes sexual activity	2.04	1.05
6	I believe that the HPV vaccination can help protect against certain types of cancer	3.30	1.08
7	Most experts believe HPV vaccination at age 12 promotes sexual activity	2.14	1.04
8	I believe you can get the flu from the flu vaccine	2.90	1.18
9	When it comes to your future vaccination plans, which of the following statements reflect your intentions best?	3.18	.95
10	Pharmaceutical companies, scientists and academics work together to cover up the dangers of vaccines to serve their own interests	2.90	1.23
11	The government is trying to cover up the link between vaccines and autism in order to protect pharmaceutical profits	2.37	1.17

Note: All variables measured on 5-pt. scales except the vaccination intent item, where the options included: "I am planning to get all recommended vaccines" (4), "I am planning to get most of the recommended vaccines "(3), "I am planning to get some of the recommended vaccines" (2) and "I am not planning to get any of the recommended vaccines" (1). Means are for original coding and do not correspond to reverse-coding described in scale construction in text.

Debriefing messages

1. All respondents saw the following message:

Earlier, we asked you which types of cancer the HPV vaccine can help protect against. The HPV vaccine has been shown to reduce the risk of cervical, penile, anal, and throat cancer. Additionally, the HPV vaccination also protects against genital warts. For more information on the HPV and its vaccination, please read this article: http://www.mscbs.gob.es/ciudadanos/enfLesiones/enfTransmisibles/sida/docs/hojaInformativaVPH_22Feb18.pdf

2. Those in the GMO experiment saw the following message:

The purpose of this study is to examine how information about expert beliefs affects support for genetically modified foods. The evidence that GMOs are safe to eat is overwhelming. We asked you to imagine a news headline stating a percentage of experts believe GMOs are safe for consumption. In reality, the percentage of scientists that believe GMOs are safe for consumption is higher than what you read in the news headline. Current expert consensus is that GMOs in food and animal feed are perfectly safe. The exact percentage reported in the news headline was different for different people. We did this so that everyone would have the same amount of information about these beliefs. This helps us make clearer conclusions about our experiment. While different people were told different percentages, the information we provided to you that GMOs are safe for consumption is accurate.For more information about GMOs and their consumption, please read the following articles:

- https://www.bbc.com/mundo/noticias/2016/05/160519_ciencia_alimentos_modificados_peligros_ninguno_gtg
- https://www.sciencedirect.com/science/article/pii/S187704281305533X
- https://allianceforscience.cornell.edu/blog/2016/05/gmo-safety-debate-is-over/

3. Those in the vaccine experiment saw the following message:

The purpose of this study is to examine how information about public or expert beliefs affects support for vaccinations. The evidence that the MMR vaccinations does not cause autism is overwhelming. We asked you to imagine a news headline stating a percentage of the public or of experts that do NOT believe that the MMR vaccination causes autism. In reality, the percentage of medical professionals that do NOT link vaccinations with autism is higher than what you read in the news headline. As for public opinion, in 2017 only 8% of the Spanish population incorrectly believe there is a link between autism and vaccinations. The exact percentage or group reported in the news headline was different for different people. We did this so that everyone would have the same amount of information about these beliefs. This helps us make clearer conclusions about our experiment. While different people were told different percentages, the information we provided to you that MMR vaccines do NOT cause autism is accurate. For more information about the scientific studies invalidating the link between vaccination and autism please read the following articles:

- https://www.vacunas.org/las-vacunas-no-causan-autismo/
- https://www.sciencedirect.com/science/article/pii/S0264410X14006367?via%3Dihub
- https://www.bbc.com/mundo/noticias-40776371