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ORIGINAL ARTICLE

Ideology and compliance with health guidelines during the COVID-19 pandemic: A comparative perspective

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Abstract

Objective: We measure the prevalence of noncompliance with public health guidelines in the COVID-19 pandemic and examine how it is shaped by political ideology across countries.

Methods: A list experiment of noncompliance and a multi-item scale of health-related behaviors were embedded in a comparative survey of 11,000 respondents in nine OCED countries. We conduct a statistical analysis of the list experiment capturing degrees of noncompliance with social distancing rules and estimate ideological effect heterogeneity. A semiparametric analysis examines the functional form of the relationship between ideology and the propensity to violate public health guidelines.

Results: Our analyses reveal substantial heterogeneity between countries. Ideology plays an outsized role in the United States. No association of comparable magnitude is found in the majority of the other countries in our study. In many settings, the impact of ideology on health-related behaviors is nonlinear.

Conclusion: Our results highlight the importance of taking a comparative perspective. Extrapolating the role of ideology from the United States to other advanced industrialized societies might paint an erroneous picture of the scope of possible nonpharmaceutical interventions. Heterogeneity limits the extent to which policymakers can learn from experiences across borders.

In the fight against epidemics, including the novel coronavirus disease (COVID-19) caused by the Sars-Cov2 virus, large-scale behavioral change is essential to limit the loss of human lives and to allow societies to resume economic and social activities. After the outbreak of COVID-19 in 2019 and its global spread as a pandemic in the first half of 2020, the absence of vaccination and medical treatment meant that nonpharmaceutical interventions—such as social distancing, handwashing, and face masks—were crucial to mitigate and contain the spread of the virus. Most governments have adopted clear recommendations and rules to limit physical and social contact, and social scientists have immediately started to study individuals' compliance with these new behavioral rules. Surveys on COVID-19 in different countries have usually shown high rates of self-reported compliance with recommended health norms in the population (Barari

et al., 2020; Brouard, Vasilopoulos, and Becher, 2020; Perrotta et al., 2020; Utych and Fowler, 2020). At the same time, research, focused mostly on the United States, has shown that political predispositions may undermine compliance with health guidelines (Allcott et al., 2020; Andersen, 2020; Grossman et al., 2020; Kushner Gadarian, Goodman, and Pepinsky, 2020; Painter and Qiu, 2020). But we know less about whether ideology plays the same role in other countries.

In the face of high self-reported compliance, several scholars have cautioned that direct survey questions risk suffering from measurement error due to social desirability bias (Barari et al., 2020; Daoust et al., 2020).[1] While some have reported that online-mode surveys reduce the impact of desirability bias (Holbrook and Krosnick, 2010), the public salience of these health measures may still induce overreporting of compliant behavior (Barari et al., 2020:4; Munzert and Selb, 2020). Social desirability is likely to be a factor when respondents are directly asked to report whether they complied with highly publicized behavioral rules. We might not only underestimate the general rate of nonadherence to health guidelines but also the importance of factors predicting it. Access to alternative measures of noncompliance, as well as credible estimates of subgroups that are least likely to comply, is thus paramount to the design of effective nonpharmaceutical interventions during the pandemic (Bavel et al., 2020; West et al., 2020).

In this article, we aim to make two contributions. First, we employ a list experiment to measure the *prevalence of noncompliance* with social distancing guidelines among the population of nine OECD countries.[2] Our sample covers approximately 65 percent of total confirmed COVID-19-related deaths at the time of the survey (Dong, Du, and Garden, 2020). It covers large variation in mortality (from less than five deaths per million inhabitants in Australia and New Zealand to more than 350 in Italy) and governmental responses (from very strong restrictions in Italy, New Zealand, and France to comparatively few restrictions in Sweden). Our data reveal a substantial degree of nonadherence to social distancing guidelines. In most countries under study, experimental estimates of noncompliance are much higher than estimates based on (single item) direct questions from other surveys fielded in the same countries at the same time, which offer a more optimistic picture (Perrotta et al., 2020). Furthermore, we find large variation in rates of noncompliance across countries. This variation is not random, but varies systematically with the severity of the crisis and the stringency of lockdown-style policies.

Second, we examine factors driving *individual variation in noncompliance* with a particular focus on the role of political ideology, which has been identified as a salient marker for divergent health behavior during the pandemic.[3] Achieving compliance with collective decisions is a general problem that states tackle with a mix of monitoring, sanctions, and voluntary cooperation. A large, cross-disciplinary literature on compliance suggests that for a given level of external enforcement, individuals may vary in their willingness to adapt their behavior to COVID-19 guidelines (Levi and Stoker, 2000; Luttmer and Singhal, 2014). A voluminous body of research in political science uses political ideology as a conceptual map structuring political beliefs and behavior (see Feldman, 2013 for a recent overview). By shaping what information people seek out and how they interpret it, ideology can affect behavior beyond the voting booth (e.g., Campbell et al., 1960; Bartels, 2002; Gerber and Huber, 2009; Graham and Svolik, 2020). The question of whether to comply with new health rules that require profound adjustments in one's daily life touches on the fundamental relationship between the state and its citizens. Different ideologies may entail different beliefs about health risks, the effectiveness of health measures or the legitimate scope of government action during the crisis (Barrios and Hochberg, 2020; Kushner Gadarian, Goodman, and Pepinsky, 2020). Relatedly, research in public health and the psychology of disease outbreaks has turned toward examining the role of (macro- and individual-level) social and psychological factors associated with health-related

[1] For example, research on self-reported behavior and attitudes shows voter turnout and racial animus estimates to be affected by social desirability bias (e.g., Belli, Traugott, and Beckmann, 2001; Bernstein, Chadha, and Montjoy, 2001; Kuklinski, Cobb, and Gilens, 1997).

[2] Blair and Imai (2012) list applications in a wide range of fields. Studying compliance during the COVID-19 pandemic, single-country list experiments have been conducted (Larsen, Petersen, and Nyrup, 2020; Munzert and Selb, 2020).

[3] Our hypothesis regarding ideology as well as the analysis of other factors discussed later was preregistered; see http://aspredicted.org/blind.php?x=hv7yv2.

behaviors (e.g., Schaller, 2011; Schaller and Park, 2011). In both Europe and the United States, systematic correlations between political ideology and health behavior and outcomes can be observed (Subramanian, Huijts, and Perkins, 2009; Subramanian and Perkins, 2009; Huijts, Perkins, and Subramanian, 2010). Our analysis thus moves beyond basic sociodemographic variables, such as age, gender, and education, which have received most attention in studies of compliance with nonpharmaceutical interventions, and examines the role of political ideology on the individual and cross-national level.

To conduct a comparative test of the association between ideology and compliance with health rules during the COVID-19 pandemic, we employ statistical tools for the analysis of heterogeneity in list experiments as well as a semiparametric analysis of the impact of ideology on general pandemic health behavior. We measure the latter by estimating a cross-national item response theory (IRT) model of a pandemic health behavior item battery (ranging from changes in handwashing frequency to no longer meeting friends) included in our survey. Our results reveal substantial cross-national variation in the link between ideology and compliance. For the United States, we find a strong association between ideology and compliance with health guidelines. Individuals that place themselves on the extreme right of the political spectrum are less likely to practice social distancing, measured using the experiment, than those with centrist views, whereas individuals with extreme left beliefs are more likely to comply with social distancing. Going beyond the list experiment and using a semiparametric latent variable model, we also find a clear ideological gap concerning broader behavioral adjustments in the United States. These results are consistent with recent evidence from the United States on the partisan gap in elite rhetoric, perceived health risk and mass compliance between Democrats and Republicans (Allcott et al., 2020; Barrios and Hochberg, 2020; Green et al., 2020; Grossman et al., 2020; Kushner Gadarian, Goodman, and Pepinsky, 2020; Painter and Qiu, 2020).

In contrast, we find that in most European countries under study political ideology is not strongly linked to compliance with social distancing in particular and health behavior adjustments more broadly during the initial stage of the pandemic. The absence of a clear association does not simply reflect a lack of variation in compliance, since it also emerges in countries with large noncompliance with social distancing (e.g., Austria and Germany). Rather, it may be due to the specifics of how the politics of the pandemic played out across countries. Thus, our results have implications for policy choices in response to the pandemic. The heterogeneity of individual-level results across countries suggests that it may be difficult to learn from other countries' experiences. Identifying the characteristics of noncompliers, who could be targeted or nudged into more compliance, might be a task that depends on country-specific political idiosyncrasies unlikely to be guided well by using results from other countries.

This article proceeds as follows. The following section describes the data, including the list experiment and pandemic health behavior item battery, followed by a section that presents experimental estimates of noncompliance rates and discusses identifying assumptions of the experiment. The next section examines the structure of heterogeneity in noncompliance due to individual- and country-level differences in political ideology. The penultimate section provides an exploratory analysis of the link between country characteristics, such as the strictness of lockdown measures, and our health behavior estimates. The final section concludes.

DATA

Survey data

Our list experiment and health behavior battery are embedded in a comparative Internet survey covering eight countries in lockdown in mid-April 2020 (Australia, Austria, France, Germany, Italy, New Zealand, United States, United Kingdom) as well as Sweden. The latter took a less stringent policy response, but still recommended changes in health behavior. Surveys were conducted online between April 15–20, 2020, by established commercial polling companies (CSA Research in Australia and the United States; Ipsos in all other countries). All participants gave explicit consent to take part in the survey. Supporting Information Table A.1 lists fieldwork periods, sample sizes, and the survey completion rate of participating respondents

TABLE 1 List experiment items

List A: Control group	
1.	I went to the doctor or to the hospital
2.	I used public transportation to get to work
3.	I exercised outdoors
4.	I ordered food using an online delivery service
List B: Treatment group	
1.	I went to the doctor or to the hospital
2.	I used public transportation to get to work
3.	I exercised outdoors
4.	I met with two or more friends or relatives who do not live with me
5.	I ordered food using an online delivery service

Note: The list experiment is introduced by an identical statement for treated and control cases: "How many of these things have you done last week? You do not need to tell me which ones you have done, just how many."

for each of the nine surveys. It also includes COVID-19 deaths and the overall strictness of lockdown-style measures. Noncompletion is generally low. Target sample sizes were about 2,000 respondents in Germany, France, and the United States, and 1,000 respondents in the remaining countries. Our final sample comprises 11,038 respondents. Sampling was done as part of existing online panels using quota sampling. The resulting samples were weighted by the survey providers to match Census population margins for gender, age, occupation, region, and degree of urbanization. All our analyses and descriptive results use probability weights unless otherwise indicated.

Our central variable, a respondent's ideology, is captured using a standard left–right or liberal–conservative 11-point self-placement item (the question reads: "on a scale from 0 to 10, where 0 is left and 10 is right, where would you place yourself politically?"; in the United States, the wording is "liberal" and "conservative" rather than "left" and "right"). This left–right dimension tends to be the most salient dimension for most of the population in the countries under study (Huber and Inglehart, 1995). It represents a simple one-dimensional conceptualization of political ideology dating back to the work of Converse on mass beliefs systems (Converse, 1964). Jost et al. (2003) provide a recent theoretical justification for a unidimensional approach to political ideology.[4]

Noncompliance experiment

The list experiment or unmatched or item count technique (Miller, 1984; Raghavarao and Federer, 1979) allows respondents to truthfully report their behavior with respect to social distancing without revealing it to the researcher. Faced with a list of items, respondents are asked how many of these things they have done last week, but not which specific things. Respondents are randomly assigned to treatment and control groups. As shown in Table 1, the treated group received an additional item capturing the violation of the social distancing norm. The key assumption is that the treatment group would have responded like the control group absent the treatment. Our set of control items includes behaviors likely influenced by the pandemic but not violating health guidelines, such as ordering food using online delivery services, or exercising outdoors. The sensitive item presented only in the treatment group states that a respondent met

[4] Note that we do not claim that the structure of political ideology in Western mass publics is one-dimensional. A large body of work provides evidence of (at least) a second dimension (see, among many, Heath, Evans, and Martin, 1994; Treier and Hillygus, 2009). We use our simple measure as a first-order approximation to individual differences in political beliefs and attitudes beyond simple demographic categories.

TABLE 2 Health behavior adjustment items

Behavior	Proportion unchanged[b]
Washing your hands more often and/or for a longer amount	0.395
Coughing or sneezing into your elbow or a tissue	0.399
Stopped greeting others by shaking hands, hugging, or kissing	0.209
Keep a distance of (six feet) between yourself and other people[a]	0.326
Reduced your trips outside home	0.388
Avoid busy places (public transportation, restaurants, sport)	0.291
Stopped seeing friends	0.338

[a]Country-specific distancing guideline values are used.
[b]Proportion of individuals indicating they did not change behavior. See Supporting Information Appendix C for definition and details. Weighted by sample-inclusion probabilities.

with family or friends who are not part of the same household in the past week. This violates the societal norms in place during the pandemic.

Meeting friends and family not living in the same household ran counter to explicit government advice and stay-at-home orders in most countries under study during the time of the survey (Hale et al., 2020; Supporting Information Table B.1 summarizes social distancing rules in each country). Usually, people were only allowed to leave their home for "essential" trips such as work, healthcare, grocery shopping, daily exercise, or emergencies. For instance, France banned all gatherings, and, in her first speech to the nation on the pandemic, German chancellor Angela Merkel told people to avoid visits to friends and family. In the United States, stay-at-home orders were in place in 43 states, including the most populated states. The main exception is Sweden, which explicitly did not prohibit private meetings with members of different households. However, while not imposing legal sanctions, it did appeal to people's personal responsibility.

Health behavior items

Our survey contains a battery of items capturing changes in health behavior following expert guidelines during the pandemic. The items were placed distantly after the survey experiment. Respondents were invited to indicate if they changed their behavior since the beginning of the pandemic with respect to a range of health-relevant actions listed in Table 2.

A nonlinear principal component analysis (see Supporting Information Figure C.1) suggests that all seven items form a one-dimensional latent factor in each country under study. We conceptualize this latent variable as an individual's disposition of *health behavior adjustment* following expert public health guidelines. This fits with the widely used definition of health behaviors, or health-related behaviors, as "actions taken by individuals that affect health or mortality [...] and can promote or detract from the health of the actor or others" (Short and Mollborn, 2015). However, since there are stark differences in societal contexts (variation in expert guidelines, differences in pandemic severity, different social norms), we employ an IRT model that explicitly allows for cross-country variation in measurement parameters (de Jong, Steenkamp, and Fox, 2007; Fox and Verhagen, 2010). Supporting Information Appendix C.1 provides more technical details, while Supporting Information Appendix C.2 provides parameter estimates and plots of the distribution of the country-specific latent factors. There we also show that *individual-level* estimates of the latent factor follow a similar rank order as *macrolevel* rates of noncompliance with social distancing guidelines estimated from the list experiment: the Spearman rank correlation between both is 0.73 (with an exact p-value of 0.031).

TABLE 3 Experimental estimates of prevalence of individuals not following health guidelines during the COVID-19 pandemic in nine countries

Country	Prevalence	SE	95% CI	*N*
Australia	0.336	0.085	[0.17, 0.50]	1007
Austria	0.425	0.082	[0.27, 0.58]	996
France	0.125	0.041	[0.04, 0.21]	2020
Germany	0.640	0.055	[0.53, 0.75]	2000
Italy	0.007	0.067	[−0.12, 0.14]	997
New Zealand	0.120	0.058	[0.01, 0.23]	998
Sweden	0.484	0.077	[0.33, 0.64]	1009
United Kingdom	−0.024	0.067	[−0.16, 0.11]	1000
United States	0.196	0.071	[0.06, 0.34]	1955

Note: Estimates based on difference-in-means between item count in the treatment and control group. Weighted by sample-inclusion probabilities.

EXPERIMENTAL ESTIMATES OF NONCOMPLIANCE

In this section, we present estimates of noncompliance with social distancing guidelines based on our list experiment. One advantage of list experiments (Miller, 1984; Raghavarao and Federer, 1979) as a measurement device is that it reduces the risk of respondents' answers being shaped by social desirability bias.

The key assumptions for identification in this design are (i) randomization of treatment (true in our survey by design), (ii) no design effects (i.e., responses to control items are not affected by the treatment), (iii) a truthful response to the sensitive item in the treatment condition under the anonymity awarded by the design (Imai, 2011). We examined three possible empirical implications of violating assumptions (ii) and (iii) and generally find no evidence that the design is invalid. The first potential concern is that (anticipated) ceiling effects may undermine the anonymity of a response: a respondent in the treatment group stating that she engaged in *all* of the listed acts would reveal her norm violation to the researcher and may thus not respond truthfully. Our set of questions deliberately uses innocuous control items unlikely to be all answered in the affirmative (or negative). Data from our experiment show that reported counts (in the control and treatment group) are not concentrated at the ceiling (see Supporting Information Table B.2). Furthermore, "self-administration" of the measurement instrument in an online survey context likely reduces nontruthful responses as well (Droitcour et al., 2011:190). Second, to ensure to not to be associated with the sensitive item, the same individual who reports a nonzero count in the treatment group might want to counterfactually report a zero count in the treatment group. However, inspection of the data from our experiment shows that the share of respondents reporting zero counts is generally not higher under treatment than under control conditions. Third, we conducted statistical tests for the assumption of no design effects (Blair and Imai, 2012) and do not reject the null hypothesis of no design effects (see Supporting Information Table B.2).

Table 3 shows the estimated fraction of individuals in each country who met two or more friends or relatives not living in their household during the previous week. The estimates reveal a substantial degree of nonadherence to social distancing guidelines during the pandemic. In six of eight countries, a large and statistically significant fraction of the population did not follow social distancing guidelines. In some countries under lockdown (Austria and Germany), a (near-)majority of the population met friends or relatives against explicit recommendations. In the United States and Australia, a large minority (of at least 20 percent or more) of the population did not follow the norm. Experimental estimates of noncompliance are lower (but still statistically significantly different from zero) for France (13 percent) and New Zealand (12 percent). The fraction of noncompliers is not statistically distinguishable from zero in Italy and the United Kingdom. Finally, in Sweden, which did not enact a lockdown and where social distancing rules

were more permissive, around half of the population (48 percent) met friends or relatives. In the final empirical section, we explore whether variation in noncompliance across countries is systematically related to the severity of the pandemic and the strictness of lockdown measures.

INDIVIDUAL HETEROGENEITY IN NONCOMPLIANCE

We now turn to an analysis of heterogeneity in noncompliance focusing on the role of political ideology. The literature on compliance with government decisions points out that political beliefs may be relevant (Levi and Stoker, 2000). If this is true in the case of COVID-19 as well, it indicates a considerable challenge for democratic governments trying to encourage compliance with nonpharmaceutical public health measures. While political beliefs are not easily changed and targeting interventions (e.g., messaging or surveillance) to different political groups raises important normative questions, it is important to understand whether political predispositions undermine compliance.

In this section, we employ two complementary empirical strategies. First, we will use the list experiment and estimate heterogeneity of noncompliance rates in terms of ideology (and other basic individual characteristics) using the estimator proposed by Imai (2011). The advantage of using the list experiment to examine subgroup heterogeneity is a clean identification of the model relying on the random assignment of respondents to treatment or control group and the use of pretreatment covariates. One should keep in mind that we do not experimentally manipulate a respondent's ideology. Therefore, the resulting heterogeneity estimates describe a statistical association between ideology and the probability of complying with social distances and do not justify a causal interpretation based on the experimental design alone. In adjusted models, we add pretreatment covariates to reduce concerns about confounding. A potential downside of the list experiment is the limited power to detect smaller effects and the difficulty of estimating more flexible model specifications. To do the latter, we use individual-level estimates of the health behavior adjustment factor extracted using a random coefficient IRT model fit to our seven-item battery of health-related behavioral changes during the pandemic (see Supporting Information Appendix C). We fit a flexible semiparametric regression model that allows us to examine in detail the structure of heterogeneity both within and among countries.

Heterogeneity in social distancing behavior

We fit beta-binomial regression models to the item count in each country (Imai, 2011; Blair and Imai, 2012) both including only the heterogeneity variable of interest and including an additional set of basic demographic controls (termed "unadjusted" and "adjusted" models). Missing observations are deleted listwise and the same set of observations are used in the unadjusted and adjusted specification. We conduct all analyses separately by country, in order to better isolate the contribution of individual-level factors from macro-level characteristics, such as variation in policies, institutions or the severity of the pandemic. Estimates are obtained using maximum likelihood using the expectation–maximization algorithm (Blair et al., 2020). Adjusted models reported in Figure 1 include the following set of individual-level covariates: age (in years) and age squared; an indicator equal to 1 if female (0 otherwise); an indicator equal to 1 if a respondent has at least a college (BA) degree; subjective personal health measured on 5-point scale, political ideology (11-point scale); an indicator for religiosity equal to 1 if a respondent feels close to any religion, and an indicator variable for interpersonal trust.[5] We measure ideology as discussed above and include it in both linear and quadratic form.

[5] Trust is measured by an indicator variable equal to 1 for respondents agreeing that "most people can be trusted" (0 if "you can never be too careful when dealing with other people"). Subjective health is measured by the item: "Generally speaking, would you say that your health is [Very good/Good/Quite good/Bad/Very bad]?"

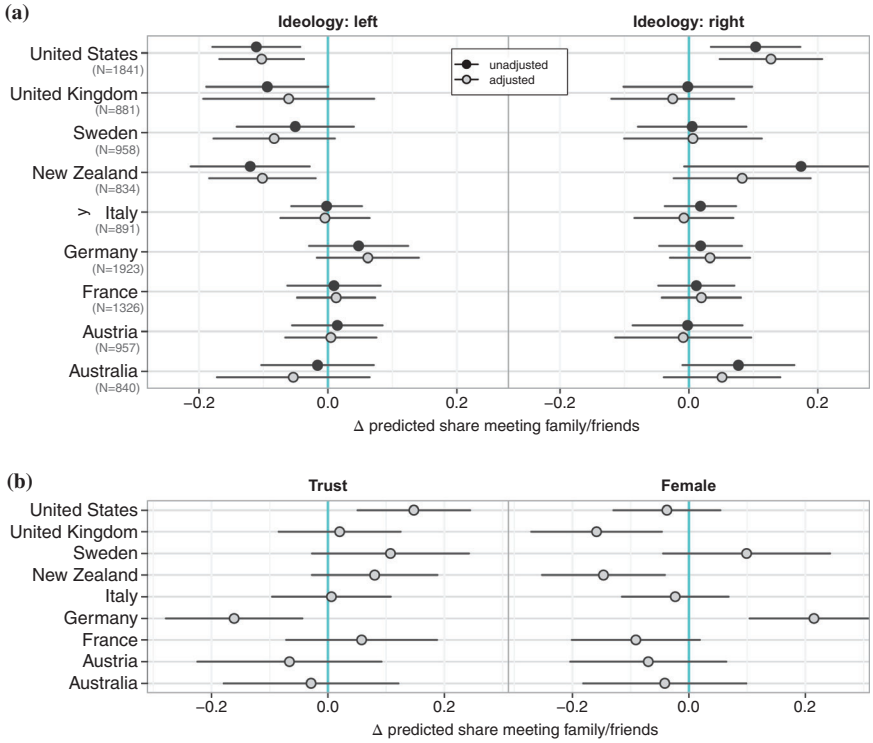

FIGURE 1 Individual characteristics and probability of not following social distancing guidelines. This figure plots changes in the predicted probability of noncompliance with 90 percent confidence intervals based on maximum likelihood estimates. Panel a plots the effect of a negative and positive standard deviation change in ideology. Panel b plots the effect of a change in indicator variables for trust and gender. Unadjusted models show the bivariate relationship between the two variables; adjusted models include a set of individual controls

Figure 1a displays the estimated relationship between political ideology and the probability of meeting friends and relatives despite social distancing guidelines for each country. It shows changes in the predicted probability of noncompliance (with 90 percent confidence intervals) arising from a standard deviation (SD) change in ideology away from the respective country mean. The first plot shows an SD decrease (i.e., moving a respondent to the left), while the second plot shows an SD increase (moving to the right). Our estimates suggest considerable cross-national variation in the impact of political ideology on following social distancing guidelines.

In the United States, we find that individuals further on the right are more likely to meet friends or relatives during the pandemic. Substantively, our estimates suggest that individuals 1 SD to the right of the national mean are approximately 12 percentage points more likely to skirt social distancing. In contrast, individuals 1 SD to the left are approximately 10 points more likely to follow social distancing guidelines.[6] This finding is consistent with evidence on polarized elite rhetoric over COVID-19 (Green et al., 2020) and evidence on partisan gaps in social distancing based on mobility patterns from smartphone data, spending behavior, and direct survey question (Allcott et al., 2020; Grossman et al., 2020; Kushner Gadarian, Goodman, and Pepinsky, 2020; Painter and Qiu, 2020). A qualitatively similar pattern exists in New Zealand and

[6] This finding is only partly consistent with our preregistered hypothesis on the role of ideology. We expected that individuals with more extreme political preferences (on the left and right) would be less likely to comply (cf. Brouard, Vasilopoulos, and Becher, 2020) implying a U-shaped pattern. Our semiparametric analysis next provides more evidence that counters this initial hypothesis.

Australia, though it is less pronounced in the latter (and confidence intervals of the ideological gap always overlap zero).

The same pattern generally does not show up in the European countries. There, the estimated impact of ideology is approximately null. Following health guidelines is not a question of political ideology in the majority of countries under study. The absence of this association is not simply a mechanical result of very high or low compliance (indicating ceiling or floor effects). Countries such as Austria and Germany show more variation in individual-level responses than the United States (Table 3). The null result also emerges in different pandemic contexts, including large variation in COVID-19 deaths and strictness of lockdown-style policies. Our results are also not easily attributed to differences in the degree of party polarization across countries: levels of political polarization in the United States are quite similar to those in other countries under study, whether one looks at mass polarization over the role of the government in the economy (Lindquist and Östling, 2010) or the polarization of party positions (Lupu, 2015:343). What may be different in the United States is not polarization in general but the polarization of elite rhetoric on COVID-19 in particular (Green et al., 2020).

One might ask if the cross-country heterogeneity evident in our estimates is simply due to country idiosyncracies in political culture and if using more "basic" individual characteristics, such as gender, would produce estimates that are more consistent among countries. Figure 1b thus plots changes in probabilities of noncompliance as function of gender and social trust. Previous work on COVID-19 finds gender to be a key predictor of (self-reported) willingness to follow social distancing (Barari et al., 2020; Galasso et al., 2020; Perrotta et al., 2020; Brouard, Vasilopoulos, and Becher, 2020). We further include interpersonal trust because the literature on externalities and social dilemmas (Ostrom, 2000) suggests its relevance for compliant behavior. An individual's compliance with nonpharmaceutical interventions contributes to the public good of containing a pandemic, but success depends on a large fraction of people changing their behavior. Under such a coordination dilemma, individuals with higher levels of interpersonal trust are more likely to behave cooperatively.

The estimates in panel B do not show higher levels of consistency for these additional variables across countries. The relationship between trust and noncompliance is positive in the United States and Sweden, but clearly negative in Germany. While women seem somewhat more likely to follow social distancing than men (the estimated adjusted gender gap is negative for seven out of nine countries), this gender difference is not statistically significant in most countries. Moreover, in Germany women are substantively less likely to comply with distancing guidelines.

Nonparametric estimates of ideology and noncompliance

We now turn to a more flexible model linking political ideology to health behavior. The dependent variable in this analysis is the individual-level within-country estimate of the latent factor, θ_W, capturing the propensity to ignore health guidelines (thus, larger values represent a lower propensity to follow health guidelines). Denote by $\theta_{W,ir}$ the estimated latent variable value for individual $i(i = 1, \ldots, N_r)$ in region $r(r = 1, \ldots, R)$. For each of the nine countries in our sample we estimate the following model:

$$\theta_{W,ir} = \beta_0 + \boldsymbol{x}_i'\boldsymbol{\beta} + f(z_i) + \xi_r + \epsilon_{ir},$$

where z_i represents political ideology, $\boldsymbol{x}_i$ is a vector of individual-level controls, including basic demographic characteristics, such as gender and age, and ξ_r represent unobserved regional-level differences.[7] We model region-specific constants as random effects drawn from a common normal distribution with freely estimated variance, $\boldsymbol{\xi} \sim N(0, \sigma_\xi^2)$.

It might be overly simplistic to constrain the relationship between health behavior and political ideology to be globally linear (or quadratic) a priori (e.g., Beck and Jackman, 1998: 598). Instead, we allow it to take

[7] These represent NUTS regions in European countries and states in Australia and the United States.

TABLE 4 Model-fit comparisons

Specification	AU	AT	FR	DE	IT	NZ	SE	UK	US
A: Basic demographics	2551	2435	4859	4964	2463	2428	2431	2408	4963
	7.2	8.4	11.4	9.3	10.1	8.2	9.9	9.4	11.4
B: f(Ideology)	2133	2340	4369	4766	2176	2063	2298	2089	4643
	10.3	11.9	12.5	11.9	14.0	11.1	12.8	12.3	16.7
C: Region differences	2134	2340	4370	4760	2176	2062	2299	2090	4644
	11.2	15.1	18.0	26.1	15.7	13.9	14.4	13.6	20.2
D: Government vote	2124	2339	3205	4751	2177	2061	2300	2090	4639
	11.7	12.9	13.6	12.9	14.7	12.0	13.9	13.3	17.7
E: Trust in executive	2127	2315	4367	4743	2170	2048	2300	2086	4638
	11.4	13.1	13.4	13.0	15.2	12.2	13.8	13.5	17.3

Note: WAIC with effective number of parameters are in italics. WAIC is the widely applicable information criterion of Watanabe (2010). WAIC penalizes model deviance by an estimate of the effective number of parameters (given in italics). Based on 10,000 markov chain monte carlo (MCMC) samples. See Supporting Information Appendix D.3 for details.

on a flexible nonlinear form if this is demanded by the data. We thus model f using B-splines (de Boor, 1978; Hastie, Tibshirani, and Friedman, 2017:186). More precisely, over a sequence of L equidistant knot locations, we define L B-spline basis functions $B_l(z_i)$ with associated coefficients $(\gamma_1, \ldots, \gamma_L)$[8]:

$$f(\mathbf{z}) = \sum_{l=1}^{L} \gamma_l B_l(\mathbf{z}).$$

Here, $B_l(\mathbf{z})$ is a set of basis functions and $\boldsymbol{\gamma} = (\gamma_1, \ldots, \gamma_L)$ are basis coefficients representing their amplitudes. Identification of the estimated function is achieved by imposing some constraint of the form $\boldsymbol{A\gamma} = \mathbf{0}$. In our application, $\boldsymbol{A}$ imposes a centering constraint so that β_0 represents the "intercept" of the semiparametric ideology regression. To control the "smoothness" of the fitted function (and to avoid overfitting), we impose a difference penalty term that punishes too abrupt function jumps (Eilers and Marx, 1996). In a Bayesian framework, this can be achieved by including a difference penalty in the prior distribution of the coefficients (cf. Brezger and Lang, 2006):

$$\pi(\boldsymbol{\gamma}) \propto \exp\left(-\frac{1}{2\omega^2}\boldsymbol{\gamma}'\boldsymbol{K}\boldsymbol{\gamma}\right).$$

Here, $\boldsymbol{K}$ is a penalty matrix constructed via $\boldsymbol{K} = \boldsymbol{D}'\boldsymbol{D}$, where $\boldsymbol{D}$ is a second-order difference matrix (created by twice applying the difference operator to adjacent spline coefficients; see Supporting Information Appendix D.1 for an example), and ω^{-2} is a smoothness penalty term. The larger the penalty, the more our estimated function will be "shrunk" toward a linear fit (Hastie, Tibshirani, and Friedman, 2017:151). We provide more details in Supporting Information Appendix D.1, where we discuss the use of a scale-dependent hyperprior for ω adjudicating the trade-off between linearity and nonlinearity in the estimated relationship, as well as our choice of priors for the remaining model parameters.

Table 4 provides a comparative model assessment for a range of specifications. It provides the Watanabe–Akaike information criterion (WAIC) (Watanabe, 2013), which penalizes model deviance by the

[8] We use quadratic B-spline bases with 10 knots penalized via second-order difference penalties and collapse the outer two categories of the ideology scale for increased numerical stability. B-splines are constructed by augmenting the 10 equally spaced interior knots (spanning all values of ideology) with two upper and two lower boundary knots.

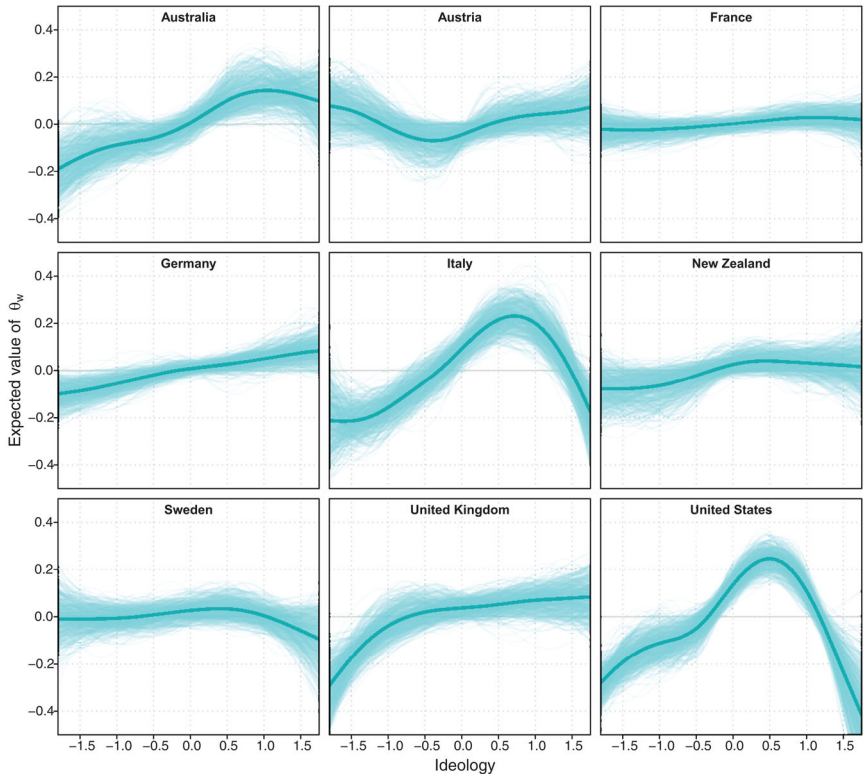

FIGURE 2 Relationship between ideology and propensity to not follow health guidelines. This figure plots expected values of θ_W from semiparametric ideology estimates based on a Bayesian mixed model representation of quadratic P-splines with second-order difference penalty while adjusting for individual characteristics and regional heterogeneity. The solid lines represent the posterior mean, estimation uncertainty is represented by hairlines plotting 500 function evaluations calculated using a random subsample of the MCMC output

effective number of parameters.[9] Specification A serves as reference point by modeling health behavior using only basic covariates: age, gender, education, and an indicator for being employed before the onset of the pandemic. Specification B adds ideology estimated using the semiparametric approach described here (as well as the basic covariates included in A). A comparison of WAIC values shows that in every country the model including ideology is strongly preferred over the model with covariates only. The improvement in WAIC is about 300 on average and is greater than 100 in all countries but Austria (95) signifying that accounting for respondents' ideology improves model performance dramatically. The remaining specifications explore heterogeneity in the functional relationship between ideology and health behavior. We will return to them after discussing our core model results.

Figure 2 plots semiparametric estimates of the relationship between ideology and the health behavior adjustment latent variable. It plots expected values of the propensity to not follow health guidelines as a function of ideology, after partialing out basic individual characteristics and systematic regional differences. The variance of the dependent variable is fixed to unity in its generating IRT model and its mean is zero (cf. Supporting Information Appendix C.1). Similarly, we scale ideology to mean zero and unit SD in each country, so that both axes of Figure 2 can be interpreted in SD units.

[9] Widely applicable information criterion (WAIC) can be seen as an extension of the AIC. It is more useful in our context since it accounts for the *effective* number of parameters to adjust for overfitting. The number of effective parameters will usually be much lower than the number of coefficients in the model due to the penalization employed in the estimation. See Supporting Information Appendix D.4 for more discussion of its merits and an alternative fit measure.

Figure 2 reveals a substantial degree of effect heterogeneity among countries. There is a set of countries in which ideology has little to no relationship with not following health guidelines: France, Austria, and Sweden are prime examples. After accounting for the uncertainty in the estimated functional relationships (shown via 500 hairline function plots) changes in ideology do not significantly change the expected value of the outcome variable. This holds by and large for the United Kingdom as well, save for the fact that very left leaning individuals (those more than 1SD below the national mean) are more likely to adjust their health behavior following expert guidelines. The estimated relationship for Germany reveals a modest (almost linear) trend: more conservative Germans are more likely to ignore health guidelines. It is however of limited magnitude (less than one-tenth of an SD over the whole range of ideology).

In another group of countries, most notably Australia, the United States, and Italy, ideology is strongly related to the propensity to not change one's health behavior. In the United States, for an individual placing herself at the average of the political spectrum, her propensity to not change her behavior is already significantly different from 0 (the overall mean of the latent variable). Moving an individual living in the United States half an SD to the right of the national mean ideology, increases their propensity to ignore health guidelines by about 0.2 SDs. A commensurate change in Italy shows a similar effect. The magnitude of the relationship is somewhat more muted in Australia, but it is still significant both in the statistical and substantive sense.[10]

Geography and ideology

It is germane to ask if our analyses are affected by systematic subnational geographic differences, such as regional or state-level differences in civic traditions (Putnam, 2000), or variation in state-level ideology (Rabinowitz, Gurian, and Macdonald, 1984). While our preferred model does include region or state random effects, a more extended specification allows the shape of the estimated ideology function to vary across geographical units. However, this flexibility comes at the cost of a large increase in the number of model parameters. The fit statistics for specification C in Table 4 take this into account (the number of effective parameters is given in italics). Remarkably, this increased flexibility does not, in general, lead to a notable improvement in WAIC. Germany is an instructive case. While the number of effective parameters in specification C almost doubles, the differences in WAIC over specification B is only 6. In the remaining countries, the fit criterion remains effectively unchanged or even worsens. We conclude from this analysis that ideology is a major source of heterogeneity among individuals and that after accounting for the possibly nonlinear function form of ideology additional regional effect heterogeneity is of no or limited importance.

Support for the government

A possibility, neglected so far in our analysis, is that ideological patterns we find are driven in part by respondents' alignment with the current government. Respondents who chose the current government in the last election, or who currently still favor it, might be more receptive to its messaging and more likely to follow health guidelines. Conversely, in settings where a government downplays the risk of the pandemic, receptive respondents might be more likely to not follow expert health guidelines. The latter relationship might explain the ideological pattern found in the United States, where the political polarization of pandemic misinformation was high and partly linked to executive communication (Havey, 2020; Kushner Gadarian, Goodman, and Pepinsky, 2020).

[10] Italy and the United States also show a decrease in noncompliance at the very upper end of the left–right ideological spectrum. This is not an artifact of the spline construction (such as the choice of spline basis or knot placements). The mean of the latent factor for respondents placing themselves in the highest category is indeed lower than the next lowest category. One might hypothesize that individuals in the rightmost individual category might be predominantly older and more at risk. But note, that our estimates are already adjusted for age, gender, and education differences. A more systematic exploration of this pattern (including its cross-national component) merits further research.

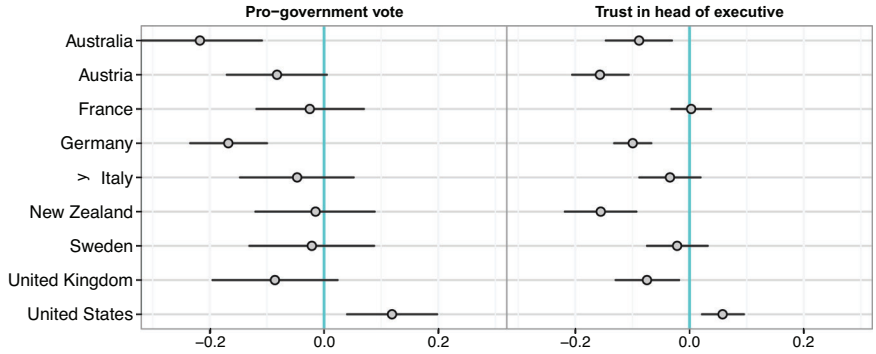

FIGURE 3 Estimates of respondents' government support on health behavior. This figure plots changes in expected values of θ_W for respondents who voted for the currently governing party or coalition in the last election (left panel) and for a standard deviation increase of respondents' trust in the head of the executive (right panel). Posterior means and 90 percent credible intervals based on 10,000 MCMC samples

In specifications D and E in Table 4, we show results from two models where we adjust for the fact that the expected value of changing health behavior might depend on respondents' support of the government. We estimate two sets of models. The first (specification D) includes an indicator variable equal to one if a respondent cast a vote for the governing party (or coalition) in the last election. The second (E) includes a variable capturing respondents' trust in the head of the executive.[11] It is measured on a 4-point scale with response options ranging from "don't trust at all" to "trust completely." While both specifications lead to a clear improvement in WAIC in a few countries (France and Germany in specification D; Austria and Germany in E), most seem rather unaffected by this change. The left panel of Figure 3 plots estimates for the coefficient on the government vote indicator variable for each country (based on estimates reported in Supporting Information Table D.1). It reveals that support for the government does not significantly influence the propensity to ignore health guidelines in most countries, with the exception of the United States, Australia, and Germany. For the latter two, supporting the government goes hand in hand with a lower propensity to resist health advice. The United States is the only country in our nine-nation sample in which support for the government is associated with a significantly *higher* propensity of not following health advice. The right panel of Figure 3 plots estimates for trust in the head of the executive (estimates represent an SD increase). In general, higher trust is related to a lowered propensity of ignoring health guidelines (with small to zero coefficients in France, Italy, and Sweden). Again, the United States emerges as the exception showing the opposite relationship.

While support of, and trust in, the executive is clearly important in some contexts, it does not alter significantly the functional form of the impact of ideology on health behavior. Supporting Information Figure D.2 compares estimated functions of ideology after accounting for government support with those displayed in Figure 2, and reveals no differences of substantive importance. Finally, in Supporting Information Appendix D.3, we further explore the role of respondents' trust in experts (scientists and doctors). We find that, in general, higher trust does lower the propensity to not follow health advice. However, accounting for trust in experts has little impact on the estimated impact of ideology.

RELATION TO PANDEMIC SEVERITY AND POLICY

We end our empirical analysis with an exploratory investigation of the relationship between our estimates of a populations' propensity to not follow health guidelines (estimated from the list experiment and the

[11] We use the latter to capture the fact that respondents' support during the pandemic might differ from what one would infer from their vote in the past. For an analysis of leader support during the pandemic, see Fredén and Sikström (2021).

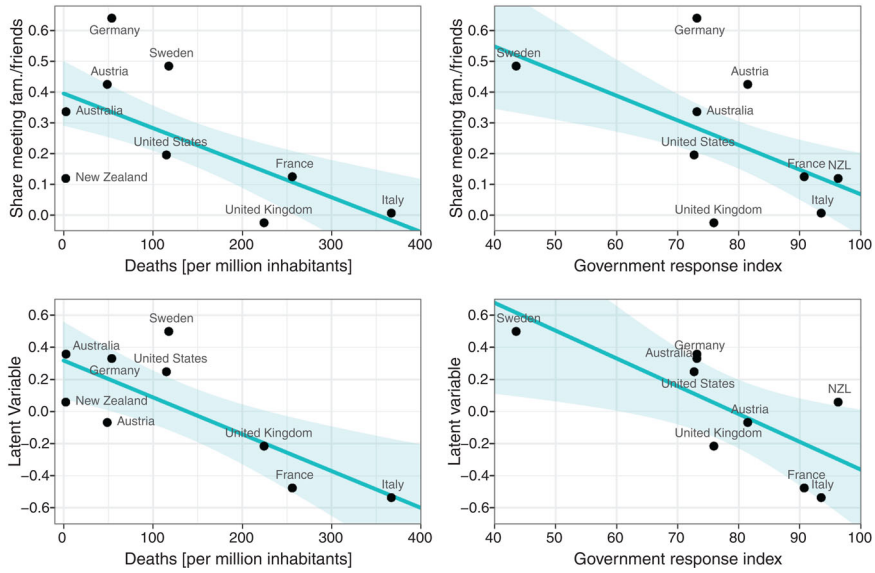

FIGURE 4 Relationship between COVID-19-related deaths, lockdown strictness, and health behavior estimates. The upper two panels of this figure plot the fraction of individuals meeting family and friends estimated from the list experiment (*y*-axis) against total COVID-19-related deaths in the week before the survey and the strictness of lockdown-style measures. The lower two panels show the same relationship but use on the *y*-axis the within and between component of our latent health measure ($\theta_w + \theta_b$). Each plot also includes a linear fit from a robust regression (using an M-estimator with Huber objective function) and 90 percent confidence intervals

latent variable model). These exploratory analyses, summarized in Figure 4, provide two empirical insights. We find that the estimated share of individuals meeting family and friends, as well as the country-level aggregate of the latent variable, are negatively correlated with the total COVID-19-related deaths in the week prior to the survey (per million inhabitants). The data we use are official government-reported counts compiled by researchers at Johns Hopkins University (Dong, Du, and Garden, 2020).[12] On average, countries with lower reported deaths, such as Austria or the United States, exhibit significantly higher levels of noncompliance than countries with higher reported deaths, such as France and Italy.

The right two panels of Figure 4 show a similar negative association with the stringency of the government response to the pandemic. This finding is consistent with country-level results from the United States (Painter and Qiu, 2020). The stringency index is taken from the Oxford COVID-19 Government Response Tracker (Hale et al., 2020) and measures (on a scale from 0 to 100) the strictness of lockdown-style policies, such as restrictions of movement and school closures, that primarily restrict individuals' behavior. On average, countries with strict policy measures, such as France or Italy, show lower levels of resistance to health guidelines compared to countries with more lenient measures, such as Australia, the United States, or (representing an extreme case) Sweden. We hasten to add that this analysis is merely descriptive. Nonetheless, it helps to make sense of the variation uncovered by the measurement experiment and latent variable and is broadly consistent external monitoring and sanctions being relevant factors (Luttmer and Singhal, 2014). Fruitful future work could employ within-country variation in pandemic severity on policy (e.g., in U.S. states) to put these relationships to a stricter test.

[12] While reporting standards vary across countries, these data have been widely reported in the media and thus shaped the public salience of the pandemic and its associated risks.

DISCUSSION AND CONCLUSION

Compared to direct survey questions, the list experimental approach makes our findings less susceptible to measurement error induced by social desirability bias that have been raised in the literature. A potential limitation of our experiment is its external validity—understood as the scope of actions captured by the experiment, which focuses on meeting friends or relatives. To address this limitation, we have also constructed and analyzed a latent variable capturing health behavior adjustment on a broader scope. Our conclusions about the country-varying relationship between ideology and compliance are supported by both approaches.

While there is a clear ideological gap in compliance with health guidelines during the COVID-19 pandemic in the United States, in a majority of the countries we studied there is no comparable association between ideology and compliance. Our results highlight the importance of taking a comparative perspective. The degree of heterogeneity revealed in both the list experiment and the semiparametric latent variable analyses suggests that researchers studying the pandemic should be cognizant of the pitfalls when extrapolating from both single-country studies and standard pooled (or homogenous) country regressions.[13]

An implication of our results is that it may be difficult for policymakers to learn from other countries' experiences when crafting policies intended to enhance compliance with public health guidelines. While behavioral social science can draw on a repertoire of experimentally tested "nudges" to enhance compliance (Bavel et al., 2020), our results highlight that the social and political characteristics of individuals less likely to follow health guidelines vary across countries. Thus, behavioral interventions intended to target noncompliers should not be based on the assumption that "noncompliers" behave identically across countries. Given heterogeneity in ideology, otherwise observationally identical individuals might make very different choices when confronted with expert health messaging. Clearly, more context-specific evidence is needed.

A somewhat more encouraging aspect of our findings is that while the relevance of political ideology for social distancing is pronounced in some countries—including the United States—this is by no means the rule. At least during the initial lockdown stage of the pandemic, the same was not true in Europe with the exception of Italy, possibly giving policymakers more scope for (future) action.

AUTHOR CONTRIBUTIONS

M.B., S.B. and D.S. conceived the study and designed the experiment. M.B., and D.S. analyzed the data and wrote the paper. E.K. provided additional funding. For comments and suggestions, we are grateful to Thomas Gschwend and participants of the conference "Public Policy, Opinions, Behavior, and Health Outcomes during the COVID Pandemic" organized by Lorena Barberia, Thomas Pluemper, Robert K. Goidel, and Guy Whitten. We also thank participants of (virtual) seminars at IAST, Berlin Social Science Center (WZB), and IE University. Stefan Preuß provided excellent research assistance. Becher acknowledges IAST funding from the French National Research Agency (ANR) under the Investments for the Future (Investissements d'Avenir) program, grant ANR-17-EURE-0010. Brouard acknowledges the financial support from ANR – REPEAT grant (Special COVID-19), CNRS, Fondation de l'innovation politique, regions Nouvelle-Aquitaine and Occitanie. Stegmueller's research was supported by Duke University and the National Research Foundation of Korea (NRF-2017S1A3A2066657). The anonymous preanalysis plan of the survey experiment is available at http://aspredicted.org/blind.php?x=hv7yv2. Ethics approval was obtained by The Review Board for Ethical Standards in Research at the Toulouse School of Economics and the Institute for Advanced Study (ref. code 2020-04-001).

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[13] We thank an anonymous reviewer for pointing this out to us. Supporting Information Figure D.5 illustrates this point graphically. There we compare our results to what one would obtain when using a common specification, namely a (pooled) linear model with country fixed effects. While such a model yields a significant slope for ideology ($\beta = 0.046 \pm 0.011$) and describes the ideology–health relationship very well in some countries (e.g., in Germany), it provides a misleading sense for many others (such as France, the United States, or Italy).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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