Trust in science boosts approval, but not following of COVID-19 rules

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Study repo: https://osf.io/s5mdh/

Abstract

How essential is trust in science to prevent the spread of COVID-19? Previous work shows that people who trust in science are more likely to comply with official guidelines, which suggests that higher levels of compliance could be achieved by improving trust in science. However, analysis of a global dataset (n=4341) suggests otherwise. Trust in science had a small, indirect effect on adherence to the rules. It affected adherence only insofar as it predicted people's approval of prevention measures such as social distancing. Trust in science also mediated the relationship between political ideology and approval of the measures (more conservative people trusted science less and in turn approved of the measures less). These effects varied across countries, and were especially different in the USA. Overall, these results mean that any increase in trust in science is unlikely to yield strong immediate improvements in following COVID-19 rules. Nonetheless, given its relationships with both ideology and individuals' attitudes to the measures, trust in science may be leveraged to yield longer-term and more sustained social benefits.

During the COVID-19 pandemic, scientists have recommended measures such as physical distancing and mask wearing, yet these have been a target of controversy. Trust in science correlates with adherence to such guidelines [1], as does political orientation [2]. Though conservatives typically trust science less [3,4], they are more likely to follow COVID-19 rules when they trust it more [5]. So is strengthening trust in science, particularly among conservatives, a good way to protect society from the pandemic? We should be cautious, lest claims by scientists that science is important seem self-serving. This article examines two potential blind spots in the view that strengthening trust in science will improve adherence to measures aimed at preventing the spread of the virus.

First, if science is to play an ethical and robust role in behavioral change during the pandemic, science should change minds, not just coerce behavior. The literature on trust and persuasion shows that people may follow new norms not because they approve of them, but because of fear or propaganda, and these coercive effects are typically short-lived [6]. Thus, one aim is to test whether trust in science influences both approval of prevention measures and adherence with those measures. Doing so is especially important as approval and adherence are distinct mechanisms in the literature on social norm change [7], and as people can follow COVID-19 rules without necessarily approving of them [8].

Second, science does not operate in a vacuum. Even if people trust science, they also trust others in their society, and observe their behavior. People often conform to others around them [9], and take their main cues on how to behave in the COVID-19 pandemic from each other [10]. Thus, another aim is to test whether trust in science still matters for adherence, controlling for this social baseline.

In line with current studies, this article tests whether trust in science will positively predict adherence to pandemic social distancing guidelines (Research Question 1). However, to better understand the kind of behavioral change necessary to beat this pandemic, it also examines whether trust in science acts more on minds ('approval' of prevention measures) or behavior ('adherence' to the measures), especially once political ideology and social conformity are accounted for (Research Question 2). Finally, given that attitudes to COVID-19 measures and the effects of ideology on those attitudes vary across countries [2], we check whether the effects of trust in science are consistent internationally, or whether any countries deviate from global patterns in those effects (Research Question 3).

Overview of the present study

As part of a larger project on the normative and social aspects of COVID-19 [10], participants in an online global survey rated their trust in science and political ideology. To capture whether science affects minds and behavior, participants rated how much they approved of and how much they adhered to physical distancing measures as implemented in their country of residence the week prior to their response. Social conformity was accounted for by asking participants how much they thought their close circle followed the same distancing rules.

Finally, the global nature of the survey affords exploration of cross-country variation in these relationships.

Results

Descriptive overview

Of the 6674 participants who finished the survey, 1577 opted out of the question on political ideology and 1199 indicated that they had no close circle (in the specific sense of 'close circle' as operationalized here: see Methods). This leaves 4341 completed responses, as 442 had missing data on both counts.

As an initial check that these gaps not bias our conclusions, there was no significant difference in the main outcome variable, adherence to physical distancing guidelines, between the 4341 participants who answered all questions (mean adherence 63.8%) and the 2333 participants who had some missing data (mean adherence 62.9%, less than a one percentage-point difference, regression $b = 0.89$, $SE = 0.55$, $t = 1.9$, $p = .11$). We explore the effects of missing data in more detail at https://osf.io/s5mdh/.

The final sample included 1293 men, 2985 women, 39 non-binary people, and 24 who chose not to answer the gender question. Mean age was 37.6 years (SD=14.5). Mean education was 3.28 on a five-point scale (from 0='No schooling completed' to 5='Postgraduate degree'). The point nearest the mean (point 3) corresponds to 'University undergraduate degree/professional equivalent'. These demographic variables were included as covariates in all analyses reported below (full details are available at https://osf.io/s5mdh/).

Does trust in science predict unique variance in adherence behavior?

The pre-registered hypothesis was that trust in science would predict adherence to physical distancing rules. However, given recent findings[10] that two strong predictors of adherence are approval of the rules and social conformity (i.e., one's close circle's adherence to the rules), it is important also to check whether trust in science still predicts unique variance in adherence behavior when these other factors are accounted for.

Fig. 1 shows coefficients from four Bayesian linear models where adherence was regressed on trust in science, or trust in science and various combinations of conformity and approval. Standardized regression coefficients are reported with 95% Credibility Intervals (CIs), as well as Bayes Factors (BFs) where we want to assess the evidence in favor of there being no relationship. These models included country as a random effect (see https://osf.io/s5mdh/ for random effects structures, model priors, calculation of Bayes Factors, and control variables age, gender and education).

The effect of trust in science on adherence behavior varied, depending on which covariates were included. When trust in science was the only predic-

tor, it predicted adherence ($\beta = 0.08$ $[0.06, 0.11]$). When social conformity was included, the effect of science was reduced ($\beta = 0.06$ $[0.03, 0.09]$). When approval of COVID-19 measures was included, the effect of science dropped out completely (with just approval as co-variate, trust in science $\beta = 0.02$ $[-0.01, 0.04]$, $\text{BF}_{01} = 34$; with approval and conformity as co-variates, science $\beta = 0$ $[-0.03, 0.02]$, $\text{BF}_{01} = 70.6$).

At best, trust in science had a small role in predicting adherence. At worst, it had no effect whatsoever. Considering *direct* predictors of adherence, then, it is inadvisable to place too much weight on people's trust in science, independently of these other critical factors.

Figure 1: Standardized linear regression betas with 95% Credible Intervals (CIs) for the effects of trust in science, individual approval, and social conformity on adherence behavior, according to which predictors were included in each model.

Does trust in science predict approval of the rules?

A second aim was to see whether trust in science predicts approval of the rules, adherence to the rules, or both. This aim can be addressed with a path analysis, comprising simultaneous Bayesian linear regressions. In addition to pathways from trust in science to approval and adherence, the model included pathways to adherence from the aforementioned predictors (approval and social conformity). Furthermore, as previous research has shown that political ideology predicts trust in science[3,4] and adherence to COVID-19 rules[2], and that trust in science may mediate the latter relationship[5], additional pathways for these relationships were included. All pathways include random intercepts for country (though see Fig. 3 below for additional random slopes). See https://osf.io/s5mdh/ for further details, including demographic control variables age, gender and education. The model pathways are illustrated in Fig. 2a. Fig. 2b plots standardized regression coefficients and CIs for the fixed effects. The model R^2 for adherence was 0.31 $[0.29, 0.33]$.

As expected, a more conservative ideology predicted lower trust in science ($\beta = -0.23\,[-0.29, -0.17]$). There was no direct effect of trust in science on adherence ($\beta = 0\,[-0.06, 0.07]$, $\mathrm{BF}_{01} = 33.45$). However, trust in science predicted approval ($\beta = 0.25\,[0.19, 0.33]$), and had an indirect effect on adherence, mediated by approval ($\beta = 0.08\,[0.06, 0.11]$). Thus, trust in science had a moderate effect on whether people think they should adhere, but only a small, indirect effect on adherence behavior.

Ideology had no direct effect on approval ($\beta = 0.01\ [-0.04, 0.06]$, $\mathrm{BF}_{01} = 38$), though it indirectly affected approval, mediated by trust in science ($\beta = -0.06\,[-0.08, -0.04]$). Ideology had no direct effect on adherence ($\beta = -0.04\ [-0.09, 0.01]$, $\mathrm{BF}_{01} = 13.35$), but had an indirect effect via the science—approval pathway ($\beta = -0.02\,[-0.03, -0.01]$).

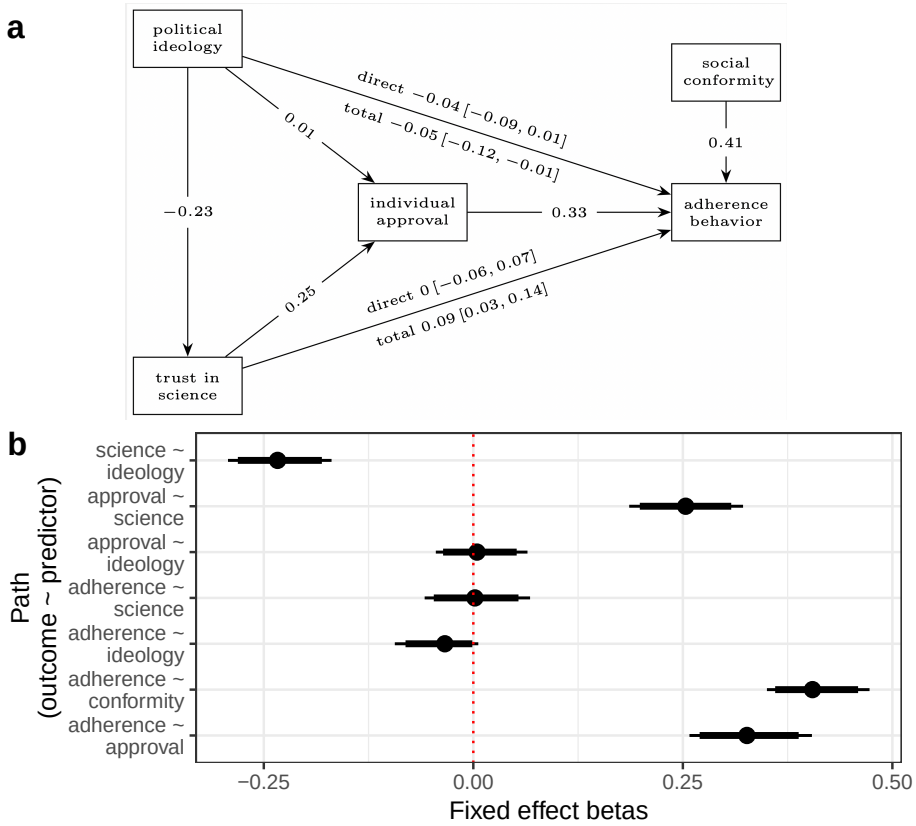

Figure 2: Pathways and posterior samples for path analysis. (a) Model pathway standardized betas, including 95% CIs for the direct and total effects of science and ideology. (b) Posterior samples for model fixed effects, with whiskers showing 89% (thick) and 95% (thin) CIs.

We have structured the above path model based on findings in the literature

(e.g., that ideology predicts trust in science[3]) and domain knowledge (e.g., as trust in science is a relatively stable trait[11] that predates the pandemic, it is more plausible that the arrows point from trust in science to approval of pandemic measures than the other way around). We stress that we do not claim this as evidence that these are causal effects. We do, however, show that the same conclusions about the role of trust in science do not depend on this specific model structure (https://osf.io/s5mdh/).

How do the key relationships vary across countries?

Given cross-country variation in the role of political polarization in COVID-19 pandemic[2] and trust in science[12], it is important to check whether there is consistency in the core relationships involving political ideology and trust in science identified above.

For this reason, the model represented in Fig. 2a included by-country random slopes for the pathway from ideology to trust in science, and for the pathway from trust in science to approval of COVID-19 measures. The variation in these relationships can be explored using the posterior samples for the random slopes (here, for the top-10 participating counties by sample size). Fig. 3 plots these posterior samples.

Despite some between-country variation, the effects of ideology on trust in science (Fig. 3a) and of science on approval (Fig. 3b) were consistently in the same direction (relative to 0, shown with a dotted red line).

However, compared to population-level effects, in the USA, conservative ideology was more negatively linked to trust in science (consistent with previous findings[2]), and trust in science was more positively linked to people's approval of COVID-19 measures. Italy showed a similar, though weaker, pattern as the USA, whereas other countries were less consistent. For instance, Turkey had a fairly typical relationship between ideology and science, whereas the relationship betwee trust in science and approval was weak.

Supplementary analyses

In the supporting material at https://osf.io/s5mdh/, we check that our findings do not depend on narrow assumptions. In particular, we discuss: imputed missing data, simulation of potential unmeasured confounds, generalized linear regressions (e.g., a zero one inflated beta regression), and alternative path models (e.g., where conformity is not just a covariate, separate from the other predictors).

Our claims about the role of trust in science are robust against all of these alternative analysis strategies. The only conclusion which changes slightly is that there is sometimes evidence for a direct effect of ideology on adherence, depending on such modeling decisions. However, as our focus here is on trust in science rather than ideology, we simply conclude that there might be a direct effect of the latter on adherence, and that future work should explore this possibility.

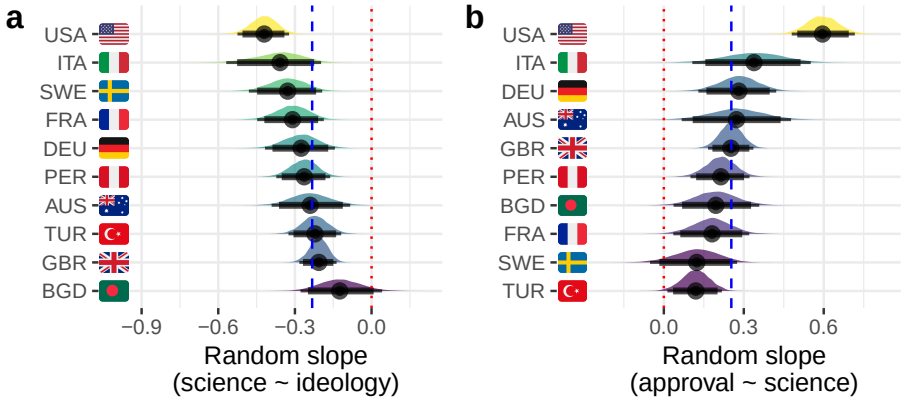

Figure 3: Posterior samples for random slopes for the top 10 countries by sample size. Samples for (a) random slopes for the effect of ideology on trust in science, and (b) for trust in science on individual approval. Fixed effects shown with dashed blue lines and 0 shown with dotted red lines. (AUS: Australia; BGD: Bangladesh; DEU: Germany; FRA: France; GBR: United Kingdom; ITA: Italy; PER: Peru; SWE: Sweden; TUR: Turkey; USA: United States of America).

Discussion

Trust in science is a topical research area and a praiseworthy end. But what difference does trust in science *really* make, when it comes to the adoption of new norms, such as those required in a pandemic? Two potential blindspots are whether trust in science makes a difference both to what people do and what they think, and whether it makes a difference over-and-above known effects of social influence.

The results of this study deliver a somewhat mixed verdict. On an optimistic note, trust in science changes minds, so its role in the pandemic is unlike those of propaganda or threat, which focus on forcing behavior[6]. On a more pessimistic note, trust in science only has a small and indirect effect on whether people followed distancing guidelines. Thus, improving trust in science is unlikely to yield major increases in adherence. To illustrate, suppose that a *wildly* successful messaging campaign leads to a 20% increase in trust in science. Multiplying this by the total effect in Fig. 2a, that would only yield a 2% increase in adherence.

Attitudes toward science are part of a complex belief system. In this context, our results show that trust in science appears to be a linchpin linking political ideology to approval of distancing guidelines. Previous research on climate change denial has shown that pro-science recommendations are more effective when they appeal to people's values and when they are consistent with their ideology[13,14]. The findings here raise the possibility that the same could be done for behavioral changes required by the health crisis.

Trust in science generates other epistemic benefits: It makes people less susceptible to misinformation[15] and influences the formation of opinion-networks[16]. It is a relatively stable trait[11], and is resistant to erosion from ideological opponents[17]. In that sense, these findings may be helpful for policy-based interventions as they suggest that trust in science could serve as a 'boost' for behavioral change. Unlike 'nudges' that focus on behavior and are usually easily reversible, 'boosts' focus on people's decision-making processes and can therefore achieve sustained behavioral change[18].

One limitation is that our social-media recruitment process did not produce a representative sample. Specifically, there was a high proportion of educated women (see 'Descriptive overview' in Results). However, the size and global nature of the sample — which were only achieved thanks to these recruitment methods — afford epistemic benefits that counterbalance the limitations of non-representativeness. Further, all analyses included demographic variables (such as age, gender and education) as covariates, and included country as a random effect.

Apart from these statistical considerations, one indication that our recruitment procedure has not seriously biased results is that the levels of the main phenomenon of interest — trust in science — are strikingly similar to levels in previous studies. The average level of trust in science reported here — measured on a percentage scale with three items — was 75.6% (SD=20). This compares with levels previously reported during the pandemic, such as 82% (4.12 on a 5-point scale, using 14 items, with a sample recruited via social media[5]), 77% (5.39 on a 7-point scale, using just two items drawn from the same instrument used here, with a representative sample of New Zealanders[19]), or 76% (3.81 on a 5-point scale, using a 21 items, with a sample of US residents recruited via Amazon's Mechanical Turk[11]). As these studies varied in the number of items (ranging from 2 to 21) and in their recruitment strategy and representativeness, this suggests that measurement of trust in science is somewhat robust to such differences.

Another limitation is that we considered only one behavior — social distancing — as it was the dominant concern at the time of data collection. It is an important avenue for future research to see how these findings generalize to mask wearing and vaccination uptake.

In sum, trust in science has the potential to promote sustainable social good. In the context of the COVID-19 pandemic, we show what the mechanisms and limits of trust in science can be for achieving behavioral change. Its role is limited to an extent, in that it does not have a direct effect on adherence to social distancing guidelines and in that its indirect effect on these (via approval of policy) is too small to make much difference. On the other hand, its role is central to the ecology of values and beliefs that govern human behavior in a pandemic, as it is the pivotal link between political ideology and attitudes to pandemic-prevention measures.

Even if trust in science has little effect on short-term behavior, as the focus of guidelines shifts from distancing and masks to vaccines, trust in science may be a vital part of decision making in the face of such volatility. Our study shows

that science performs best, not at changing behavior, but at convincing minds.

Methods

Participants

Participants were recruited via social media, university mailing lists, press releases and blog posts. Participation was not compensated. Overall, 6674 participants completed the survey. However, participants were able to opt out of certain personal questions (e.g., on political ideology). Further, the operationalization of "close social circle" (see below) meant that some participants responded that they had no close circle, in which case there is no data for whether they thought their close circle was adhering to COVID-19 measures (our social conformity measure). These two sources of missing data mean that there are 4341 complete responses for the variables reported here.

Participants' countries of residence with samples larger than 100 were: UK (1612); Turkey (630); USA (459); Peru (216); Germany (189); France (188); and Australia (109). For further details about recruitment and demographics, see ref[10].

The study received ethical approval through the University of Nottingham, and all participants provided informed consent. Data was not retained from any surveys that were abandoned before the final debrief.

Procedure

The survey was delivered via a custom web app (desktop and mobile) written in jsPsych[20]. A link to a full demonstration of this app can be found in the wiki at https://osf.io/ke5yn/.

Participants first selected which language they would like to do the survey in (options: Arabic, Bangla, Chinese, English, Farsi, French, German, Hindi, Italian, Spanish, Swedish, Turkish).

After providing informed consent, participants indicated their close social circle using an established method[21]. First, participants listed the first names of all those people with whom they had had a conversation with in the previous 7 days (these names are not retained in the data). Second, those names were presented on the screen, and participants selected which names (if any) they would turn to for comfort or advice, using checkboxes. Their close social circle is operationalized as the subset of names that they selected at this second stage.

Participants were reminded of the general guidelines at the time (April–May, 2020): to keep physical distance from others. They used sliders to respond whether they were adhering to this advice (labels 0='Not been following the advice at all'; 50='Been following the advice exactly'; 100='Been doing more than what is advised'), and show their approval of the guideline (0='Not following the advice is completely ok'; 100='Not following the advice is completely wrong'). They were reminded of the names of those in their close social circle,

and responded whether they thought their close social circle was adhering with the same guidelines (using the same slider response format).

Three items were selected from the six-item Credibility of Science scale[22] for reasons of brevity, given the length and voluntary nature of the study. This compares with a previous study with a smaller sample size[19] that used two items from this scale. The items used here were:

1. People trust scientists a lot more than they should
2. A lot of scientific theories are dead wrong
3. Our society places too much emphasis on science

Participants rated their agreement with these statements using a slider (0='completely disagree'; 100='completely agree'). The 'trust in science' score is the average of these three responses (reliability[23] $\omega_t = 0.75$).

Participants described their political ideology, again using a slider (0='very liberal'; 100='very conservative'). They could opt out in two ways, with one checkbox indicating that this continuum did not describe their beliefs, and another checkbox indicating that they did not wish to respond.

Finally, participants provided demographic information, including age, gender and education level (which are included as control variables in all models reported here). For other questions asked in the survey as part of the larger project on the normative and social aspects of COVID-19, see ref[10].

Open materials, data and analyses

The Open Science Framework (OSF) repository for the broader project (https://osf.io/ke5yn/) includes an interactive demonstration of the full study. The OSF repository for this specific study (https://osf.io/s5mdh/) contains the data and analyses.

The survey design was preregistered at the above project repository. The same registration included the hypothesis that adherence to official guidelines would be predicted by trust in science. For other hypotheses in the broader project, see ref[10].

The Bayesian models reported below were not pre-registered, but the full R analysis script is available at the above study repository. This includes full details of model priors, random effects structures, and control variables such as gender, age and education.

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Contributions

JS: conceptualization, methodology, investigation, data curation, analysis, visualization, software, writing - original draft, writing - review & editing; OD: conceptualization, methodology, investigation, writing - review & editing; funding acquisition; GD: conceptualization, investigation, writing - review & editing; MN: investigation, writing - review & editing; YZ: data curation, analysis, writing - review & editing; MEZ: conceptualization, methodology, investigation, writing - original draft, writing - review & editing; BT: conceptualization, methodology, investigation, data curation, analysis, writing - review & editing, project administration.

References

[1] Pagliaro, S. *et al.* Trust predicts covid-19 prescribed and discretionary behavioral intentions in 23 countries. *PloS One* **16**, e0248334 (2021).

[2] Pennycook, G., McPhetres, J., Bago, B. & Rand, D. Predictors of attitudes and misperceptions about COVID-19 in Canada, the UK, and the USA (2020).

[3] Gauchat, G. Politicization of science in the public sphere: A study of public trust in the united states, 1974 to 2010. *American sociological review* **77**, 167–187 (2012).

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

[5] Plohl, N. & Musil, B. Modeling compliance with COVID-19 prevention guidelines: The critical role of trust in science. *Psychology, Health & Medicine* **26**, 1–12 (2021).

[6] Mercier, H. How gullible are we? A review of the evidence from psychology and social science. *Review of General Psychology* **21**, 103–122 (2017).

[7] Bicchieri, C. *Norms in the wild: How to diagnose, measure, and change social norms* (Oxford University Press, 2016).

[8] Betsch, C. *et al.* Social and behavioral consequences of mask policies during the covid-19 pandemic. *Proceedings of the National Academy of Sciences* **117**, 21851–21853 (2020).

[9] Cialdini, R. B. & Goldstein, N. J. Social influence: Compliance and conformity. *Annual Review of Psychology* **55**, 591–621 (2004).

[10] Tuncgenc, B. *et al.* We distance most when we believe our social circle does. *British Journal of Psychology* (2021).

[11] Agley, J. Assessing changes in US public trust in science amid the COVID-19 pandemic. *Public Health* (2020).

[12] Czarnek, G., Kossowska, M. & Szwed, P. Right-wing ideology reduces the effects of education on climate change beliefs in more developed countries. *Nature Climate Change* **11**, 9–13 (2021).

[13] Wolsko, C., Ariceaga, H. & Seiden, J. Red, white, and blue enough to be green: Effects of moral framing on climate change attitudes and conservation behaviors. *Journal of Experimental Social Psychology* **65**, 7–19 (2016).

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

[15] Roozenbeek, J. *et al.* Susceptibility to misinformation about COVID-19 around the world. *Royal Society Open Science* **7**, 201199 (2020).

[16] Maher, P. J., MacCarron, P. & Quayle, M. Mapping public health responses with attitude networks: the emergence of opinion-based groups in the UK's early COVID-19 response phase. *British Journal of Social Psychology* **59**, 641–652 (2020).

[17] Kreps, S. & Kriner, D. Model uncertainty, political contestation, and public trust in science: Evidence from the COVID-19 pandemic. *Science advances* eabd4563 (2020).

[18] Hertwig, R. & Grüne-Yanoff, T. Nudging and boosting: Steering or empowering good decisions. *Perspectives on Psychological Science* **12**, 973–986 (2017).

[19] Sibley, C. G. *et al.* Effects of the COVID-19 pandemic and nationwide lockdown on trust, attitudes toward government, and well-being. *American Psychologist* (2020).

[20] De Leeuw, J. R. jsPsych: A javascript library for creating behavioral experiments in a web browser. *Behavior Research Methods* **47**, 1–12 (2015).

[21] Dunbar, R. I. & Spoors, M. Social networks, support cliques, and kinship. *Human nature* **6**, 273–290 (1995).

[22] Hartman, R. O., Dieckmann, N. F., Sprenger, A. M., Stastny, B. J. & DeMarree, K. G. Modeling attitudes toward science: development and validation of the credibility of science scale. *Basic and Applied Social Psychology* **39**, 358–371 (2017).

[23] Revelle, W. & Condon, D. M. Reliability from alpha to omega: a tutorial. *Psychological Assessment* **31**, 1395–1411 (2019).