COVID-19 vaccine sceptics are persuaded by pro-vaccine expert consensus messaging

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Article accepted for publication,
Journal of Experimental Psychology: Applied

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To further understand how to combat COVID-19 vaccination hesitancy, we examined the effects of pro-vaccine expert consensus messaging on lay attitudes about vaccine safety and intention to get a COVID-19 vaccine. We surveyed 729 unvaccinated individuals from four countries in the early stages of the pandemic, and 472 unvaccinated individuals from two countries after two years of the pandemic. We found belief of vaccine safety strongly correlated with intention to vaccinate in the first sample and less strongly in the second. We also found that consensus messaging improved attitudes toward vaccination even for participants who did not believe the vaccine is safe nor intended to get it. The persuasiveness of expert consensus was unaffected by exposing participants' lack of knowledge about vaccines. We conclude that highlighting expert consensus may be a way to increase support toward COVID-19 vaccination in those hesitant or sceptical.

Significance Statement

Unvaccinated individuals are persuaded by consensus information that Public Health experts believe the vaccine is safe to administer to humans or that the experts intend to get vaccinated (Study 1, early pandemic) or that they got vaccinated (Study 2, late pandemic). The positive shift in attitude toward vaccination is modest but suggests that some individuals will be more willing to get vaccinated if consensus information on the safety and administration of the vaccine is communicated.

Keywords: covid-19, attitudes, expert consensus, illusion of explanatory depth, persuasion, vaccination

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Experts agree that vaccines are the most promising way to stop the COVID-19 pandemic because vaccines can decrease transmission of the virus and reduce the severity of the disease (Thompson et al., 2021). In short, experts believe vaccines save lives. Yet, despite wide access to vaccines in developed countries, some individuals refuse to get vaccinated (Mathieu et al., 2021). Part of this hesitancy is due to differences between individual moral philosophies that cannot be easily remedied (Byrd & Białek, 2021). Even when philosophical differences do not require remedying, prolific misinformation campaigns regarding the virus, the vaccine, and possible treatment alternatives may still explain why some choose to vaccinate while others do not (Roozenbeek et al., 2020; Tasnim et al., 2020). A perceived lack of consensus in experts, or distrust in them, may also explain vaccine hesitancy. Indeed, media presenting a balance of opinions even when one opinion is favored much more strongly than the other can mislead individuals into believing there is more disagreement than truly exists (Dixon & Clarke, 2013; Koehler, 2016). So-called “flip-flopping”, reversals of guidance and recommendations from public health bodies, lowers perceptions of trust and expertise in official sources of information (Gretton et al., 2021). These findings suggest that one reason people may be vaccine hesitant is because they believe to know more than they really do. For instance, people may believe things that are not actually true (“misinformation”) or believe there is less of a consensus between experts than is presented. Thus, we reason that one source of vaccine hesitancy is overestimating one’s knowledge and posit that this can be countered by presenting people with the consensus agreement among experts about COVID-19 vaccines.

When people encounter a problem but lack the expertise required to solve that problem, they should probably defer to an expert (Johnston & Ballard, 2016). For instance, in the case of the COVID-19 pandemic, lay people may have been better off deferring to the consensus of relevant experts (e.g., virologists, public health officials) and focusing on differentiating experts from non-experts (e.g., their peers, celebrities; The Lancet Infectious Diseases, 2020). However, identifying the consensus of experts is often challenging and people tend misconstrue the true distribution of expert opinion on any issue because of the pervasiveness of so-called *merchants of doubt* (Lewandowsky et al., 2013; Oreskes & Conway, 2010). Merchants of doubt are individuals who – in an attempt to persuade others - deliberately undermine scientific consensus by highlighting consensus-inconsistent findings (regardless of their quality) or challenging the validity of scientific methods. In addition to merchants of doubt, seeing a representative from each side of a debate distorts people's perception of the true numbers supporting each side (Koehler, 2016). Correcting this misconstrual can help individuals acquire an accurate view of the world (van der Linden, Maibach, et al., 2015; van der Linden, 2021). For example, sending messages of scientific consensus to lay people led to an increase in their support for vaccines (van der Linden et al., 2015) and for the mitigation of a global increase in temperature (van der Linden, Leiserowitz, et al., 2015; van Stekelenburg et al., 2021). The Gateway Belief Model describes how communicating expert consensus might change people's beliefs and attitudes (van der Linden, 2021). For illustration, consider the problem of climate change. The basic idea of the Gateway Belief Model is that people doubt the reality of some phenomenon (e.g., human-caused acceleration of climate change) because they underestimate the consensus among relevant experts. Correcting the misperception about expert consensus serves as a gateway to subsequent increases in: (1) beliefs that the climate is changing, (2) worry that the climate is changing, and (3) belief in humans contributing to the changing climate. Hence, correcting misperceptions about scientific consensus can affect people's support for the fight against climate change. We hypothesized that underestimating the consensus on the vaccine safety may justify vaccine hesitancy and that providing more accurate estimate of the consensus could increase the willingness to vaccinate.

Some additional benefits of communicating scientific consensus are that it can depolarize (Flores et al., 2022) and depoliticize the debate across cultures (van der Linden et al., 2018). Directly applied to the COVID-19 pandemic, communicating relevant scientific consensus has been shown to increase personal support for mitigation policies (Kerr & van der Linden, 2022), and boost vaccine uptake (Bartoš et al., 2022). According to a recent meta-analysis, peoples' factual beliefs can be affected by consensus messaging by about $g = 0.12$ (van Stekelenburg et al., 2022). To put the magnitude of this effect into context, an intervention targeting IQ with the same effect size would produce an increase of under 2 IQ-points (one standard deviation is 15 IQ points). A change of this magnitude is probably not meaningful to any given person but it can be very meaningful to large groups of people.

In this project, we provided participants not yet vaccinated for COVID-19 with consensus opinions said to be from their local Public Health experts. The goal was to determine whether consensus information might improve attitudes toward vaccination among the unvaccinated. As explained above, the Gateway Belief Model provides theoretical arguments supporting this hypothesis. Yet, communicating expert consensus may not be effective in convincing people to vaccinate against COVID-19 because the issue is highly politicized. Moreover, some of the anti-vaxxers may consider health experts as an out-group and therefore disqualify their opinions. People sometimes fail to privilege expert consensus (over the opinions of their peers) when forming or updating their beliefs (Johnston & Ballard, 2016). This could be due to people overestimating how much they know, leading them to implicitly fail to disqualify themselves (and their peers) as experts (Keil, 2006; Meyers et al., 2020). Fortunately, a person can reduce their overestimation by attempting to explain how the phenomenon works, leading to a restoration of the privilege of opinion to the experts.

Specifically, when individuals attempt to explain how a complex causal system works (i.e., how a vaccine can reduce the severity of an illness), they tend to recognize the gaps in their knowledge that would otherwise not be salient to them (Meyers et al., 2022). This leads them to credit sources who are perceived to hold such information, such as experts. In other words, individuals may ignore expert consensus because they lack the intuition about how much their knowledge differs from the knowledge experts possess, but when an individual recognizes their lack of knowledge (through explanation) the difference becomes more salient.

We aimed to improve the effectiveness of communicating experts' consensus by exposing people's lack of knowledge about the vaccines. If people are overestimating how much they know about COVID-19 vaccination, then providing expert consensus may have little effect. Exposing an illusion of explanatory depth (by asking people to explain an issue) can help people to incorporate consensus of professional in their judgments (Meyers et al., 2020), but this has only been tested in for expert economists and economic issues. Exposing the illusion may also reduce attitude polarization (Crawford & Ruscio, 2021; Fernbach et al., 2013; Sloman & Vives, 2022). Taken together, if consensus information is presented in conjunction with exposing an illusion of explanatory depth, people may shift their attitudes toward the consensus opinion.

In the present work, we report two experiments (conducted in early-to-mid-2021 and in mid-2022 respectively), where we tested two types of expert consensus: (1) *Safety Consensus* and (2) *Intent Consensus*. The Safety Consensus was an affirmative answer of experts to a question of whether the available (or to become available) COVID-19 vaccine is safe to be administered in humans. The Safety Consensus was designed to help one to build a positive attitude toward the vaccine (or decrease negative attitude caused by concerns about its safety). For example, if a person is uncertain whether vaccines are safe, or incorrectly believes vaccines are unsafe, the new piece of information could make them feel less confident in their beliefs. The Intent Consensus was an affirmative answer of experts to a question of whether they would vaccinate themselves as soon as the vaccine was available to them (Experiment 1) or whether they have already received at least one dose of a vaccine (Experiment 2). Here, the information can be used as a social proof (Cialdini, 2009) to infer that any risks to the vaccines could be worth the benefit. People might be especially convinced by the Intent Consensus because it involves the experts putting skin in the game (Holmström, 1979). This is because having been administered the vaccine allows the expert to act as living evidence of the safety and effectiveness of the vaccine.

The current studies

In two experiments, we tested whether we could improve attitudes toward COVID-19 vaccines in unvaccinated individuals by presenting them with information about expert consensus on either the safety of the vaccine (Experiments 1 and 2), or on the intention to get vaccinated (Experiment 1) or having already gotten vaccinated (Experiment 2). We tested an individual's attitude toward COVID-19 vaccines with two items: 1) whether they believed the vaccine is safe to administer to humans, and 2) whether they intended to get vaccinated. In Experiment 1, we also tested a way to increase the efficiency of the consensus communicate, namely by asking individuals to explain how a vaccine works, hoping to expose their illusion of explanatory depth. In Experiment 2, we tested whether a change in the perceived consensus of experts moderates the effectiveness of consensus messaging.

Transparency and openness

We describe our sampling plan, all data exclusions (if any), all manipulations, and all measures in all studies. All data, analysis code, and research materials are available at Open Science Framework repository https://osf.io/63nmv/. Data were analysed using JAMOVI 2.2.5 (The Jamovi Project, 2021). Study 1 design and its analysis were preregistered at

AsPredicted.org, https://aspredicted.org/ni2rn.pdf. Study 2 design and its analysis were preregistered at AsPredicted.org, https://aspredicted.org/3n7sj.pdf. UK, US, and Polish samples were collected under the University of Wrocław ethics clearance, and the Portuguese sample under the ISCTE-Instituto Universitário de Lisboa ethics clearance.

Experiment 1

Participants

We conducted the experiment in four countries recruiting participants who were not yet vaccinated for COVID-19. Following preregistration, we excluded any participant who failed to select "0" when asked how many times they have had a fatal heart attack while watching movies. After exclusions, our sample contained 719 participants (N_{Poland} = 157, N_{UK} = 181, N_{USA} = 192 , $N_{Portugal}$ = 173, and 16 who declared to be from other countries, see Table 1 for details)[1]. This sample offers 80% power to detect within-subject differences of d > .10 and correlations r > .09. Thus we urge caution in interpreting results that are statistically significant but below these magnitude thresholds (see Simonsohn, 2015).

We collected data across 2 months, which is a meaningful period in terms of vaccine development. Table 1 reports the timeline of our study in the context of vaccine availability, and the percentage of vaccinated individuals. As the column "baseline attitudes toward vaccine" shows, unvaccinated participants in this experiment evaluated vaccines positively overall. That is, the average belief about vaccine safety was 3.70 and the intent to vaccinate was 3.47, both expressed on a 1 to 5 scale. Furthermore, these means were above 4 in countries where the vaccine was not yet fully publicly available at the time of our survey but first administered to prioritized individuals like the elderly or healthcare workers (UK & Portugal). Hence, our sample includes many individuals who intended to get the vaccine but

[1] In Portugal we used a slightly modified comprehension question, but it produced similar rejection rates.

could not yet get it. This severely reduced our ability to detect the positive effects of consensus information because we were essentially trying to convince people who were already willing to get vaccinated to get vaccinated. Since we did not expect this to happen, we only preregistered analyses on the full sample. We decided to supplement the preregistered analysis with an analysis testing the effectiveness of our manipulation taking into account the baseline attitudes of participants. To achieve this, we created a new between-subjects variable called “Attitude Toward Vaccines” by averaging responses to the Belief in Safety and Intent to vaccinate questions (that correlated at $r(726) = .81$). This new variable divided participants into three categories: Sceptics (baseline attitude ≤ 2, $n = 138$), Uncertain (2.5 ≤ baseline attitude ≤ 3.5, $n = 173$), and Supporters (baseline attitude ≥ 4, $n = 408$).

Table 1. Key details and descriptive statistics of Experiments 1 and 2.

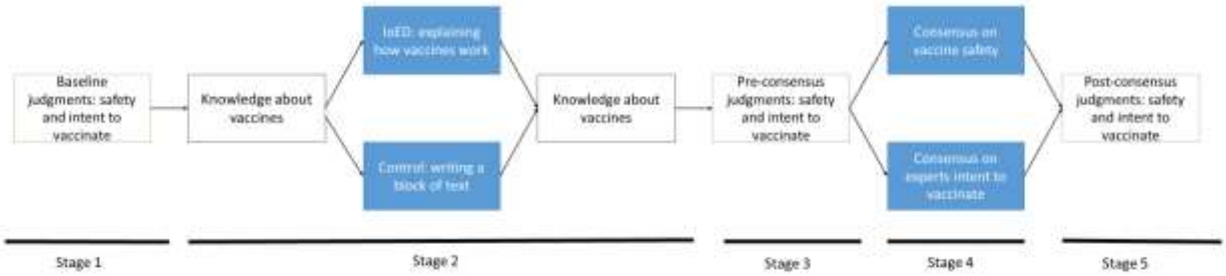
	Sample	$N_{included}$	N_{IoED}	Mean Age (*SD*)	N female	Dates of collection period	Date of the vaccine availability	% of vaccinated adults	Baseline attitude toward vaccines (mean, *SD*) Safety	Intent to vaccinate	Baseline attitudes toward vaccines categories (N's) Sceptics	Uncertain	Supporters
Experiment 1	*USA*	192	75	39.8 (*11.6*)	91	14-15th April, 2021	5th May 2021	26.9%	3.70 (*1.08*)	3.30 (*1.50*)	36	59	97
	UK	181	83	27.7 (*7.6*)	139	12th May, 2021	24th June 2021	27.8%	4.20 (*0.92*)	4.13 (*1.23*)	13	31	138
	Poland	157	73	35.6 (*10.1*)	95	28 June – 18 July, 2021	4th May 2021	42.8%	2.73 (*1.11*)	2.22 (*1.25*)	75	56	28
	Portugal	173	82	33.5 (*12.6*)	97	30 April – 13 May, 2021	14th August 2021	11.9%	4.05 (*0.92*)	4.05 (*1.19*)	15	24	134
	other	16	9	31.2 (*7.49*)	9	-	-	-	3.88 (*1.20*)	3.94 (*1.48*)	2	3	11
	TOTAL	**719**	**328**	**34.1**	**58.7 %**	**-**	**-**	**-**	**3.70 (*1.15*)**	**3.47 (*1.50*)**	**138**	**173**	**408**
Experiment 2	*Poland*	295	-	26.0 (*7.86*)	70	18-22 May 2022	-	59.8%	3.33 (*1.10*)	2.38 (*1.27*)	84	155	56
	USA	177	-	36.1 (*11.0*)	63			78.4%	3.84 (*0.79*)	3.85 (*1.17*)	12	37	118
	TOTAL	**472**	**-**	**29.8 (*10.4*)**	**28.2 %**			**-**	**3.52 (*1.02*)**	**2.93 (*1.42*)**	**96**	**192**	**174**

Note: Where appropriate we present the mean (and standard deviation). IoED – illusion of explanatory depth. The data for % of vaccinated adults comes from Mathieu et al., (2021). We considered all adults who had at least one dose to be "vaccinated". All dependent variables were assessed on a 1 – 5 scale. Baseline attitudes categories were created by grouping participants based on their Attitude Toward Vaccination. We categorized participants who scored 2 or below as "Sceptics", those who scored 4 or above as "Supporters" and those in between as "Uncertain".

Procedure and Materials

Figure 1

Procedure of Experiment 1.



Note. The blue boxes denote the experimental manipulations: exposing illusion of explanatory depth (Stage 2), and consensus messaging (Stage 4).

The procedure of this experiment was adapted from Meyers et al., (2020). It consisted of five stages, as depicted in Figure 1.

Stage 1: baseline judgments. Participants provided their baseline beliefs regarding the safety of the vaccine becoming available in their country ("The COVID-19 vaccine approved in my country is safe to administer to humans"), and their intention to vaccinate ("I intend to get vaccinated with the COVID-19 vaccine approved in my country"), using a 5-point scale labelled 1 – strongly disagree, 5 – strongly agree. All participants took part in this stage.

Stage 2: exposing the illusion of explanatory depth. Participants were assigned to one of two conditions: Explanation or No Explanation (a control condition). The Explanation condition was designed to expose participant's lack of thorough understanding of how vaccines work (i.e., illusion of explanatory depth). In this condition, participants first rated their understanding of how a COVID-19 vaccine works using a 7-point scale ("How well do you understand how the COVID-19 vaccine works to prevent a vaccinated individual from contracting COVID-19?”). Next, participants then attempted to explain precisely how the vaccine works to prevent contraction of the virus. The instructions for this part were as follows:

> *Now, we'd like to probe your knowledge in a little more detail. Please describe all the details you know about how the COVID-19 vaccine works to prevent a vaccinated individual from contracting COVID-19, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, try to tell as complete a story as you can, with no gaps. Please take your time, as we expect your best explanation.*

After explaining, participants then re-rated their understanding of how a COVID-19 vaccine works. In the No Explanation condition, participants instead typed-out a random block of text contained in an image. The length of the text was similar to the length of a typical explanation produced by participants in the experimental condition. The typing task ensured that all participants completed the experiment at a similar pace.

Stage 3: pre-consensus judgments. This stage was identical to Stage 1. Participants re-rated the Safety of the Vaccine and Intent to get Vaccinated using the same scales as in Stage 1. All participants took part in this stage.

Stage 4: consensus information. We then provided each participant with consensus information (Figure 2). We told them that the information came from *a sample of Public Health Experts from your country with widely varying political preferences*. Half of the participants were presented with Safety Consensus (Figure 2, Panel A), and the other half with Intent Consensus (Figure 2, Panel B). The consensus information was overwhelmingly supportive for the vaccines, displaying unanimous agreement among experts that the vaccine is safe to use and that they intended to get it themselves.

Figure 2

Consensus information presented to participants

The COVID-19 vaccine approved in my country is safe to administer to humans.

	Strongly Disagree.	Disagree.	Uncertain.	Agree.	Strongly Agree.
Percentage of Public Health Experts who gave this response.	0	0	0	34	66

I intend to get vaccinated with the COVID-19 vaccine approved in my country as soon as it becomes available to me.

	Strongly Disagree.	Disagree.	Uncertain.	Agree.	Strongly Agree.
Percentage of Public Health Experts who gave this response.	0	0	0	34	66

Stage 5: post-consensus judgments. This stage was identical to Stages 1 and 3. Participants provided a third rating of Safety of the Vaccine and Intent to get Vaccinated. All participants took part in this stage.

After Stage 5 concluded, we debriefed the participants by informing them that the consensus numbers were made up but that most experts endorse vaccination.

Research questions

Of primary interest and the main dependent variable was the *Total Attitude Update;* an effect of the entire experimental procedure on attitudes toward COVID-19 vaccination. Thiswas the comparison of the attitude of COVID-19 vaccines held at the start of the experiment compared to at the end of the experiment (Stage 1 vs. Stage 5). The total effect can be split into two smaller components: the effect of exposing the illusion of explanatory depth (IoED; Stage 1 vs Stage 3), and the effect of presenting *Consensus Information* from experts (Stage 3 vs. Stage 5). Note, that:

[1] Total Attitude Update = The Effect of Exposing the Illusion of Explanatory Depth + The Effect of Consensus Information

Some types of consensus may be more effective in persuading people than other types of consensus. In our project, *Intent Consensus* (i.e., information that the experts are ready to get the vaccine themselves) can differ in its effectiveness from *Safety Consensus* (i.e., information that the experts believe that the vaccine is safe for humans). If this is true, the magnitude of the *Total Attitude Update* and the effect of *Consensus Information* may depend on the *Type of Consensus*.

We planned to assess the *effect of exposing the illusion of explanatory depth* by comparing whether attitudes toward vaccines increased from Stage 1 to Stage 3 more in the experimental group than in the control group. If this would be the case, we could infer that exposing the illusion of explanatory depth has its own effect on improving the attitudes toward COVID-19 vaccination. We also planned to assess the *moderating effects of exposing the illusion of explanatory depth* by testing whether asking people to explain how the vaccine works resulted in greater susceptibility to the consensus information compared to a control group that only typed some neutral text. In that case, we would expect an *Illusion of explanatory depth* by *Consensus Information* interaction.

Results

We deemed a test statistically significant when its associated p-value was lower than .05. For post-hoc tests we used Tukey's Honest Significant Difference, which corrects for multiple pairwise comparisons. When interpreting effects, we chose to follow the classification of Funder and Ozer (2019), with effects of r = .05 being labelled as very small, r = .10 as small, r = .20 as medium, and r = .30 as large. We used Δ to describe the difference between raw scores across conditions.

Manipulation check

The experimental manipulation meant to expose the illusion of explanatory depth should lead to a decrease in self-reported knowledge about COVID-19 vaccination after the person attempts to explain how vaccination protects the individual from potential harm. Indeed, people reported knowing less about the vaccine (M = 3.92, SD = 1.67) after explaining compared to before explaining (M = 4.15, SD = 1.53), $t(327) = 3.78$, $p < .001$, d = 0.21 95% CI [0.10-0.32].

Dependent variable

We asked participants about two issues: (1) whether COVID-19 vaccines are safe, and (2) whether they themselves were willing to get vaccinated. We preregistered to combine the two variables into a single variable if they "strongly correlated" (that is, if $r > .6$). Indeed, safety beliefs and intention to vaccinate were strongly correlated at each Stage they were assessed (all *r's* > .80) and so we combined them into a single variable. We labelled this new variable "*Attitude Toward Vaccination*".

Manipulation effects on the attitudes toward vaccinations

This analysis aimed to answer the main question of this project: is positive expert consensus messaging effective in persuading unvaccinated individuals to hold more positive attitudes about vaccination? And if it is, to what extent does the effectiveness depend on the type of consensus presented (Safety vs. Intent), and does it matter whether an illusion of explanatory depth has been exposed? To answer these questions we analysed all available data, temporarily putting aside the differences between national samples (e.g., when the study was launched and the availability of vaccines and political consensus on vaccinations). This also means we did not include country as a factor in our analysis because it is strongly related to the baseline attitudes toward vaccination. For example, the Portuguese and UK samples consisted mostly of vaccine supporters who had not yet had the opportunity to get vaccinated, while the Polish sample consisted mostly of vaccine sceptics who had decided not to vaccinate despite vaccine availability. Because of this correlation, we could not control for both country and baseline attitudes in one model. Thus, we inserted baseline attitudes in the model because they seemed more theoretically relevant.[2]

We preregistered a repeated-measures ANOVA comparing baseline vs post-consensus judgments (within-subjects) depending on the type of consensus and whether an explanation was provided or not. As Table 2 shows, there was a small overall increase in attitude toward COVID-19 vaccination[3] (the magnitude of the effect is roughly equivalent to r = .09, a small effect according to Funder & Ozer, 2019). However, as explained above, most participants already held positive attitudes toward vaccination, weakening the potential effects of communicating vaccine-positive consensus. So, we supplemented the preregistered analysis with another that split participants into three categories based on their baseline attitude toward vaccination (i.e., Sceptics, Uncertain, and Supporters). When adding categorized baseline beliefs as a covariate, this new parameter interacted with the effects of consensus, $F(2, 707) = 5.35$, $p = .005$, $\eta 2p = .02$, suggesting the effects of consensus varied depending on the participant's baseline attitude toward COVID-19 vaccination. Table 2 and Figure 3 present the results divided by the groups of participants. Post-hoc tests revealed that consensus improved the Attitudes Toward Vaccination in Uncertain individuals but did not significantly affect the attitudes of Sceptics or Supporters. No other effect was significant, suggesting the effect of presenting unvaccinated individuals with expert consensus is relatively robust to its type (Safety vs. Intent to vaccinate) and to exposing the illusion of explanatory depth.

[2] An alternative solution was to slice the dataset into four subsamples by country, but this would come with a great reduction of statistical power. Interested readers can access the data and run country-by-country analyses for themselves.

[3] When we additionally inserted country as a factor (excluding the 'other' category), we observed a main effect of a country but no interaction.

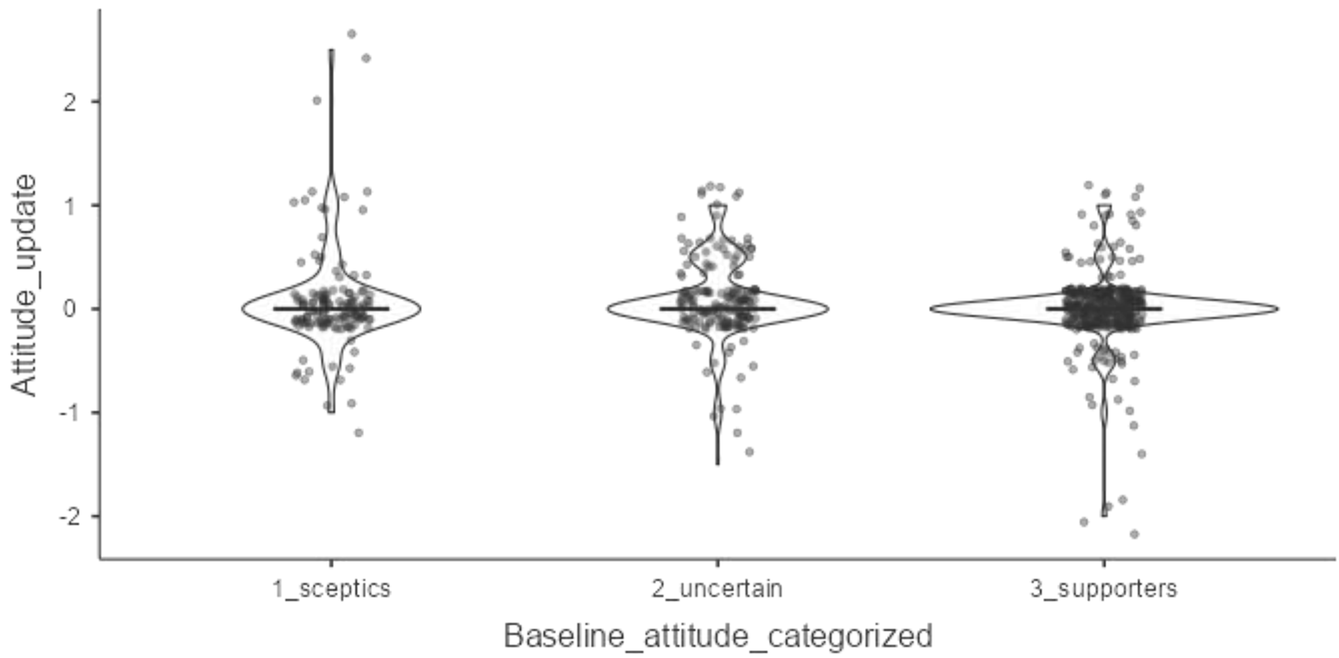
Table 2. Effects of the experimental procedure on the attitudes toward COVID-19 vaccine, comparing baseline to post-consensus attitudes in Experiment 1

Predictor	Full sample (N = 719)	Sceptics (N = 138)	Uncertain (N = 173)	Supporters (N = 408)
Consensus (pre vs. post)	**F = 6.01, p = .014,** $\eta 2p$ = .01	F = 3.86, p = .052, $\eta 2p$ = .03	**F = 10.29, p = .002,** $\eta 2p$ = .06	F = 0.19, p = .659, $\eta 2p$ < .01
Consensus type (Safety vs. Intent)	F = 0.54, p = .464, $\eta 2p$ < .01	F = 0.64, p = .427, $\eta 2p$ = .01	F = 0.75, p = .387, $\eta 2p$ < .01	F = 2.12, p = .146, $\eta 2p$ = .01
IoED	F = 1.71, p = .191 , $\eta 2p$ < .01	F = 2.26, p = .135, $\eta 2p$ = .02	F = 0.17, p = .680, $\eta 2p$ < .01	F = 0.19, p = .659, $\eta 2p$ < .01
Consensus x Consensus type	F< 0.01, p = .946, $\eta 2p$ < .01	F = 0.89, p = .348, $\eta 2p$ = .01	F = 0.02, p = .894, $\eta 2p$ < .01	F = 1.22, p = .270, $\eta 2p$ < .01
Consensus x IoED	F= 0.13, p = .721, $\eta 2p$ < .01	F = 0.55, p = .461, $\eta 2p$ < .01	F = 0.02, p = .875, $\eta 2p$ < .01	F = 0.07, p = .787, $\eta 2p$ < .01
Consensus type x IoED	F = 0.38, p = .539, $\eta 2p$ < .01	F = 0.32, p = .570, $\eta 2p$ < .01	F = 1.07, p = .303, $\eta 2p$ = .01	F = 0.37, p = .543, $\eta 2p$ < .01
Consensus x Consensus type x IoED	F = 0.02, p = .878, $\eta 2p$ < .01	F = 0.01, p = .925, $\eta 2p$ < .01	F = 0.91, p = .340, $\eta 2p$ < .01	F = 0.50, p = .478, $\eta 2p$ < .01
Overall effect	Improvement	No change	Improvement	No change
Attitude change (raw)	0.03	0.09	0.09	-0.01

Note: IoED – Illusion of Explanatory Depth. Note: table presents only the within-subject effect of presenting consensus information and its interactions. Between-subject effects are reported in Supplementary Online Materials located on the OSF.

Figure 3

Total Attitude Update toward COVID-19 vaccine (beliefs about vaccine safety and intent to vaccinate) after being presented with consensus information, split by baseline attitude.



Note. Positive values on the y-axis represent an increase in positive attitudes toward vaccination as a result of being presented with consensus information. In each violin plot, a grey dot represents a data point, and a black line represents the group mean. The shape of the violin represents the density of each variable, with wider sections representing that more people obtained that specific Total Attitude Update value.

Discussion

After presenting participants with expert consensus regarding vaccination safety or experts' intent to get vaccinated we found that people's Attitudes Toward Vaccination improved. However significant, the overall effect size was negligibly small, with merely a 0.03-point increase throughout the entire procedure. This suggests that the procedure might not be very effective if one is trying to change the mind of a single person. However, when applied to a larger scale (which is often the case when consensus messaging is cited), it might motivate thousands of individuals to view the vaccine in a more positive light. We need to remember that the overall effect is a composition of moderate positive effects of expert consensus on vaccine Sceptics and Uncertain individuals and no effect on unvaccinated vaccine Supporters.

Our data show that unvaccinated people can be swayed by expert consensus so that they report holding opinions similar to what the experts claim to believe. Consistent with past literature (van der Linden, Clarke, et al., 2015), this suggests that providing people with new information about expert consensus on vaccines can help them update their beliefs accordingly.

Our findings sparks a question to what extent participants' stated beliefs translate into real-world behaviours like getting vaccinated against COVID-19. We know that self-reported attitudes are correlated to factual behaviour, but this correlation tends to be imperfect (Ajzen & Timko, 1986). Indeed, when comparing the attitudes toward vaccination in Experiment 1 to real-world vaccination rates in Poland and Portugal approximately one year after we conducted our initial experiment, Portugal's positive attitude toward vaccination was later followed by vaccination rate increase from 12% to 95% while Poland's more neutral attitude toward vaccination was followed by vaccination rate increase from 42% to just over 50% (Mathieu et al., 2021). Hence, it seems that attitudes toward vaccine declared by our participants correspond well with the population real-world behaviour.

Finally, our experiment showed no moderating effect of exposing an *Illusion of Explanatory Depth* on the effectiveness of the *Consensus Information*. As the picture is likely more nuanced than "the manipulation did not work, therefore there is no illusion," we recognized that we did not have the physical resources to conduct further work trying to answer this question in addition to the primary focus of whether consensus has an effect outright. So, we omitted the explanatory depth component from Experiment 2.

Experiment 2

In this experiment, we replicated Experiment 1 with minor design improvements. As a year had passed between Experiments 1 and 2, the vaccine was now widely available in most major countries of the world. This meant that any qualified and motivated person could have become vaccinated. Our samples of the unvaccinated in this experiment are thus unlikely to represent people who would have otherwise gotten the vaccine were it available – unlike Experiment 1. In other words, the unvaccinated samples of Experiment 2 represent individuals who despite having access to a vaccine elected to not get it.

We removed the illusion of explanatory depth manipulation because we did not find a general effect and we needed to balance practical constraints with theoretical ones. Instead, we focused on an alternative mechanism for the effectiveness of presenting consensus information: perceived consensus. We tested for perceived consensus in experts twice: once prior to presenting the consensus information and once immediately after presenting the consensus information. We expected that changes in the Attitude Toward Vaccination would reflect the changes in perceived consensus.

Participants

We tested 299 unvaccinated participants from Poland via Prolific Academic and 377 from the USA via Amazon’s Mechanical Turk. Data were collected in late May of 2022. We decided not to test participants from the UK or Portugal because their high vaccination rates (95% for Portugal, 69% for UK – Mathieu et al., 2021) made it difficult to obtain a large sample of the unvaccinated. Naturally, the sample for Experiment 2 consisted of relatively fewer vaccine supporters than the sample for Experiment 1, which affords us a stronger test of whether presenting consensus information is effective in persuading vaccine sceptics. Demographics of the sample are presented in Table 1 above.

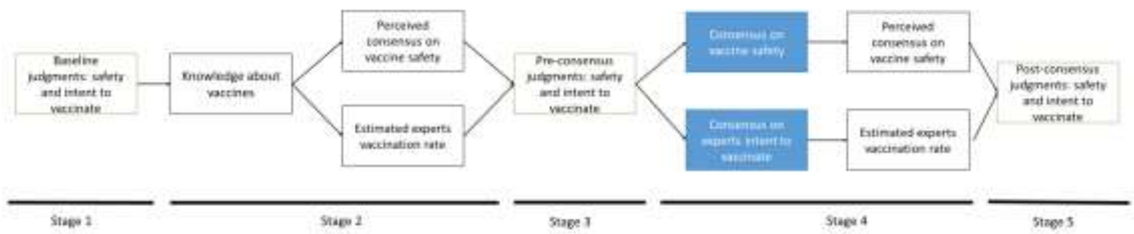
We used the same exclusion criterion as in Experiment 1; we excluded participants who indicated that they had encountered at least one fatal heart attack while watching Netflix. 99% of Polish participants passed this question. Surprisingly, only 47% of the US participants passed. We excluded those inattentive participants, resulting in a sample of 295 participants from Poland and only 177 from the USA. When combined, this dataset had 80% power to detect within-subject differences of $d > 0.13$ and correlations of $r > .13$. Smaller effects or complex interactions might therefore be missed, or when found significant, should be treated as unreliable.

Procedure and Materials

We slightly modified the procedure of Experiment 1 (Figure 4). In this new experiment, Stages 1, 3, and 5, where participants provided their ratings of how safe they perceived the vaccine to be as well as their intention to vaccinate were identical to Experiment 1. In Stage 2 participants estimated their knowledge about vaccines and estimated the consensus of experts on how safe they perceived COVID-19 to be or the true vaccination rate among experts. Finally, they provided demographic information about themselves.

Figure 4

Procedure of Experiment 2.



Note. The blue-shaded boxes denote the Type of Consensus experimental manipulation.

When presenting experts consensus to participants, we changed the question that health experts supposedly responded to, from (1) intent to get the vaccine to (2) whether the experts had gotten vaccinated. The new question about Perceived Safety Consensus ("What do you think is the consensus of experts in your country on the safety of available COVID-19 vaccines?") was answered on a scale of 1 (No consensus) to 7 (Full consensus). The new question about Perceived Vaccination Consensus among health experts ("What do you think is the proportion of experts in your country that received COVID-19 vaccines themselves?") was also measured using a 1 (no expert was vaccinated) to 7 (all experts are vaccinated) scale.

The remainder of the experiment was identical to Experiment 1. At the end, participants were debriefed and thanked for their time.

Results

Manipulation check

First, we tested whether presenting individuals with expert consensus affected their perception of the consensus of experts. This was indeed the case. Perceived consensus increased from 3.97, 95%CI [3.83, 4.10] to 4.47, 95%CI [4.36, 4.58], $F(1,470) = 125.00$, $p<.001$, $\eta 2p = .21$. We also tested whether beliefs about vaccine safety and intent to get vaccinated correlated strongly enough (we preregistered a threshold of $r > .6$) to justify combining them into one factor. Unlike in Experiment 1, this was not the case in Experiment 2 ($r = .56$ for initial judgments and $r = .60$ for second judgments). Hence, as preregistered, we conducted analyses for each of the beliefs separately. Finally, we compared baseline Attitudes Toward Vaccines between Poland and USA. We found that Americans ($M = 3.84$, $SD = 0.79$) compared to Poles ($M = 3.33$, $SD = 1.10$) believe the vaccine is more safe, $F(1,455) = 35.16$, $p<.001$. Americans ($M = 3.85$, $SD = 1.17$) also possessed a stronger intention to get vaccinated than Poles (*M* = 2.38, *SD* = 1.27), *F*(1,395) = 163.60, *p*<.001, and fewer of them declared to have contracted COVID-19 (33% vs 60%, $\chi^2(471) = 32.30$, p<.001).

Confirmatory analysis

We conducted two mixed-model ANOVAs comparing pre- and post-consensus attitudes toward vaccination, controlling for type of consensus.[4] Table 3 reports the statistics of these models. We found that beliefs about vaccine safety increased in response to receiving consensus information, and more so after participants received relevant consensus information (i.e., about vaccine safety rather than experts' decision to get vaccinated). There was no increase in intent to get vaccinated (Table 3).

Table 3. Effects of the experimental procedure on the attitudes toward COVID-19 vaccine, comparing baseline to post-consensus attitudes in Experiment 2.

Predictor	Vaccine safety		Intent to vaccinate	
	Simple model	Full model	Simple model	Full model
Consensus information	**F= 7.42, *p* = .007, *η2p* = .02**	**F= 24.09, p < .001, *η2p* = .05**	F= 2.43, *p* = .120, *η2p* = .01	F= 1.94, *p* = .164, *η2p* < .01
Consensus information x consensus type	**F= 5.82, *p* = .016, *η2p* = .01**	**F= 10.69, *p* = .001, *η2p* = .02**	F= 1.28, *p* = .258, *η2p* < .01	F= 0.77, *p* = .380, *η2p* < .01
Consensus information x beliefs categorized	-	**F= 20.66, p < .001, *η2p* = .08**	-	**F= 11.01, p < .001, *η2p* = .05**
Consensus information x consensus update	-	F= 0.06, *p* = .813, *η2p* < .01	-	F= 0.05, *p* = .819, *η2p* < .01
Consensus information x contracted COVID	-	F= 0.47, *p* = .493, *η2p* < .01	-	F=0.26, *p* = .608, *η2p* < .01
Consensus information x consensus type x beliefs categorized	-	F=1.35, *p* = .260, *η2p* = .01	-	F=0.22, *p* = .802, *η2p* < .01
Consensus information x consensus type x contracted COVID	-	F=2.19, *p* = .139, *η2p* = .01	-	F=0.57, *p* = .451, *η2p* < .01

[4] Again, inserting Country as a between-subject factor produced only the main effect of Country with more positive views toward COVID-19 vaccination held by Americans.

consensus x beliefs categorized x contracted COVID	-	F=0.48, *p* = .622, *η2p* < .01	-	**F= 4.52, *p* = .011, *η2p* = .02**
consensus x consensus type x beliefs categorized x contracted COVID	-	F=0.12, *p* = .891, *η2p* < .01	-	F= 0.08, *p* = .918, *η2p* < .01
Overall effect	improvement	improvement	No change	improvement only in Sceptics
Attitude change (raw)	0.08	0.18	0.05	0.06

Note: The table presents the within-subject effect of presenting consensus information and its interactions. Models including the between-subjects factor can be found in the Supplementary Online Materials located on the OSF.

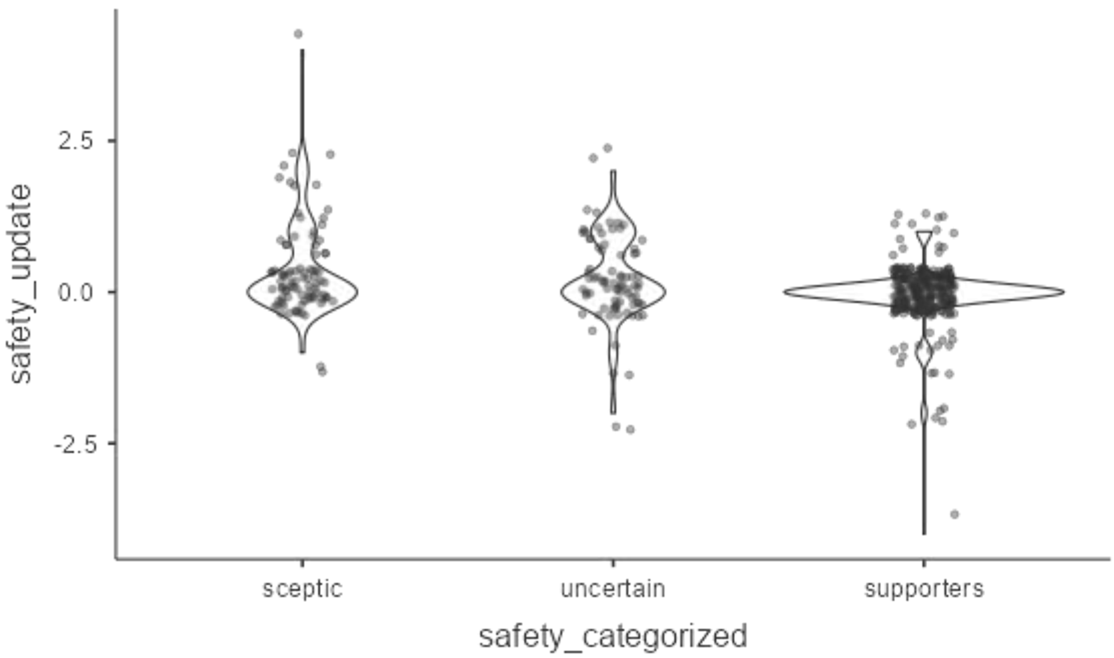
Preregistered exploratory analyses

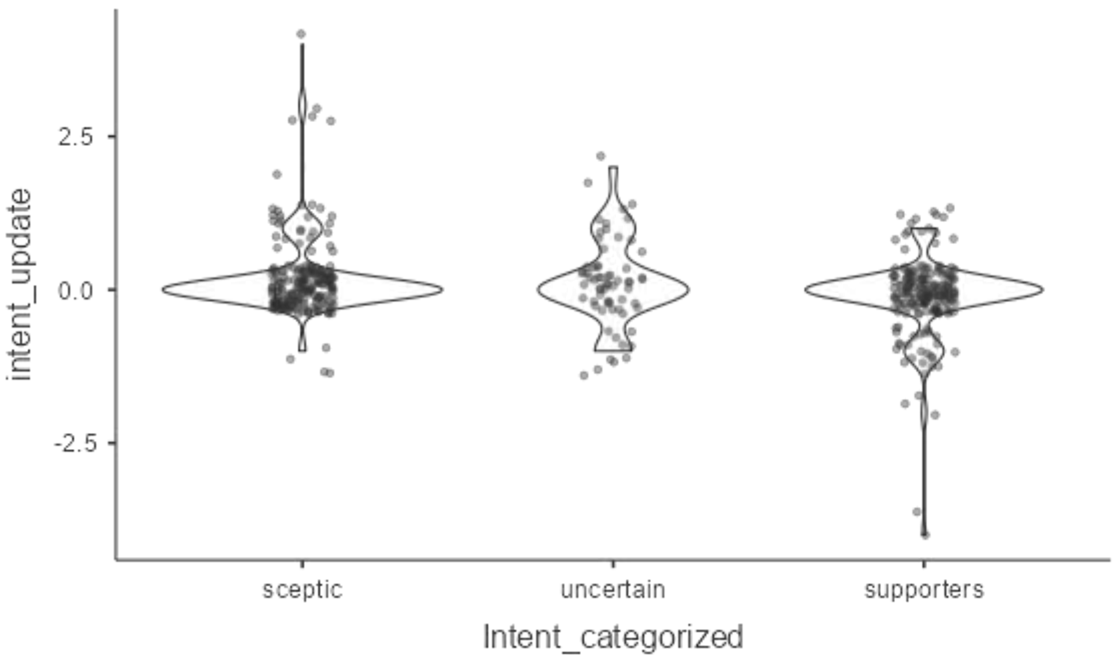
We computed a mixed ANOVA to test whether attitudes toward COVID-19 vaccination improved after presenting expert Consensus Information depending on: (1) Categorized Prior Beliefs (with responses of 1 and 2 coded as Sceptics, 3 as Uncertain, and 4 and 5 as Supporters), and (2) Perceived Consensus Update (i.e., a difference between baseline and post-manipulation perceived consensus), and (3) participant having contracted COVID-19 (yes vs. no). Because of this hypothesis, we only report whether these variables interacted with the main effect of Consensus Information.

As visible in Figure 5, for safety beliefs, we observed a significant interaction of the Consensus Information with the Categorized Prior Beliefs about vaccine safety, showing an increase in Uncertain individuals ($\Delta = 0.24$, $p<.001$) and Sceptics ($\Delta = 0.36$, $p<.001$), but no change in Supporters ($\Delta = -0.05$, $p=.108$). For Intention to Vaccinate, the Consensus Information by Categorized Prior Belief interaction showed an increase in the intent to vaccinate in Sceptics ($\Delta = 0.20$, $p<.001$) but no change in Uncertain ($\Delta = 0.09$, $p=.902$) and in Supporters ($\Delta = -0.11$, $p=.165$). This interaction was further qualified by having contracted COVID-19, but we refrain from interpreting it because of the low power to detect it reliably, and thus uncertainty regarding its replicability. No Consensus Information by Perceived Consensus Update interaction was observed in any of the dependent variables.

Figure 5.

Update of beliefs about vaccine safety and intent to vaccinate after exposition to the consensus information, split by the baseline attitude.





Note. Positive values on the y-axis represent an increase in positive attitudes toward vaccination as a result of being presented with consensus information. In each violin plot, a grey point represents a data point. The shape of the violin represents the density of each variable.

Discussion

In a sample of unvaccinated Americans and Poles we successfully replicated the positive effects of expert consensus on attitudes toward vaccination. Specifically, we found that vaccine Sceptics, individuals who had yet to receive even a single dose of a COVID-19 vaccine one year after they became publicly available, adjusted their attitudes of the COVID-19 vaccine toward the consensus attitudes of experts. Consistent with Experiment 1, the improvement in attitudes toward vaccination did not extend to those who already held a positive view of the vaccine (Supporters), possibly due to them being already convinced about the advantages of vaccination.

General Discussion

Informing people about a strong consensus of local Public Health experts on vaccine safety and intention (Experiment 1) or decision (Experiment 2) to vaccinate persuaded unvaccinated people to hold more positive attitudes toward COVID-19 vaccines. The overall effects observed in all participants were small, which we attributed to many people already holding a positive view of the vaccine. Most notably, however, we consistently found that presenting consensus information positively impacted the views of those originally sceptical of the vaccine. When considering effects at the population level, we believe that communicating expert consensus on COVID-19 vaccination will lead to some individuals to get vaccinated, including unvaccinated sceptics.

Despite relying on self-reported attitudes and creating the distribution of consensus rather than relying on real-world data, our findings were highly consistent with a recent field study conducted in the Czech Republic. In that study, Bartoš et al. (2022) surveyed doctors to estimate that about 90% agree that the COVID-19 vaccine available in the Czech Republic is safe to administer. After presenting this information to participants (who thought the consensus was closer to “50% of doctors agreed”), the research team observed several longitudinal consequences including an increase in vaccination rates (compared to a group who did not receive clear consensus information).

In our experiments, vaccine supporters finished the experiment with almost identical opinions about COVID-19 vaccination as they held before the experiment. This is because many of them possessed attitudes already aligned with expert consensus. The same was not true, however, for the uncertain and sceptic groups. While there was a risk that vaccine sceptics presented with vaccine-supporting arguments could become even more sceptical (Nyhan & Reifler, 2010; Wood & Porter, 2019), we did not observe this. Indeed, on the aggregate level, the sceptic group moved just as much toward the expert consensus as the uncertain group. Thus, the possibility of strengthening anti-vaccination attitudes by presenting expert consensus was not supported in this research.

One might be tempted to argue that the observed pattern of results reflects regression to the mean (Healy & Goldstein, 1978). The argument follows that participants did not adjust their scores because they were provided consensus information, but because over time we expect scores to move from the extreme to more neutral. While this may explain the pattern in the vaccine sceptic group, it does not explain the pattern of the uncertain group (attitude improvement) or the supporters (consistently positive attitude).

In Experiment 1, we observed no moderating effect of exposing the illusion of explanatory depth. Asking people to explain, step-by-step, how a vaccine works was intended to expose their lack of true knowledge and make them more open to expert opinion. Despite lowering self-rated knowledge about how a COVID-19 vaccine works, this intervention had no effect on the susceptibility to expert consensus information. Because we did not collect knowledge ratings in the control group, we are unable to say whether the observed decrease in self-rated knowledge after explaining how the vaccine works is any different from merely evaluating one’s knowledge twice, which does lead to a reduction across judgments (Meyers et al., 2022). Therefore, we cannot rule out that our effort to expose the illusion of explanatory depth failed and thus produced no effects on the attitudes toward COVID-19 vaccines. However, the reduction in self-reported knowledge is more consistent with observed drops due to exposing an illusion than to simply providing two ratings (which usually leads to a reduction of approximately d = .10). This suggests we were likely successful in exposing an illusion of explanatory depth, which proceeded to have no impact on how people adjusted to consensus information from experts. But due to the limitations of our design, we cannot confidently rule out either explanation, leaving this question open for further investigation.

Our experiments suffer some other limitations. Firstly, our participants were recruited from four countries with varying political climates. In Experiment 1, in addition to each country having a different schedule of when the vaccine would become available, our data collection occurred across different time points, so the context of vaccine availability and robustness of the available evidence supporting its safety and efficacy varied within our population. As a result, baseline attitudes that were correlated to the country of origin of our participants were also confounded with these factors, which may have affected our results. For example, mild consequences of the pandemic in one country could decrease a citizen's willingness to get vaccinated but not affect their belief in the vaccines' safety or efficacy (Glöckner et al., 2020). This could decrease the effectiveness of our pro-vaccine argumentation presented to participants because the argumentation did not target the other sources of vaccine hesitancy (e.g., the misbelief that the pandemic would soon be over without undertaking any effort, or that the COVID-19 is not life-threatening).

Secondly, the overall effect of improving attitudes by providing expert consensus could differ in magnitude from what we observed. One reason to expect some degree of difference between our estimates and the true effect of presenting consensus is that consensus rarely looks like it does in the way that we presented it to participants (Figure 1). Namely, experts in a single field almost never universally agree on anything. The real effect of communicating expert consensus on reshaping public attitudes likely depends somewhat on what the distribution of consensus is or at least is perceived to be. In this case, our consensus may have been close enough to the true level of consensus for it not to be concerning, however, we urge caution in trying to extend this persuasion method to any other context without consideration of what the consensus actually is. Taking this first step is essential to improving scientific communication about the natural level of uncertainty surrounding the scientific progress (Białek, 2018; Wingen et al., 2020).

Thirdly, even if we accurately estimated the size of the increase in pro-vaccine attitudes, there is no way of knowing how much of an effect this would have on vaccine uptake. Declarative studies are only a proxy of real-world decisions because the latter are affected by many additional factors and contexts.

The current project was inspired by the Gateway Belief Model (van der Linden, 2021) which explicitly requires the consensus information to be of expert. Our data cannot verify this claim. That is, our expert consensus information could have served as a social proof: a prominent in ambiguous situations phenomenon in which people unreflexively copy the behaviour of other people (Cialdini, 2009). In this context, our participants could have been swayed by expert consensus simply because experts are people, too. Thus, maybe their expertise was not critical in driving the revision of beliefs in our participants.

Conclusions

Presenting expert consensus on the safety and intention to receive COVID-19 vaccinations can improve the attitude toward vaccination of individuals (including sceptics) not yet vaccinated for COVID-19. The increase in positive perception corresponds with a small boost to the likelihood that these individuals will get vaccinated. Thus, communicating expert consensus may be a valuable method to be used in conjunction with other scientific communication methods to motivate people to increase their protection from COVID-19 by getting vaccinated. We found no evidence of any unwanted consequences of providing consensus information. However, an absence of evidence is not evidence of absence. Nevertheless, we suggest that communicating expert consensus poses little risk and offers a modest benefit for those who are trying to convince others to get vaccinated.

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