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Support for COVID-19 mandatory vaccination in the United States: examining the role of cultural worldviews, risk-benefit perceptions, and trust in scientists

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Abstract

This study sets out to understand the role of cultural worldviews, risk perceptions, and trust in scientists in impacting U.S. participants' support for COVID-19 mandatory vaccination. Results from an online survey (N = 594) suggest that stronger individualistic and hierarchical worldviews are associated with more perceived COVID-19 vaccination risks, less perceived COVID-19 vaccination benefits, and lower support for COVID-19 mandatory vaccination. Perceived benefits mediate the impact of cultural worldviews on support for COVID-19 mandatory vaccination. Trust in scientists moderates the relationship between cultural worldviews and perceived benefits of COVID-19 vaccination. Theoretical and practical implications of the findings are discussed.

Keywords

Popularization of science and technology; Public perception of science and technology; Risk communication

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Introduction

To counter the public health threat of the recent novel coronavirus disease (COVID-19), many public organizations and private pharmaceutical sectors have worked together to develop vaccines to help slow the spread of new infections and lower the risk. Now, more than two years after the infectious outbreak swept the world, the COVID-19 vaccines are becoming widely available and accessible. In the United States, the COVID-19 vaccines were rolled out for the first time in December 2020 and were approved for all 16-year-olds and older in April 2021 [U.S. Department of Health & Human Services, 2022]. Some governments and health systems have enacted mandatory vaccination policies in response to the scientific community and public health experts advocating the importance of mass vaccination to achieve herd immunity [e.g., Haynes, 2021]. Mandating vaccines may be an effective policy to help defeat the pandemic, but it could also lead to public resistance based on concerns that limit individual choices [Batteux, Mills, Jones, Symons & Weston, 2022; Schmelz & Bowles, 2022]. For instance, when the

Biden administration implemented the COVID-19 vaccine mandate across much of the federal workforce in the United States in November 2021, not surprisingly, some opponents were against this policy, citing "a violation of personal freedom" along with other reasons, while some supported the policy as a legitimate regulation enabling a "wider freedom" [Gostin, 2021]. The debate about COVID-19 vaccine mandates in the United States is divided along partisan lines. According to a national survey in March 2022 among U.S. adults, about 82% of Republicans believed that employers with COVID-19 vaccination requirements should allow employees with religious objections to keep their jobs even if they decline to receive the vaccine, while only 52% of Democrats agreed with this statement [Nortey, 2022]. This begs the question of how public responses to policies to protect members of the community from public health threats can appear so different.

The current body of knowledge on vaccines has focused on individual decisions about vaccine uptake based on the findings of existing studies that ideologies, cultural worldviews, and values can impact individuals' attitudes and behaviors toward science issues [Hornsey & Fielding, 2017; Yang & Hobbs, 2020]. For instance, recent research shows that political ideology influences individuals' vaccine hesitancy [Bilewicz & Soral, 2021], and the political divide in vaccine hesitancy has increased over the course of the COVID-19 crisis in the U.S. [Cowan, Mark & Reich, 2021; Fridman, Gershon & Gneezy, 2021]. Yet, compared to the current scholarship on individuals' vaccine decisions, little is known about the extent, if any, to which value dispositions influence support for vaccine mandatory policies, with the exception of limited research conducted in other vaccine contexts. For instance, in the context of childhood vaccination, Kahan, Braman, Cohen, Gastil and Slovic [2010] found that people with individualistic and hierarchical worldviews perceived more risks from mandatory vaccination policies than those with communitarianism and egalitarianism worldviews, as they believed that the policy would be more intrusive on individual decision-making. While Kahan et al.'s work [2010] is important as it demonstrated that individuals' worldviews could impact their support for mandatory vaccination policies, there is scarce evidence regarding the role of worldviews in impacting people's policy support during the COVID-19 pandemic.

To address this research gap, we designed the current study based on the existing belief that acceptance of mandatory vaccination policy must take into account social, cultural, and political contexts in addition to disease severity and vaccine safety [Boas, Rosenthal & Davidovitch, 2016]. Specifically, built upon the cultural cognition theory [Kahan, 2012], we empirically examine how, if at all, individuals' cultural worldviews influence their attitudes toward COVID-19 vaccine mandate policies during public health emergencies. We also explore whether trust in scientists plays a moderating role in this process.

Literature review

Politicized science communication and cultural worldviews

COVID-19 presented society with an unknown and invisible threat that affected society, unlike any recent event. At the onset of the COVID-19 pandemic, the general uncertainty about the virus left the American public unsure of how to think. The debate around COVID-19 prevention behaviors became heavily politicized, especially on whether vaccinations should be mandatory. The level of

threat COVID-19 presented was widely debated and led to politicized messaging [Salmon et al., 2021]. Hesitation to receive the vaccination was present in the United States before the widespread access to the vaccine [Salmon et al., 2021]. Vaccine hesitancy is not new or specifically unique to the COVID-19 vaccination. For example, a national survey by the Kaiser Family Foundation (KFF) showed that 28% of U.S. adults expressed hesitancy about the Measles, Mumps, and Rubella (MMR) vaccine [Health, 2022]. In the United States,

vaccine opponents often linked vaccine choice to individual freedom and framed vaccine refusal as a civil right [Broniatowski et al., 2020; Colgrove, 2006]. This hesitation is also seen in whether COVID-19 vaccines should be mandated [Pew Research Center, 2021], and there is a need to understand what forms these attitudes.

Individuals' beliefs and attitudes are rooted in their ideologies, worldviews, and values [Hornsey & Fielding, 2017]. Personal belief systems, such as cultural worldviews, are widely regarded as essential in determining attitudes toward scientific issues [Silva & Jenkins-Smith, 2007]. According to an integrated model of science communication [Longnecker, 2016], external factors (e.g., social norms) and internal factors (e.g., values, beliefs, attitudes) influence how people engage with information and form new knowledge. Cultural worldviews are defined as the product of values, beliefs, and societal relations [Swedlow, 2002]. Cultural worldviews refer to cultural ways of life and are often categorized as individualistic, communitarian, hierarchical, or egalitarian [Kahan, 2012]. An individualistic worldview is when the individual is expected to protect their interests independently from the collective [Kahan et al., 2010]. Individualists place a higher value on personal freedoms. Conversely, communitarians place value on the achievements and interests of the collective. A hierarchical cultural worldview will lead an individual to place more value on traditional societal structures, while an egalitarian cultural worldview favors equal opportunity regardless of traditional structures, and unbounded societal participation is encouraged [Kahan, 2012; West, Bailey & Winter, 2010]. Empirical research in cultural theory has revealed that cultural worldviews are core to one's belief system and are largely stable [Kahan, 2012].

Of particular interest is the link between cultural worldview and political party affiliation. Given that cultural worldviews are largely nonfluid, they can potentially have strong explanatory power on contentious politicized scientific issues [Kahan et al., 2010]. Party affiliations have long strongly influenced how members form attitudes toward contentious issues [Converse, 2006]. Political affiliation has been reported to interact with core values to influence attitudes toward issues [Jackson, 2014]. Politicized debates are complex, and often party affiliation is not enough to accurately understand how attitudes are shaped toward contentious issues. Furthermore, cultural theory suggests that people's worldviews shape their political preferences, which may in turn reinforce their cultural values and worldviews [Wildavsky, 1987]. Past work indicates that cultural worldviews and political ideology do share some overlap but are understood to be conceptually unique from each other and should be used to represent different core beliefs [Ripberger, Song, Nowlin, Jones & Jenkins-Smith, 2012]. While being distinct constructs, both represent complementary methods for attitudes to form [Hornung & Bandelow, 2021].

Politized science topics and cultural worldviews have been studied in other topical areas than vaccine mandates. Most notably, the role of cultural worldviews has been studied in environmental debates and climate change [Verweij et al., 2006]. Individualistic and hierarchical worldviews are associated with having less concern with environmental issues, whereas those who value communitarianism and egalitarianism will place greater importance on protecting nature [Ney & Thompson, 2000]. This divide is also seen in political party affiliation in the United States, as Republicans have a lower concern for the environment than Democrats [Cruz, 2017]. Another noteworthy area of research is how one's cultural worldviews influence their partisan media consumption [T. P. Newman, Nisbet & Nisbet, 2018]. For example, conservative leaning media sources appeal to hierarchical and individualistic values more than liberal leaning media, which appeal to communitarian and egalitarian values [B. I. Newman, 2016]. Cultural worldviews allow a deeper understanding of science public opinion beyond simply a dichotomous Democrat-Republican divide. Attitudes toward politicized science issues will be linked to partisan identity, but cultural worldviews will allow for a more nuanced understanding of the underlying values driving these attitudes.

Given the growing concerns about the political divide over mandatory vaccinations, it is vital to understand the discernible core beliefs of different party groups that drive the formation of polarized views. Therefore, we hypothesize that:

> H1: Republicans and Independents will report stronger individualistic (H1a) and hierarchical (H1b) worldviews than Democrats.

Cultural cognition and the cultural theory of risk

The cultural cognition thesis [Kahan et al., 2010] posits that cultural worldviews shape the publics' risk perceptions of contentious science issues. The core of this concept is that individuals perceive threats and benefits that either endanger or strengthen an idealized social construction. Cultural cognition grew out of the cultural theory of risk, which represents how cultural factors shape societal relations [Douglas & Wildavsky, 1982]. This theory describes cultural worldviews as latent predispositions of the individual [Kahan, 2012]. The cultural theory of risk places cultural worldviews along two dimensions: *group* and *grid* [Douglas, 1992]. The cultural theory of risk uses the two-dimensional *group* and *grid* typology to define how risk will be perceived given one's cultural worldview. Along the *group* dimension lies the cultural worldviews of individualism and communitarianism. Communitarianism values a strong *group* way of life that prioritizes social needs over the needs of an individual, whereas individualism values a weak *group* way of life [Rayner, 1992]. Cultural worldviews along the *grid* dimension are hierarchical and egalitarian. A high *grid* cultural worldview is very hierarchical, with a strong emphasis on maintaining a rank-based system in society [Rayner, 1990]. A low *grid* cultural worldview is represented by egalitarianism, which argues that societal roles should not be prohibited by social factors [Rayner, 1990]. People's perceptions of risk and the manner in which they manage that risk vary depending on their cultural worldviews [Johnson & Swedlow, 2019].

Kahan [2012] expanded the cultural theory of risk by psychometrically defining the cultural worldviews of risk — introducing the cultural cognition thesis. Kahan

measured the two dimensions of cultural worldview as: individualism-communitarianism (IC) and hierarchical-egalitarianism (HE). IC represents the *group* dimension and HE represents the *grid* dimension of cultural worldviews. The cultural cognition thesis [Kahan, 2012] posits that the publics' risk perceptions of contentious science issues are shaped by their cultural worldviews. In this study, we follow Kahan's theorizing that cultural worldviews are potentially powerful societal mechanisms that influence publics' beliefs on mandatory COVID-19 vaccine risk perceptions.

The cultural theory of risk makes two core claims on how cultural worldviews can affect risk perceptions. The first claim is that a higher level of perceived risk tends to be associated with one cultural worldview and would be registered as a low threat to another cultural worldview [Douglas, 1992]. For example, communitarianism and individualism would not identify the same perceived risk as the two worldviews place different values on the group and the individual.

A growing body of literature has confirmed that cultural worldviews can impact one's risk perceptions about science issues. For example, people with individualistic and hierarchical worldviews were found to dismiss environmental risks because they believed that acknowledging environmental risks would threaten market autonomy and the status of social elites Shi, Visschers and Siegrist, 2015; Yang and Hobbs, 2020. In the context of the human papillomavirus vaccination mandate, however, individuals with a hierarchical (vs. egalitarian) worldview perceived greater risks and less benefits associated with the HPV vaccination mandate [Nan & Madden, 2014]. In the context of COVID-19, both individualism and hierarchical worldviews were associated with lower perceived risks of the virus [Dryhurst et al., 2020]. This study extends the research literature on cultural worldviews by testing the association of support for COVID-19 mandatory vaccinations with Kahan's two dimensions of cultural worldview. We hypothesize:

> H2: a stronger individualistic worldview is associated with higher perceived risks of COVID-19 vaccination (H2a), lower perceived benefits of COVID-19 vaccination (H2b), and lower support for COVID-19 mandatory vaccination (H2c).
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> H3: a stronger hierarchical worldview is associated with higher perceived risks of COVID-19 vaccination (H3a), lower perceived benefits of COVID-19 vaccination (H3b), and lower support for COVID-19 mandatory vaccination (H3c).

The cultural theory of risk makes a second claim on the relationship between cultural worldviews and perceived risk. This claim proposes that individuals perceive risks in a way that reaffirms their cultural worldview. Whereas the first claim is that certain perceptions of risk are more associated with specific cultural worldviews, the second claim emphasizes how risk perceptions will adhere to a desired way of life [Douglas & Wildavsky, 1982]. Schneider et al. [2021] reported that risk perceptions of COVID-19 could be influenced by several psychological and socio-demographic predictors. These predictors included holding individualistic worldviews and trust in science and medical professionals. Individualistic worldview was associated with lower COVID-19 risk perceptions,

whereas trust in science and medical professionals was associated with higher COVID-19 risk perceptions. However, limited studies have examined the mechanism through which cultural worldviews impact individuals' support for vaccination mandates. Savadori and Lauriola's work [2021] indicated that risk perception is a precursor for protective behaviors. The level of perceived risk will influence one's behavioral intentions. In this study, we predict that cultural worldviews will influence whether one supports a COVID-19 mandatory vaccination and the mechanism operates through individuals' perceived risks and benefits of mandatory vaccination. Specifically, we hypothesize:

> H4: the influence of cultural worldviews on support for COVID-19 mandatory vaccination is mediated by perceived risks (H4a) and perceived benefits (H4b) of COVID-19 vaccination.

Trust in scientists

Trust in scientists, as a form of institutional trust, denotes "beliefs in the expertise and honesty of people working within scientific institutions" [Kossowska, Szwed & Czarnek, 2021, p. 721]. People rely on their trust in scientists as an important heuristic when forming opinions on science-related topics [Hmielowski, Feldman, Myers, Leiserowitz & Maibach, 2014; Wang, 2021]. In a public health emergency, such as the COVID-19 pandemic, people often report increased level of trust in scientists as they rely on the scientific community to interpret risks and navigate uncertainty [Bromme, Mede, Thomm, Kremer & Ziegler, 2022].

Trust in scientists has been found to be a key driver of support for public health policies and compliance with protective health measures during outbreaks. For example, a longitudinal study in 12 countries [Algan, Cohen, Davoine, Foucault & Stantcheva, 2021] found that trust in scientists was a main predictor associated with people's support for non-pharmaceutical interventions, especially in the United States. Relatedly, Chalmers and Nicol [2004] suggest that trust in scientific institutions drives public support for controversial science. In addition to individual-level scientific trust, Sturgis, Brunton-Smith and Jackson [2021] also examined the role of societal-level trust in science in promoting vaccination. They found that people in countries with a high aggregate level of trust in science are more confident about vaccination [Sturgis et al., 2021]. These findings highlight the important role of trust in scientists in promoting favorable attitudes toward vaccination and public policy support.

While a growing number of studies suggest that people's science attitudes and public policy support are rooted in their predispositions and worldviews [Hornsey & Fielding, 2017], emerging evidence shows that trust in scientists could play a potential moderating role in this process. In a study about public support for nanotechnology, Kim, Yeo, Brossard, Scheufele and Xenos [2014] found that individuals' deference to scientists moderated the association between their need for information and perceived benefits and risks of nanotechnology, such that the impacts of need for information on individuals' risk and benefit perceptions are weaker among those with higher deference to scientists. In other words, individuals more deferent to scientific authority are more likely to process information heuristically [Kim et al., 2014]. In another study about climate change,

Diehl, Huber, de Zúñiga and Liu [2019] found that trust in the scientific community moderated the impact of individuals' social media usage on their pro-social beliefs about climate change, such that high trust in scientists boosted the positive influence of social media usage on pro-social climate change beliefs. Diehl and colleagues argued that individuals with higher trust in scientists could be less influenced by ideological filter bubbles.

Limited studies have examined whether trust in scientists could moderate the relationship between cultural worldviews and individuals' risk/benefit perceptions and public policy support. Given the previous evidence, we argue that individuals with high trust in scientists are less likely to engage in motivated reasoning and therefore less influenced by their pre-existing values (e.g., cultural worldviews) as heuristics when forming opinions about COVID-19 vaccination. Hence, we hypothesize that:

> H5: trust in scientists moderates the impact of cultural worldviews on individuals' risk/benefit perceptions and support for mandatory vaccination policies, such that the impact of cultural worldviews is weaker among people with stronger trust in scientists.

Method

Participants and procedure

We conducted an online survey and recruited participants through M-Turk in March 2021. Eligible participants included U.S. residents who were 18 or older. Participants read an introduction page of the survey, signed a consent form online, and were paid $2 for their participation. An Institutional Review Board approved the study protocol.

A total of 594 eligible participants were included in this study. Participants reported an average age of 39 (*Median* = 36, *Range* = [18, 79], *SD* = 12.8). The sample included 55.4% (n = 329) males, 41.4% (n = 246) females, 0.5% (n = 3) non-binary individuals, and 2.7% (n = 16) individuals who did not report their gender. Among the participants, 8.6% (n = 51) had less than high school, high school, or GED education, 12% (n = 71) had some college, 8.6% (n = 51) had an associate degree, 45.3% (n = 269) had a bachelor's degree, 23% (n = 137) had a postgraduate degree, and 2.5% (n = 15) did not report their education. Additionally, 48.3% (n = 287) participants identified themselves as Democrats, 26.1% (n = 155) reported being Republicans, 20% (n = 119) reported being Independents, and 5.6% (n = 33) did not report their political party affiliations.

Measures

Cultural worldviews

A short-form version of the Cultural Cognition Worldviews Scale was adopted from a previous study [Kahan, Jenkins-Smith & Braman, 2011]. In total, the 12 items in the scale characterize individuals' cultural worldviews along two dimensions: hierarchical-egalitarianism and individualism-communitarianism. Six items were used to measure *individualism-communitarianism worldview* (e.g., "The

government should stop telling people how to live their lives."), and six items were used to measure *hierarchical-egalitarianism worldview* (e.g., "We have gone too far in pushing equal rights in this country"). All the items were presented in a random order. Participants were asked to rate their agreement with each item on a 5-point Likert-type scale, ranging from "1 = strongly disagree" to "5 = strongly agree." A higher score on the individualism-communitarianism worldview indicated a higher tendency toward the individualism worldview; conversely, a lower score indicated a higher tendency toward the communitarianism worldview (M = 3.07, SD = .78, *Cronbach's* α = .70). A higher score on the hierarchical-egalitarianism worldview indicated a higher tendency toward the hierarchical worldview; conversely, a lower score indicated a higher tendency toward the egalitarianism worldview (M = 2.38, SD = 1.02, *Cronbach's* α =.86).

Perceived risk

Perceived risk of COVID-19 vaccination was assessed with the following item: "How risky would you say vaccination against COVID-19 is likely to be?" Responses were indicated on a five-point Likert scale (1 = *not at all risky*, 5 = *very risky*) (M = 2.38, SD = 1.38).

Perceived benefit

Perceived benefit of COVID-19 mandatory vaccination was assessed with the following item: "How beneficial would you say vaccination against COVID-19 is likely to be?" Responses were indicated on a five-point Likert scale (1 = *not at all beneficial*, 5 = *very beneficial*) (M = 4.21, SD = 1.11).

Trust in scientists

Participants rated their agreement or disagreement (1 = *strongly disagree*, 5 = *strongly agree*) with five items about their trust in scientists: 1) "Scientists know best what is good for the public." 2) "It is important for scientists to get research done even if they displease people by doing it." 3) "Scientists should do what they think is best, even if they have to persuade people that it is right." 4) "Overall, I support federal funding for basic scientific research." 5) "I am confident in the safety and regulatory approval systems governing scientific issues." The five items were averaged to form an index for trust in scientists (M = 3.93, SD = 0.69, *Cronbach's* α = .80). A higher value on the index suggests stronger trust in scientists.

Support for COVID-19 mandatory vaccination

Participants rated their agreement or disagreement (1 = *strongly disagree*, 5 = *strongly agree*) with one item that assessed their support for COVID-19 mandatory vaccination: "I will support a U.S. government policy of mandating COVID vaccination in the interests of public health" (M = 3.53, SD = 1.44).

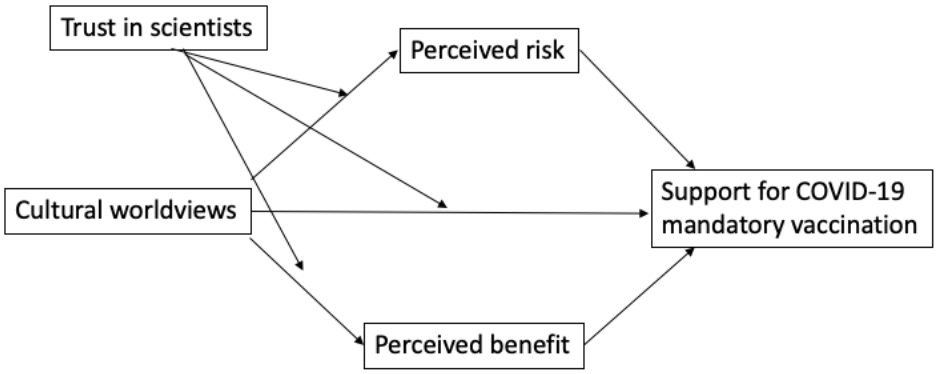


Figure 1. The Conceptual Map of The Relationships Among Cultural Worldviews, Risk-Benefit Perceptions, Trust in Scientists, and Support for COVID-19 Mandatory Vaccination.

Statistical analysis

We conducted the analyses in two steps using SPSS. First, to test H1, we conducted two analyses of variance (ANOVA) with post-hoc pairwise comparisons. Political party affiliation (i.e., Democrat, Republican, Independent) was entered as the independent variable. Individualism-communitarianism worldview and hierarchical-egalitarianism worldview were entered as dependent variables, respectively. Second, to test H2-H5 and RQ1, we ran two moderated mediation models using PROCESS Model 8 [Hayes, 2013], with individualism-communitarianism and hierarchical-egalitarianism entered as independent variables respectively. In each moderated mediation model, perceived risk and perceived benefit were entered as two mediators, trust in scientists was entered as the moderator, support for mandatory COVID-19 vaccination was included as the dependent variable, and demographic variables (i.e., age, gender, education, political party affiliation) were included as covariates. To probe the interaction effects, we centered the independent variable and the moderator in each model by their means. We depicted the conceptual map in Figure 1.

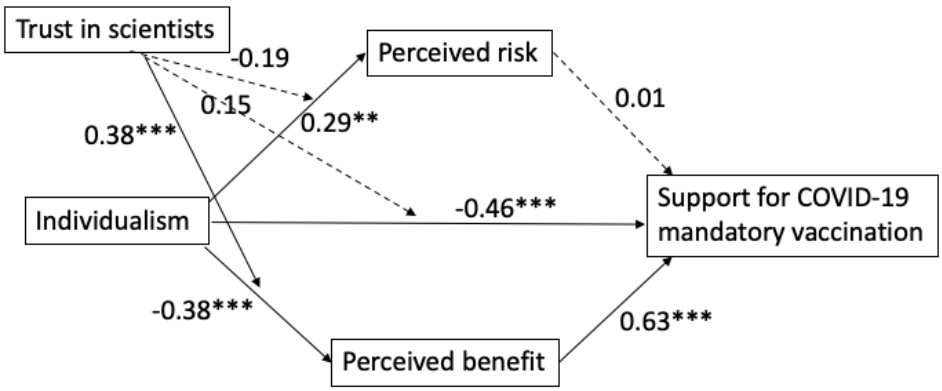
Results

Cultural worldviews and political party affiliations (H1)

H1 proposed that Republicans and Independents will report stronger individualistic (H1a) and hierarchical (H1b) worldview than Democrats. Results from the ANOVA tests suggested that the three groups had significant differences on their individualistic (F (2, 558) = 37.66, $p < .001$) and hierarchical worldviews (F (2, 558) = 89.26, $p < .001$). Specifically, compared to Democrats (M = 2.82, SE = 0.04), Republicans (M = 3.35, SE = 0.06, $p < .001$) and Independents (M = 3.30, SE = 0.06, $p < .001$) reported significantly stronger individualistic worldview. Moreover, Republicans (M = 3.23, SE = 0.07, $p < .001$) and Independents (M = 2.56, SE = 0.08, $p < .001$) also reported significantly stronger hierarchical worldview than Democrats (M = 2.03, SE = 0.05). Therefore, H1a and H1b were supported.

Cultural worldviews, risk/benefit perceptions, and science decisions (H2-H5).

H2 and H3 hypothesized that stronger individualistic (H2) and hierarchical worldviews (H3) are associated with higher perceived risk and lower perceived



Note. Covariates include age, dummy-coded gender (male, female, non-binary) education, and dummy-coded political party (Republican, Democrat, Independent).

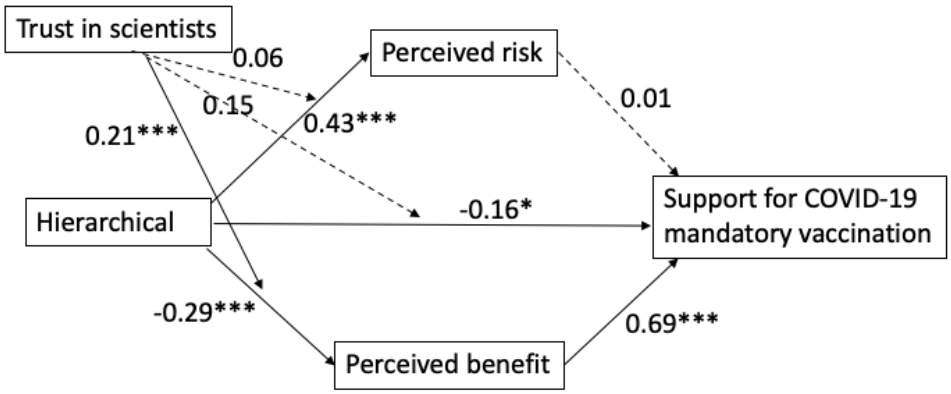
Figure 2. Predicting Risk/Benefit Perceptions and Science Decisions with Individualism-Communitarianism Worldview.

benefit of COVID-19 vaccination, and lower support for COVID-19 mandatory vaccination. As shown in Figure 2, our results from the moderated mediation model suggested that individualism positively predicted perceived risk of COVID-19 vaccination ($b = 0.29$, $p < .01$), negatively predicted perceived benefit of COVID-19 vaccination ($b = -0.38$, $p < .001$), and had a negative direct association with support for mandatory COVID-19 vaccination ($b = -0.46$, $p < .001$). Therefore, H2 was supported. Similarly, results in Figure 3 suggested that individuals with stronger hierarchical worldview reported more perceived risk of COVID-19 vaccination ($b = 0.43$, $p < .001$), less perceived benefit from COVID-19 vaccination ($b = -0.29$, $p < .001$), and lower support for COVID-19 vaccination ($b = -0.16$, $p < .05$). Therefore, H3 was supported.

H4 and H5 proposed that the influence of Individualistic (H4) and hierarchical worldviews (H5) on support for COVID-19 mandatory vaccination is mediated by perceived risk and perceived benefit of COVID-19 vaccination. Results (see Figure 2 and Figure 3) suggested that perceived benefit significantly mediated the influence of individualistic ($b_{indirect} = -0.24$, 95% CI = [−0.36, −0.14]) and hierarchical worldviews ($b_{indirect} = -0.20$, 95% CI = [−0.30, −0.12]) on support for COVID-19 mandatory vaccination. However, perceived risk was not a significant mediator in the relationship between individualistic ($b_{indirect} = 0.003$, 95% CI = [−0.02, 0.03]) or hierarchical worldview ($b_{indirect} = 0.004$, 95% CI = [−0.03, 0.05]) and support for COVID-19 mandatory vaccination. Therefore, H4a and H5a were rejected whereas H4b and H5b were supported.

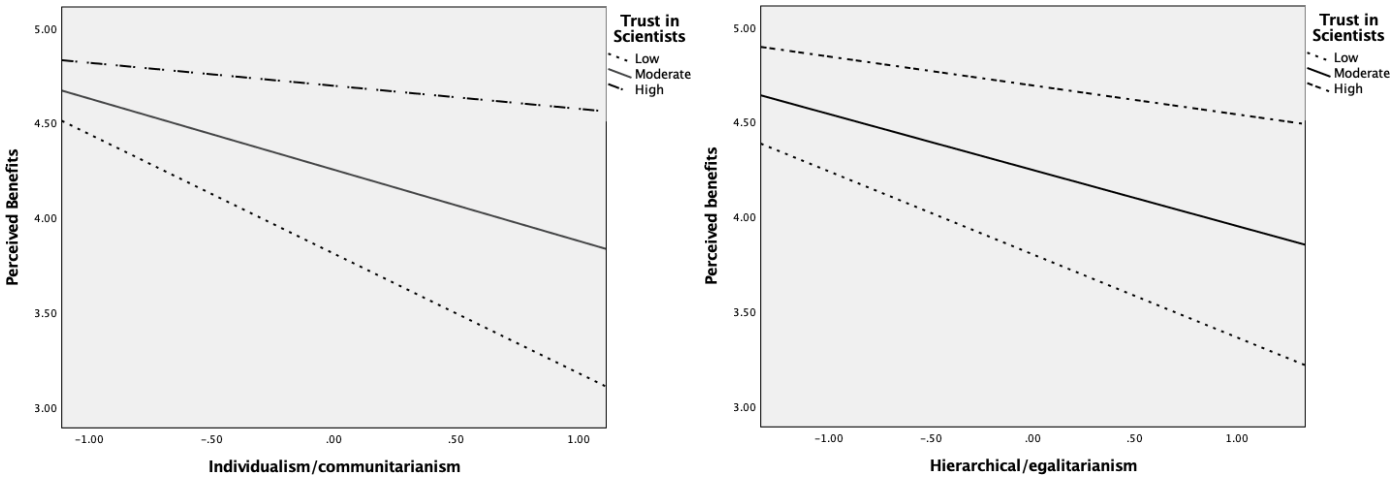
The moderation role of trust in scientists (H5)

Finally, we examined whether trust in scientists moderated the impact of cultural worldviews on individuals' risk/benefit perceptions and support for COVID-19 mandatory vaccination policies (H5). Results from the moderated mediation models suggested that trust in scientists did not significantly moderate the impact of cultural worldviews on perceived risk or support for mandatory COVID-19 vaccination. However, it significantly moderated the influence of individualism ($b_{interaction} = 0.38$, 95% CI = [0.23, 0.53], $p < .001$) and hierarchical worldviews



Note. Covariates include age, dummy-coded gender (male, female, non-binary) education, and dummy-coded political party (Republican, Democrat, Independent).

Figure 3. Predicting Risk/Benefit Perceptions and Science Decisions with Hierarchical-Egalitarianism Worldview.



Note. A higher value on individualism/communitarianism suggests a stronger individualist worldview. A higher value on hierarchical/egalitarianism suggests a stronger hierarchical worldview. A higher value on trust in scientists suggests a more positive attitude. Low trust in scientists was represented by Mean-1 SD, moderate trust in scientists was represented by mean, and high trust in scientists was represented by Mean +1 SD.

Figure 4. The Moderating Effect of Trust in Scientists on The Relationship of Individualism-Communitarianism (Figure 4a)/Hierarchical-Egalitarianism (Figure 4b) and Perceived Benefits of COVID-19 Mandatory Vaccination.

($b_{interaction}$ = 0.21, 95% CI = [0.08, 0.34], p <.01) on perceived benefit of COVID-19 vaccination. Specifically, the negative impact of individualism on perceived benefit of COVID-19 vaccination is only significant when people have low or moderate trust in scientists ($b_{high} = -0.12$, $p = .17$, $b_{moderate} = -0.38$, $p < .001$, $b_{low} = -0.63$, $p <$ .001). Moreover, the negative impact of hierarchical worldview on perceived benefit of COVID-19 vaccination becomes weaker when people have stronger trust in scientists ($b_{high} = -0.15$, $p < .05$, $b_{moderate} = -0.30$, $p < .001$, $b_{low} = -0.44$, $p < .001$). Therefore, H5 was partially supported. We depicted the interaction plots in Figure 4a and Figure 4b.

Discussion

This study sets out to understand the role of cultural worldviews, risk perceptions, and trust in scientists in impacting U.S. participants' support for COVID-19 mandatory vaccination. Built upon the cultural cognition theory, this study adds to the existing literature by examining (1) whether Republicans, Independents, and Democrats differ in terms of cultural worldviews, (2) the impact of cultural worldviews on individuals' risk/benefit perceptions and support for COVID-19 mandatory vaccination, and (3) the moderating effect of trust in scientists in the relationship between cultural worldviews and risk/benefit perceptions about COVID-19 mandatory vaccination.

Main findings of this study

First, we found that Republicans, Independents, and Democrats have different underlying cultural worldviews. Compared to Democrats, Republicans and Independents reported stronger individualistic and hierarchical worldviews. Our study is consistent with Kahan's study [2012], which suggests that Republicans and Independents tend to prioritize independence (i.e., individualistic worldview) and believe that privileges and obligations should be assigned based on static social strata (i.e., hierarchical worldview). In contrast, Democrats tend to value collective benefits (i.e., communitarian worldview) and endorse social order free of social class (i.e., egalitarian worldview) [Kahan, 2012]. Concerns are growing regarding increasing political polarization over science in the U.S., especially during the COVID-19 pandemic [Jungkunz, 2021]. Our study suggests that polarized scientific debates could be rooted in people's different underlying worldviews. Therefore, evidence-based persuasion might fail when people are motivated to reject scientific arguments [Hornsey & Fielding, 2017]. We encourage health professionals to develop interventions tailored to individuals' cultural worldviews when promoting COVID-19 vaccination.

Next, we examined how individuals' cultural worldviews impact their risk/benefit perceptions about COVID-19 vaccines and support for COVID-19 mandatory vaccination. Consistent with the cultural cognition thesis [Kahan, 2012], our findings suggest that stronger individualistic and hierarchical worldviews are associated with higher perceived risk of COVID-19 vaccination, lower perceived benefit of COVID-19 vaccination, and less support for mandatory COVID-19 vaccination among participants. These findings align with past research in other vaccination contexts [e.g., Kahan et al., 2010], which suggests that people with stronger individualism and hierarchical worldviews perceived childhood vaccination as riskier and were less likely to support mandatory childhood vaccination.

Moreover, our study contributes to the cultural theory of risk by disentangling the mechanism underlying the impacts of cultural worldviews on individuals' support for COVID-19 mandatory vaccination. Our results suggest that the negative impact of individualism and hierarchical worldviews on COVID-19 mandatory vaccination support were mediated by perceived benefits of COVID-19 vaccination. In other words, people with stronger individualism and hierarchical worldviews perceived COVID-19 vaccination as less beneficial, lowering their support for COVID-19 mandatory vaccination. Surprisingly, perceived risk of COVID-19 vaccination was not a significant mediator. Although individualism and

hierarchical worldviews led to a greater perceived risk of COVID-19 vaccination, there was no significant relationship between perceived risk of COVID-19 vaccination and support for COVID-19 vaccination mandates. These findings suggest that distrust in the benefits of COVID-19 vaccination, rather than concerns about the vaccination risks, could be the barrier that hinders people's support for COVID-19 vaccination mandates. Our study coheres with previous studies [e.g., Kim et al., 2014; Ma, Wang & Kim, 2022], suggesting that highlighting the benefits of a science or public health issue could be an effective communication strategy in promoting policy support, in addition to addressing people's concerns about risks.

Finally, one of the important goals of this research was to examine the potential role of trust in scientists in moderating the impacts of cultural worldviews on peoples' risk/benefit perceptions and mandatory COVID-19 vaccination support. Findings suggest that trust in scientists significantly moderated the relationship between individualistic/hierarchical worldviews and perceived benefits of COVID-19 vaccination. The negative impacts of individualism and hierarchical worldviews on perceived COVID-19 vaccination benefits become weaker as people's trust in scientists increases. Past studies suggest that cultural worldviews could drive selective information processing, which further increases attitude polarization in public debates [Kahan et al., 2010; T. P. Newman et al., 2018]. Our findings highlight the potential of trust in scientists in mitigating individuals' selective processing and motivated reasoning tendency. As people's trust in scientists increases, they are less influenced by their pre-existing worldviews when forming scientific opinions and making science-related decisions. Public discourses about COVID-19 are largely characterized by political polarization and distrust in scientists and medical professionals [Jiang et al., 2021; Wang & Chen, 2022]. Therefore, it is vital for policymakers and scientists to build public trust by fostering dialogues and highlighting that science contributes to the public good.

Implications for science communication and education

Developing effective science communication is crucial for addressing vaccine hesitancy and fostering vaccine confidence. Our findings have several practical implications for scientists and policymakers regarding vaccine messaging and education.

First, we found that people with lower support for COVID-19 mandatory vaccination policies tend to hold stronger individualistic and hierarchical worldviews. Therefore, pro-vaccine messages targeting COVID-19 vaccine opponents may tailor to their cultural worldviews, for instance, by emphasizing the individual benefit of getting a COVID-19 vaccine and how COVID-19 vaccination can help maintain the existing social order. Moreover, studies have found that loss-framed (vs. gain-framed) messages were more persuasive in promoting support for HPV vaccination mandate among individuals with a hierarchical worldview [Nan & Madden, 2014]. We believe the same conclusion should apply to COVID-19 vaccination communication and recommend that scientists use loss-framed messages when communicating the benefits of COVID-19 vaccines to individuals with a hierarchical worldview (e.g., Republicans).

Second, consistent with earlier research [Kahan, 2012], our results indicate that Republicans, Independents, and Democrats hold distinct cultural worldviews.

Nevertheless, it is important to note that the polarized media landscape in the United States may reinforce the cultural worldviews of individuals, which in turn influences their political preferences and scientific decisions. For example, people with strong cultural worldviews were found to selectively choose ideologically congruent media outlets and selectively process the science information they encountered [T. P. Newman et al., 2018]. In addition to partisan media polarization, social media echo chambers, which can be defined as "environments in which the opinion, political leaning, or belief of users about a topic gets reinforced due to repeated interactions with peers or sources having similar tendencies and attitudes" [Cinelli, Morales, Galeazzi, Quattrociocchi & Starnini, 2021, p. 1], also contribute to reinforcing people's pre-existing values. Therefore, we encourage more science education programs to focus on enhancing people's media literacy and cultivating the public's critical awareness of the partisan media ecology and human's confirmation bias. Moreover, we also recommend more scientists actively share vaccine facts with the public on social media, which could boost vaccine opponents' access to and acceptance of ideologically incongruent scientific evidence.

Finally, our findings highlight the critical role of trust in scientists in impacting people's support for COVID-19 vaccination mandates. Scientists and institutions should prioritize maintaining the integrity of the scientific community and elevating the public's trust in scientists [Nan, Wang & Thier, 2022]. In addition, scientists can work with science journalists to interpret facts and scientific findings for the general public in a timely manner [Brüggemann, Lörcher & Walter, 2020]. To promote trust in scientists, we also advocate for more transparency in science (e.g., open access to data) and science communication (e.g., communicating vaccination side effects).

Limitations and future research

While discussing the results, it is also important to point out limitations. First, with a cross-sectional survey, we cannot make causal claims about the relationships investigated in this study. Future studies may conduct experimental studies to examine whether cultural worldviews causally impact individuals' science decisions. Second, participants in this study were recruited from M-Turk and therefore are not nationally representative. Although M-Turk samples generally yield high-quality data, the scarcity of older workers on the panel raises questions about its demographic representativeness [Chandler, Rosenzweig, Moss, Robinson & Litman, 2019]. Also, M-Turk samples tend to be more liberal than the general U.S. adults [Huff & Tingley, 2015]. Compared to the 2020 US Census data, our sample was slightly younger (median age = 36 vs. 38.8), had fewer females (41.4% vs. 50.5%), and was more educated (88.9% vs. 53.5% had some college or higher) [United States Census Bureau, 2022]. Our sample consisted of fewer Republicans (26.1% vs. 43%) and slightly more Democrats (48.3% vs. 46%) compared to the general American public [Jones, 2022]. Therefore, our findings should be interpreted with caution when generalized to the general U.S. public. Moreover, we only recruited participants from the United States, and whether our findings are applicable to other countries is not ascertained. People's cultural worldviews, trust in scientists, and risk perceptions of COVID-19 vary across different countries [Algan et al., 2021; Dryhurst et al., 2020]. Therefore, future research is needed to

replicate our studies in other cultural settings. Finally, we conducted the survey in March 2021, when the COVID-19 vaccines had just been made available to the general public. It is not clear whether the relationships established in our study still hold true when people become more familiar with COVID-19 vaccines. We encourage future research to replicate our study in the post-pandemic stage.

Conclusion

Drawn upon the cultural cognition theory, our study examined how individuals' cultural worldviews shape their risk/benefit perceptions about COVID-19 vaccination and support for COVID-19 vaccination mandates. Our study revealed that the political polarization over COVID-19 vaccination has deep roots in people's cultural worldviews. Individualistic and hierarchical worldviews lead to greater vaccine hesitancy (i.e., more perceived risk and less perceived benefit) and lower support for COVID-19 vaccination mandates. Building trust in scientists has the potential to mitigate the negative impact of cultural worldviews on publics' COVID-19 vaccination perceptions. We encourage health professionals to build public trust and design tailored persuasive messages based on publics' cultural worldviews.

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Supplementary material

Questionnaire

Individualism-communitarianism

Q1. People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly you agree or disagree with each of these statements?

Strongly disagree				Strongly agree
1	2	3	4	5

1) The government interferes far too much in our everyday lives.
2) Sometimes government needs to make laws that keep people from hurting themselves.
3) It's not the government's business to try to protect people from themselves.
4) The government should stop telling people how to live their lives.
5) The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.
6) Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

Hierarchical-egalitarianism

Q2. People in our society often disagree about issues of equality and discrimination. How strongly you agree or disagree with each of these statements?

Strongly disagree				Strongly agree
1	2	3	4	5

1) We have gone too far in pushing equal rights in this country.
2) Our society would be better off if the distribution of wealth was more equal.
3) We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women.
4) Discrimination against minorities is still a very serious problem in our society.
5) It seems like blacks, women, homosexuals and other groups don't want equal rights; they want special rights just for them.
6) Society as a whole has become too soft and feminine.

Perceived risk of COVID-19 vaccination

Q3. How risky would you say vaccination against COVID-19 is likely to be?

Not at all risky				Very risky
1	2	3	4	5

Perceived benefit of COVID-19 vaccination

Q4. How beneficial would you say vaccination against COVID-19 is likely to be?

Not at all beneficial				Very beneficial
1	2	3	4	5

Trust in scientists

Q5. Next are some items about how people feel about the scientific community. Please tell us how much you agree or disagree.

Strongly disagree				Strongly agree
1	2	3	4	5

1) Scientists know best what is good for the public.
2) It is important for scientists to get research done even if they displease people by doing it.

3) Scientists should do what they think is best, even if they have to persuade people that it is right.
4) Overall, I support federal funding for basic scientific research
5) I am confident in the safety and regulatory approval systems governing scientific issues

Support for COVID-19 mandatory vaccination

Q6. Now, please rate how much you agree with the statement: "I will support a U.S. government policy of mandating COVID vaccination in the interests of public health."

Strongly disagree				Strongly agree
1	2	3	4	5

Demographics

Q7. Finally, we have a few last questions we'd like you to answer.
What is your age? _____

Q8. What is your gender?

Male 1
Female 2
Non-binary 3
Prefer not to answer 4

Q9. What is the highest level of education you have completed? If currently enrolled, please check highest degree received.

Less than High School 1
High School/GED 2
Some College 3
2-Year College Degree (Associates) 4
4-Year College Degree (BA,BS) 5
Master's Degree 6
Ph.D or other advanced professional Degree 7
Prefer not to answer 8

Q10. Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, or something else?

Republican 1
Democrat 2
Independent 3
Something else 4
Prefer not to answer 5

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