



Research Article

Exploring partisans' biased and unreliable media consumption and their misinformed health-related beliefs

This study explores U.S. adults' media consumption—in terms of the average bias and reliability of the media outlets participants report referencing—and the extent to which those participants hold inaccurate beliefs about COVID-19 and vaccination. Notably, we used a novel means of capturing the (left-right) bias and reliability of audiences' media consumption, leveraging the Ad Fontes Media ratings of 129 news sources along each dimension. From our national survey of 3,276 U.S. adults, we found that the average bias and reliability of participants' media consumption are significant predictors of their perceptions of false claims about COVID-19 and vaccination.

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Research questions

- (How) do political ideology, media reliability, and media bias predict holding misinformed beliefs about COVID-19 and vaccination?
- Do partisans' media diets differ in their average bias and reliability?

Essay summary

- We surveyed 3,276 U.S. adults, applying Ad Fontes Media's (2023) ratings of media bias and reliability to measure these facets of participants' preferred news sources. We also probed their perceptions of inaccurate claims about COVID-19 and vaccination.
- We found participants who tend to vote for Democrats—on average—consume less biased and more reliable media than those who tend to vote for Republicans. We found these (left-leaning) participants' media reliability moderates the relationship between their media's bias and their degree of holding false beliefs about COVID-19 and vaccination. Unlike left-leaning media consumers, right-leaning media consumers' misinformed beliefs seem largely unaffected by their news sources' degree of (un)reliability.

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- This study introduces and investigates a novel means of measuring participants' selected news sources: employing Ad Fontes's (2023) media bias and media reliability ratings. It also suggests the topic of COVID-19, among many other scientific fields of recent decades, has fallen prey to the twin risks of a politicized science communication environment and accompanying group-identity-aligned stances so often operating in the polarized present.

Implications

The COVID-19 pandemic demonstrated the effects of inhabiting a polarized media environment—including aspects of selective media exposure and cognitive dissonance avoidance—in the context of an extended global disease scenario the likes of which the world hasn't experienced in a century. The news-seeking (and avoiding) behaviors in this context highlight the longstanding concern that those who embrace—and subsequently seek out—misinformation, even if inadvertently, constitute a group at risk of endangering their own and others' health. This exploratory study—the first, to our knowledge, to assess two media credibility dimensions (bias and reliability) in a national survey—set out to analyze these dimensions and their relationships with accepting misinformation among a national U.S. sample, suggesting implications for news media (whose audiences may consist, at least in part, of misinformation believers and seekers) operating in a country sharply divided along partisan lines.

Background: Selective exposure, cognitive dissonance, and COVID-19 news-seeking behaviors

In the polarized age of COVID-19, negative attitudes toward COVID-19 vaccinations (Motta et al., 2021), beliefs in the virus' relative inertness (Hammad et al., 2021; Šrol et al., 2021), and positive attitudes toward unproven alternative treatments such as hydroxychloroquine (Teovanović et al., 2020) and Ivermectin (Hua et al., 2022) have become identity-defining. This ingrained perception fostered cognitive dissonance as evidence increasingly mounted that the vaccines are safe, the virus is not, and the most effective preventative for COVID-19 hospitalization is vaccination (Christie et al., 2021; Thompson et al., 2021). Even so, the problematic perceptions persisted.

A plausible motivation for individuals to take on the risks of contracting and transmitting COVID-19 in eschewing even less-than-onerous recommended precautions is the desire to forestall cognitive dissonance (Arendt et al., 2016; Festinger, 1957). Anti-vaccine attitudes are known to be tenacious and challenging to counter, unyielding to evidence, and bolstered by persuasive anti-vaccine messaging—which is not difficult to find and immerse oneself in (Moran et al., 2016). In the COVID-19 context, several identity groups appear to have engaged in this immersion.

When perceptions about “decision-relevant science” (Kahan, 2017)—that is, science of importance to the average person's behavior and choices—become entangled in politicized communications, the results are a polluted science communication environment and identity-protective cognitions (Kahan & Landrum, 2017). The science communication environment is polluted “when the social processes that normally align diverse citizens with what is known from science are disrupted by antagonistic social meanings” (Kahan & Landrum, 2017, p. 2). This is what occurred with COVID-19: citizens were not aligned with the knowledge provided by the scientific enterprise, because the communication environment in which these findings were presented had been polluted by the social meanings that quickly developed along partisan lines.

This study found that right-leaning media consumers seem to be largely unaffected by the degree of (un)reliability present in their selected news sources. This suggests that efforts such as fact-checking and debunking could prove ineffectual for informing misinformed media consumers. Additionally, many in the United States reside in “news deserts”—communities without reliable local news providers whose members tend to turn to social media for (mis)information (Mathews, 2022; Mihailidis, 2022). This study

found participants reported engaging with many national news outlets (of varying degrees of reliability and bias), suggesting such outlets have the capacity to spread and reinforce—but also potentially counter—misinformation even in news deserts (at least among those groups that are not resistant to the degree of (un)reliability in their preferred news sources). The implications of the potentially outsized influence of national outlets in areas lacking strong local reporting include the opportunity for these providers to investigate misinformation rampant in such areas (such as via social media studies) and develop reporting designed to counter it. Similarly, these findings suggest that the ineffectiveness of fact-checking and debunking to inform a substantial share of media consumers (e.g., right-leaning constituents) makes a case for further research investigating alternative strategies to provide intractable audiences with corrected information. Such strategies include public awareness campaigns and encouraging influencers to promulgate correct(ed) information (Siwakoti et al., 2021).

Jamieson and Albarracín (2020) found exposure to specific media—most especially conservative and social media—was associated with being misinformed, even when controlling for partisanship, early in the pandemic. They also report these misinformed beliefs are not incidental to behavior: those exposed to conservative media and social media were more likely to express, for example, “unwarranted confidence in vitamin C consumption as a means of preventing infection by SARS-CoV-2” (p. 7). Peterson and Iyengar (2022) also found partisan differences in both preferred news sources and beliefs about COVID-19, with misinformed views being sincerely held, as evidenced by their resistance to change in the face of financial incentives. Moreover, Bridgman et al. (2020) found strong associations linking misinformation exposure to non-compliance with pandemic health measures via misperceptions resulting from misinformation in the media consumed. These studies suggest news media, when providing biased and unreliable content, contribute to a misinformed public—with evident public health implications. A misinformed public may be resistant to efforts to safeguard collective and individual health. Misinformation about vaccines, medications, and standard medical practice threatens compliance with physician recommendations and, consequentially, individual and public health—even in a non-pandemic context.

Such studies, and this one, highlight the associations between partisanship, news source preferences, misinformation susceptibility, and the science communication context that suggest novel communication strategies and continuing scholarly investigations are in order along the fault lines of media consumers' polarization.

Applying Ad Fontes Media bias and reliability ratings to participants' selected sources and assessing their misinformed beliefs

The Ad Fontes methodology consists of multi-analyst ratings of news sources along seven categories of bias and eight of reliability. Each source is rated by an equal number of politically left-leaning, politically right-leaning, and politically centrist analysts, whose scores along each dimension are averaged (after any notable score discrepancies are discussed and scores adjusted if the outlier is convinced) (Otero, 2021). Each analyst completes a political identity assessment; all analysts hold at least a bachelor's degree—and most hold a graduate degree—with one-third holding or in the process of obtaining a doctoral degree (Otero, 2021). Analysts are selected by a panel of application reviewers consulting a rubric of candidate qualifications—including education, political/civic engagement, familiarity with news sources and United States government systems, reading comprehension and analytical skills, among others (Otero, 2021). Once hired, analysts complete a minimum of 20 training hours to learn the content analysis procedure before contributing ratings to the data set (Otero, 2021).

This approach produces aggregated third-party ratings of each source's reliability and left-to-right bias. Whereas surveys in this context often rely on participants' or coders' self-reported perceptions of bias and reliability (Mena et al., 2020)—with the attendant lack of uniformity and empirically investigated

reliability—the use of Ad Fontes's ratings in the research context presents a novel alternative: trained reviewers' blended perceptions of source bias and reliability. We propose that using Ad Fontes's ratings presents a viable operationalization of audiences' media selections, with the current study employing the COVID-19 pandemic as a case study of this method. Lin et al. (2023) found that, despite differences in criteria consulted to rate news sources, there is substantial agreement in evaluations of such sources among six news quality rating sets—including Ad Fontes, along with NewsGuard, Iffy index of unreliable sources, Media Bias/Fact Check, independent professional fact-checkers, and Lasser et al. (2022)—suggesting robustness in such ratings.

While Ad Fontes's media bias and reliability ratings follow a clearly defined and politically balanced process, they are not without their limitations. Subjectivity and bias are inevitable in coding indicators of bias and reliability, and this limitation is not completely removed by employing multiple coders for each article analyzed to rate each source—though Lin et al.'s (2023) findings suggest the ratings, which share similar scores to other such systems, are reliable. As this study is the first of which we are aware to employ the measure in this research context, its reliability has not been ascertained through the accumulation of data across studies. The method, however, is robust in that it has behind it the collaborative perception of media bias and reliability as judged by ideologically diverse panels of trained coders—rather than individual participants or coders. It does not (and cannot) measure objective media bias and reliability, but it also shares this limitation with other available measures of the phenomena.

Findings

Finding 1: People who tend to vote for Democrats consume less biased media on average than people who tend to vote for Republicans.

In this study, we calculated media bias in two ways. The first, which we use later in our analysis, involved averaging the Ad Fontes media bias scores across participants' selected news sources. It is worth noting, however, that this method might obscure the extent to which participants engage with partisan and hyper-partisan sources: a participant who only references balanced sources may have an average media bias score similar to a person who references hyper-partisan content on both the right and the left. We refer to this score as the Left to Right (L2R) Media Bias score. A limitation of this study stemming from the use of Ad Fontes media bias scores is that, at the time, we only measured national news sources. This method does not consider the bias and reliability of local news sources or interpersonal communications among people's social networks, which are also likely to be sources of misinformation. We also did not include in our analysis other types of sociodemographic variables that may strongly influence people's beliefs about COVID-19 and vaccination, such as personal experience with COVID-19 (e.g., having lost a family member or friend because of the virus).

The second method, which we used for this finding, first takes the absolute value of each source's media bias score before averaging across participants' source selections. This way, we can see the average deviation from center for each participant, regardless of the direction of the bias. We refer to this score as the media bias score or the absolute value media bias score.

Results from ANOVA with Tukey correction suggest that those in our sample who tend to vote for Democratic candidates ($n = 1,404$) select less biased sources on average ($M = 6.46$, $SD = 4.11$) than those who typically vote for Republican candidates ($n = 923$, $M = 9.99$, $SD = 7.06$), $p < .001$, Cohen's $d = 0.71$ (Hedges $g = 0.65$). Democrats also consumed less biased media on average than participants who tend to vote for third-party candidates ($n = 133$, $M = 8.27$, $SD = 5.77$, $p = .003$, Hedges $g = 0.42$). But Democrats did not differ significantly from those who said that they do not vote ($n = 268$, $M = 6.12$, $SD = 5.03$, $p = .887$, Hedges' $g = 0.08$). Republicans consumed media that were more biased on average than both third-

party participants ($p = .007$, Hedges' $g = 0.25$) and participants who don't vote ($p < .001$, Hedges' $g = 0.58$). See Figure 1.

One potential explanation for the finding that Republicans consume more biased media than Democrats is that someone who tends to select right-leaning media would consume more biased media by default because there are fewer options that are close to center. However, when looking at the outlets that were selected by more than 10% of Republicans in the sample (as well as those selected by more than 10% of Democrats), most of the popular sources had bias scores near the center (e.g., ABC News and CBS News). However, the cable TV news outlets were frequently chosen and have higher bias ratings, and Fox News (selected by 27% of Republicans in the sample) is rated as more biased (absolute value = 24.56) than both CNN (absolute value = 11.87, selected by 30% of Democrats) and MSNBC (absolute value = 20.87, selected by 20% of Democrats). Thus, the effect may be driven primarily by the differences in the ratings of these popular cable news outlets. For the top 25 most frequently selected sources, see Appendix A.

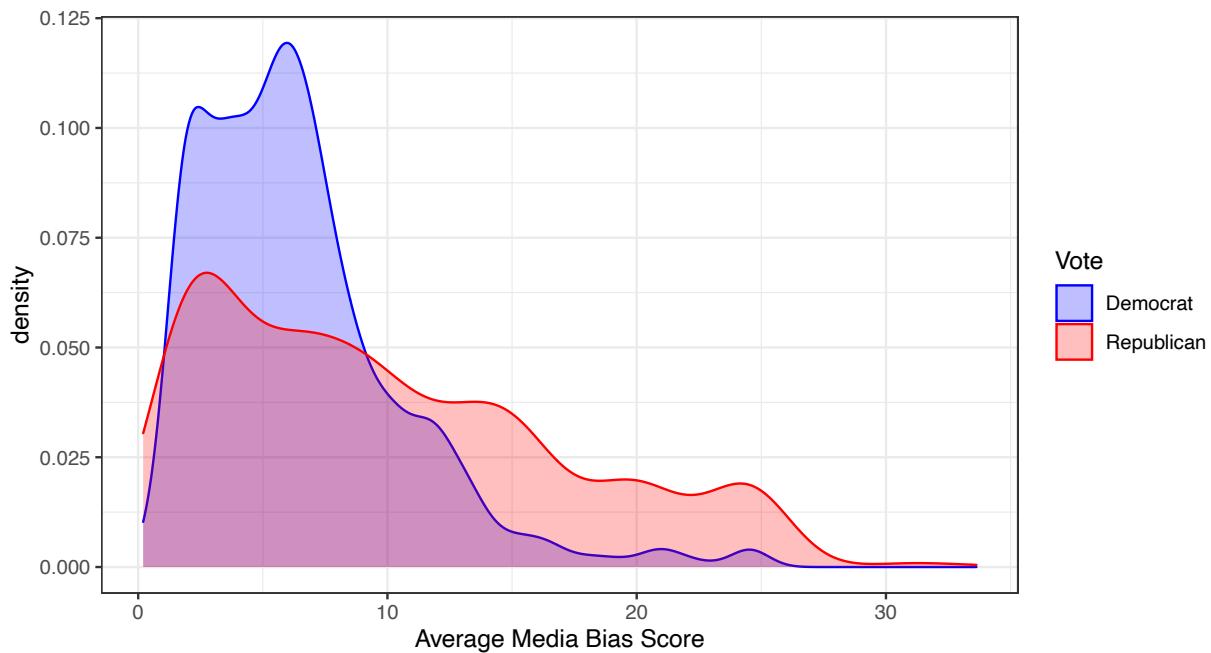


Figure 1. Distribution of (absolute value) media bias scores by participants' voting behavior.

Finding 2: People who tend to vote for Democrats consume more reliable media on average than people who tend to vote for Republicans.

We also found that Democrats selected more reliable sources on average ($M = 42.86$, $SD = 4.89$) than Republicans ($M = 38.12$, $SD = 8.63$), $p < .001$, Cohen's $d = 0.68$ (Hedges $g = 0.71$). Democrats also consumed more reliable media than third-party participants ($M = 40.38$, $SD = 6.81$, $p < .001$, Hedges $g = 0.49$). But Democrats did not differ significantly from those who said that they do not vote ($M = 42.53$, $SD = 6.83$, $p = .952$, Hedges' $g = 0.06$). Republicans consumed media that were more biased on average than both third-party participants ($p = .003$, Hedges' $g = 0.27$) and participants who don't vote ($p < .001$, Hedges' $g = 0.53$). See Figure 2.

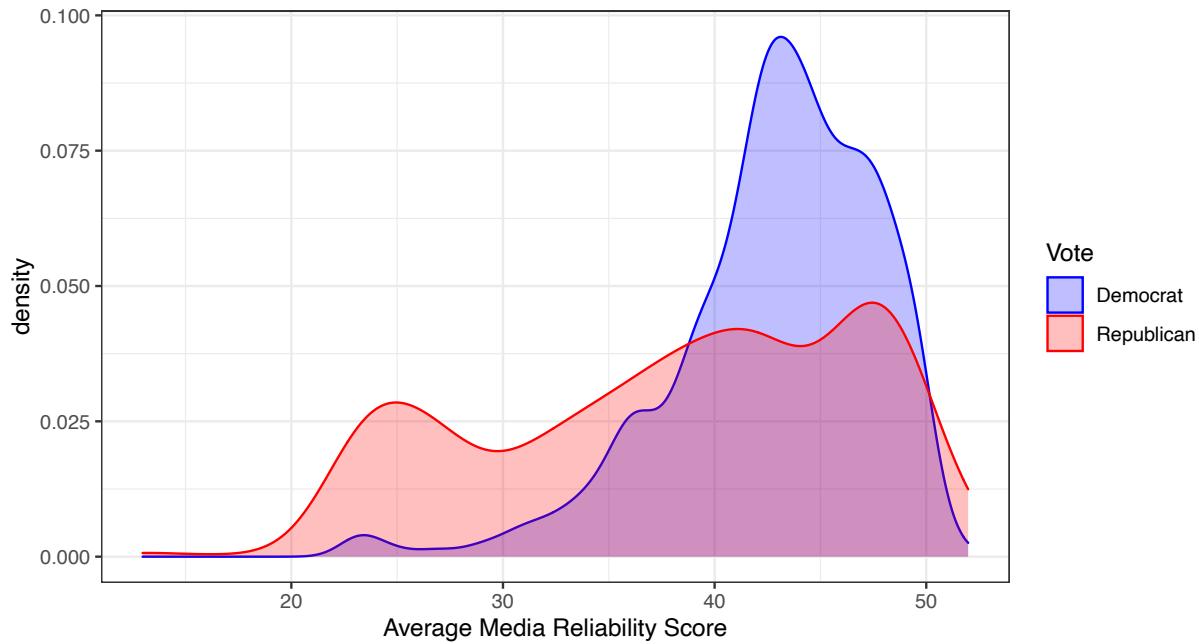


Figure 2. Distribution of media reliability scores by participants' voting behavior.

Finding 3: Average reliability scores moderate the relationship between left-to-right media bias scores and holding false beliefs about COVID-19 as well as holding false beliefs about vaccination.

We conducted a moderated mediation model using the Process Macro for R (Hayes, 2022). We hypothesized that participants' left-to-right political ideology would predict the left-to-right bias of the media consumed (i.e., left-to-right media bias scores), and that their left-to-right media bias scores would predict holding false beliefs. Furthermore, we expected this later relationship to be influenced by the reliability of the media consumed (i.e., media reliability scores). We conducted two models, one predicting holding false beliefs about COVID-19 and one predicting holding false beliefs about vaccination. See Figure 3.

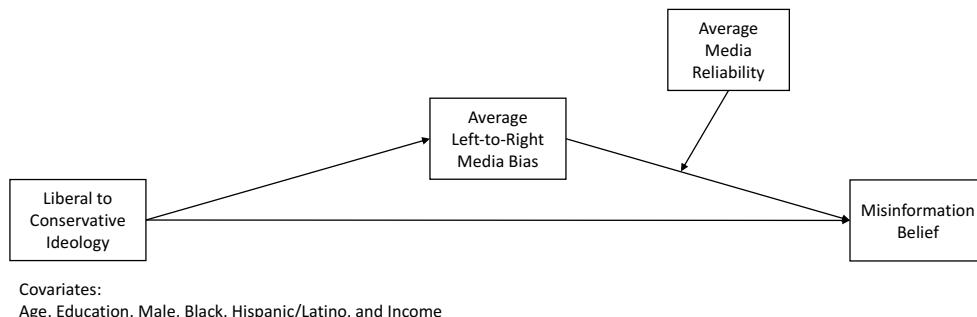


Figure 3. Moderated mediation model tested. We tested two models, one predicting misinformed beliefs about COVID-19 and one predicting misinformed beliefs about vaccination.

We found that ideology predicts left-to-right media bias scores ($b = 2.88, p < .001, r = 0.43$). However, though left-to-right media bias is positively correlated with holding misinformed beliefs about COVID-19 ($r = 0.21, p < .001$), the relationship between these variables in the model is negative ($b = -0.06, p < .001$). To understand this effect, we probed the significant interaction ($b = 0.002, p < .001$) using the Johnson-

Neyman technique. We found that participants who consume stronger right-leaning media appear to hold more misinformed COVID-19 beliefs regardless of the average reliability of their media selections, consistent with Jamieson and Albarracín (2020). In contrast, participants who consume stronger left-leaning media vary in the strength of their misinformed COVID-19 beliefs, with those consuming more reliable media holding less misinformed beliefs about COVID-19 and those consuming less reliable media holding more misinformed beliefs. See Appendix B.

The results for predicting misinformed beliefs about vaccination echo what we saw when predicting misinformed beliefs about COVID-19: media reliability had a greater impact on those who have stronger left-leaning media bias scores. Among participants with similar left-leaning media bias scores, those who consumed less reliable media on average held greater misinformed beliefs than those who consumed more reliable media on average. Among those with similar right-leaning media bias scores, participants did not appear to differ significantly based on reliability. See Figure 4 and Appendix C.

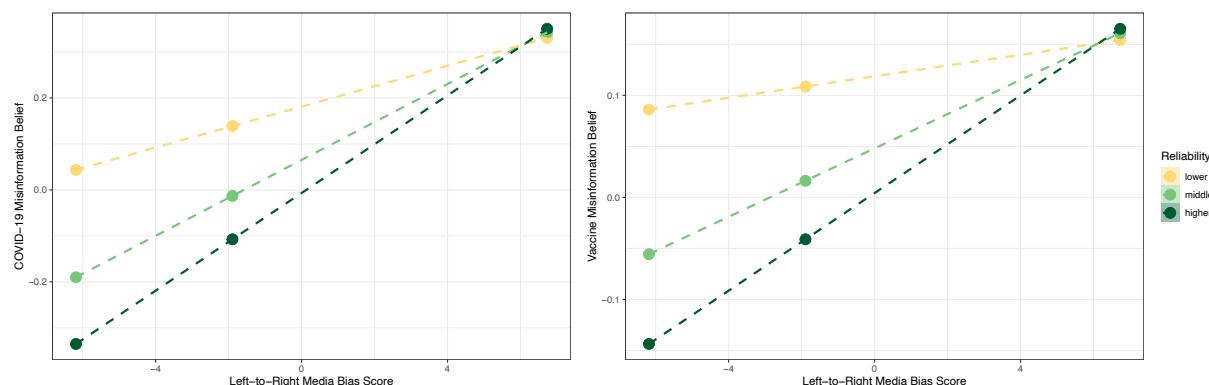


Figure 4. Conditional effects of left-to-right media bias scores on misinformation belief scores regarding COVID-19 (left) and Vaccination (right). Consumers of right-biased media seem to be less affected by the reliability of the outlets, while those who consume left-biased media seem to be more strongly influenced by the reliability of the sources.

Finding 4: Participant left-to-right political ideology indirectly influences misinformation belief through left-to-right media bias score and is contingent on media reliability.

Political ideology directly and indirectly influences belief in misinformation. At varying levels of outlet reliability, political ideology influences belief in misinformation through the selection of biased media outlets. Our moderated mediation models also showed that these indirect effects are conditional; for both models, as media reliability scores increase, so do the strengths of the indirect effects. See Table 1. The complete results of both moderated mediation models are available in Appendix B and Appendix C.

Table 1. Indirect effects conditional on media reliability scores.

Reliability Scores	Ideo -> L2R Media Bias -> COVID-19			Ideo -> L2R Media Bias -> Vaccination		
	Effect	95% CI	Effect	95% CI		
Lower (W = 34.49)	0.06	0.05	0.08	0.02	0.00	0.03
Middle (W = 42.60)	0.12	0.09	0.15	0.05	0.02	0.07
Higher (W = 47.64)	0.15	0.12	0.19	0.07	0.04	0.10

Methods

We conducted a secondary analysis using data collected from a national sample of 3,276 individuals recruited using the Lucid Theorem tool. Our sample was 58.04% female, 40.85% male, and 0.75% other genders (e.g., non-binary, trans male; $n = 23$); 11 participants declined to report their gender. The average age of participants was 48.09, and 34% of participants reported having earned at least a college degree ($n = 1044$). Ten percent of participants report identifying as Black, 9% identified as Hispanic/Latino/a/x, and 5% identified as Asian or Asian American. The sample differs from the sociodemographic breakdowns of a nationally representative sample based on values from the U.S. census: our sample was older, had more females, and had fewer people who identify as Black or Hispanic/Latino. Thus, we entered the sociodemographic variables into the PROCESS models as covariates. See Appendix D.

Data for the current study was originally collected as part of the NSF-funded project COLLABORATIVE RESEARCH: RAPID: Influencing Young Adults' Science Engagement and Learning with COVID-19 Media Coverage. The survey was conducted between January 20, 2021, and February 2, 2021, approximately one year into the COVID-19 pandemic. In the online survey, participants were asked what they knew and thought about topics related to germs (viruses and bacteria), COVID-19, and vaccines. Consenting participants were asked to what extent statements about viruses, bacteria, COVID-19, and vaccinations were likely to be true on a 4-point scale. Then, participants were asked to select—from a list of 129—the news sources that they used to get information about COVID-19. Lastly, participants answered a series of standard demographic questions. Participants who completed the survey were compensated by Lucid consistent with their survey panel agreements.

Our first outcome variable for this study is an index of false beliefs about COVID-19. We used the 18 inaccurate statements about COVID-19 that were asked in the survey, such as hydroxychloroquine has been scientifically proven to be effective in preventing and/or treating COVID-19; there is a cure for COVID-19 that is being withheld from the public; disinfectants can safely be swallowed to treat COVID-19; and COVID-19 is less dangerous than the flu. Participants were asked whether each statement was definitely true (4), likely true (3), likely false (2), or definitely false (1). Participants' responses to these items were combined into an index and evaluated using item response theory (grm model, Samejima, 1969; for R package, see Rizopoulos, 2006). Participants' scores ranged from -1.84 to 3.6 ($M = 0.02$, $SD = 0.91$).

Our second outcome variable for this study is an index of false beliefs about vaccinations. We used the six inaccurate statements about vaccines, such as vaccinations work by giving you a mild case of the disease; some childhood vaccinations can cause autism, and all vaccines are made from living viruses. As with the COVID-19 items, participants were asked whether each statement was definitely true (4), likely true (3), likely false (2), or definitely false (1). Participant responses to these items were combined into an index and evaluated using item response theory. Participant scores ranged from -1.91 to 2.24 ($M = 0.01$, $SD = 0.86$).

To measure average media reliability and average left-to-right media bias, we provided participants with a list of 129 news outlets for which Ad Fontes had posted reliability and left-right bias ratings at the time the data were collected (Ad Fontes Media, 2023). Each listed outlet's left-to-right bias score could range from -42 to +42, with stronger negative scores indicating stronger politically left bias and stronger positive scores indicating stronger politically right bias. Reliability scores, on the other hand, range from 0 to 64, with lower scores reflecting content that may contain inaccurate or fabricated information and higher scores indicating factual reporting.

As stated earlier, survey participants were asked to select all the sources from which they have gotten information about COVID-19. If participants selected a source, they had a "1" in that variable column. If they did not select the source, they had an "NA" (i.e., the way R understands missing data). Then, we

recoded this data, creating two columns for each news source—one for each source's reliability score and one for each source's left-to-right bias score. In R, we wrote a script to replace the "1" with the Ad Fontes reliability rating for that source in the reliability column and the Ad Fontes left-to-right bias rating for that source in the bias column. Next, we averaged the source reliability scores across each participant's set of selected sources, and we did the same for the left-to-right bias scores. One limitation of this method is that we did not weight the scores by frequency of each source's use; this was because we were concerned that it would make the survey too long, given that participants could have selected up to 129 sources. That said, the average number of sources selected was 4 (median = 3), and the vast majority of participants (95%) selected fewer than 16 sources. Participants' average source reliability scores ranged from 7.41 to 51.98 ($M = 41.05$ of 64, $SD = 7.07$), and their average left-to-right media bias scores ranged from -23.46 to 33.63 ($M = -0.11$, $SD = 8.42$).

It is worth noting that across the 129 sources included in this study that were rated by Ad Fontes at the time we collected data, the average bias rating was slightly left-leaning at -1.2 (Median = -2.44, $SD = 14.99$, skew = 0.33, kurtosis = -0.6) and the average reliability rating was 35.13 (of 64, Median = 36, $SD = 10.96$). A total of 83 sources fell on the left side of center (bias = 0), whereas 46 sources fell on the right side. But, even though there are more left-leaning sources than right-leaning sources, the average bias (absolute value) of the left-leaning sources ($M = 10.2$, $SD = 8.45$) is lower than the average bias of the right-leaning sources ($M = 15.03$, $SD = 9.51$, $t(84.20) = -2.88$, $p = .005$, Hedges' $g = 0.55$).

Bibliography

Ad Fontes Media. (2023). *Methodology*. <https://adfontesmedia.com/how-ad-fontes-ranks-news-sources/>

Arendt, F., Steindl, N., & Kümpel, A. (2016). Implicit and explicit attitudes as predictors of gatekeeping, selective exposure, and news sharing: Testing a general model of media-related selection. *Journal of Communication*, 66(5), 717–740. <https://doi.org/10.1111/jcom.12256>

Bridgman, A., Owen, T., Zhilin, O., Merkley, E., Ruths, D., Loewen, P. J., & Teichmann, L. (2020). The causes and consequences of COVID-19 misperceptions: Understanding the role of news and social media. *Harvard Kennedy School (HKS) Misinformation Review*, 1(3). <https://doi.org/10.37016/mr-2020-028>

Christie, A., Brooks, J. T., Hicks, L. A., Sauber-Schatz, E. K., Yoder, J. S., Honein, M. A., & CDC COVID-19 Response Team. (2021). Guidance for implementing COVID-19 prevention strategies in the context of varying community transmission levels and vaccination coverage. *MMWR Morbidity and Mortality Weekly Report*, 70(30), 1044–1047. <https://doi.org/10.15585/mmwr.mm7030e2>

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford University Press.

Hammad, A. M., Hamed, R., Al-Qerem, W., Bandar, A., & Hall, F. S. (2021). Optimism bias, pessimism bias, magical beliefs, and conspiracy theory beliefs related to COVID-19 among the Jordanian population. *American Journal of Tropical Medicine and Hygiene*, 104(5), 1661–1671. <https://doi.org/10.4269/ajtmh.20-1412>

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). The Guilford Press.

Hua, Y., Jiang, H., Lin, S., Yang, J., Plasek, J. M., Bates, D. W., & Zhou, L. (2022). Using Twitter data to understand public perceptions of approved versus off-label use for COVID-19-related medications. *Journal of the American Medical Informatics Association*, 29(10), 1668–1678. <https://doi.org/10.1093/jamia/ocac114>

Jamieson, K. H., & Albarracín, D. (2020). The relation between media consumption and misinformation at the outset of the SARS-COV-2 pandemic in the US. *Harvard Kennedy School (HKS) Misinformation Review*, 1(3). <https://doi.org/10.37016/mr-2020-012>

Kahan, D. M. (2017). *Misconceptions, misinformation, and the logic of identity-protective cognition* (Cultural Cognition Project Working Paper No. 164). SSRN. <http://dx.doi.org/10.2139/ssrn.2973067>.

Kahan, D. M., & Landrum, A. R. (2017). A tale of two vaccines—and their science communication environments. In K. H. Jamieson, D. M. Kahan, & D. A. Scheufele (Eds.), *The Oxford handbook of the science of science communication* (pp. 165–172). Oxford University Press. <https://doi.org/10.1093/osfordhb/9780190497620.013.18>

Lin, H., Lasser, J., Lewandowsky, S., Cole, R., Gully, A., Rand, D. G., & Pennycook, G. (2023). High level of correspondence across different news domain quality rating sets. *PNAS Nexus*, 2(9), 286. <https://doi.org/10.1093/pnasnexus/pgad286>

Mathews, N. (2022). Life in a news desert: The perceived impact of a newspaper closure on community members. *Journalism*, 23(6), 1250–1265. <https://doi.org/10.1177/1464884920957885>

Mena, P., Barbe, D., & Chan-Olmsted, S. (2020). Misinformation on Instagram: The impact of trusted endorsements on message credibility. *Social Media + Society*, 6(2). <https://doi.org/10.1177/2056305120935102>

Mihailidis, P. (2022). News literacy practice in a culture of infodemic. In S. Allan (Ed.), *The Routledge companion to news and journalism* (pp. 388–397) (2nd ed.). Routledge. <https://doi.org/10.4324/9781003174790>

Moran, M. B., Lucas, M., Everhart, K., Morgan, A., & Prickett, E. (2016). What makes anti-vaccine websites persuasive? A content analysis of techniques used by anti-vaccine websites to engender anti-vaccine sentiment. *Journal of Communication in Healthcare*, 9(3), 151–163. <https://doi.org/10.1080/17538068.2016.1235531>

Motta, M., Callaghan, T., Sylvester, S., & Lunz-Trujillo, K. (2021). Identifying the prevalence, correlates, and policy consequences of anti-vaccine social identity. *Policies, Groups, and Identities*, 11(1), 108–122. <https://doi.org/10.1080/21565503.2021.1932528>

Otero, V. (2021). *White paper: Multi-analyst content analysis methodology September 2021* [White paper]. Ad Fontes Media. <https://adfontesmedia.com/white-paper-2021/>

Peterson, E., & Iyengar, S. (2022). Partisan reasoning in a high stakes environment: Assessing partisan informational gaps on COVID-19. *Harvard Kennedy School (HKS) Misinformation Review*, 3(2). <https://doi.org/10.37016/mr-2020-96>

Rizopoulos, D. (2006). Item: An R package for latent variable modeling and item response theory analyses. *Journal of Statistical Software*, 17(5), 1–25. <https://doi.org/10.18637/jss.v017.i05>

Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. *Psychometrika*, 34(S1), 1–97. <https://doi.org/10.1007/bf03372160>

Siwakoti, S., Yadav, K., Bariletto, N., Zanotti, L., Erdogan, U., & Shapiro, J. N. (2021). How COVID drove the evolution of fact-checking. *Harvard Kennedy School (HKS) Misinformation Review*, 2(3). <https://doi.org/10.37016/mr-2020-69>

Šrol, J., Ballová Mikušková, E., & Čavojová, V. (2021). When we are worried, what are we thinking? Anxiety, lack of control, and conspiracy beliefs amidst the COVID-19 pandemic. *Applied Cognitive Psychology*, 35(3), 720–729. <https://doi.org/10.1002/acp.3798>

Teovanović, P., Lukić, P., Zupan, Z., Lazić, A., Ninković, M., & Žeželj, I. (2020). Irrational beliefs differentially predict adherence to guidelines and pseudoscientific practices during the COVID-19 pandemic. *Applied Cognitive Psychology*, 35(2), 486–496. <https://doi.org/10.1002/acp.3770>

Thompson, M. G., Stenehjem, D., Grannis, S., Ball, S. W., Naleway, A. L., Ong, T. C., DeSilva, M. B., Natarajan, K., Bozio, C. H., Lewis, N., Dascomb, K., Dixon, B. E., Birch, R. J., Irving, S. A., Rao, S., Kharbanda, E., Han, J., Reynolds, S., Goddard, K. ... & Klein, N. P. (2021). Effectiveness of COVID-19 vaccines in ambulatory and inpatient care settings. *The New England Journal of Medicine*, 385(15), 1355–1371. <https://doi.org/10.1056/NEJMoa2110362>

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Competing interests

The authors have no competing interests to declare.

Ethics

The research protocol employed for the larger study from which this data was a part was approved as exempt research by the institutional review board of Texas Tech University on 6/19/2018. All study participants provided informed consent. Gender and race/ethnicity (among other demographic variables) were collected to be able to describe the study sample and to be able to control for demographic factors in the analyses. Researchers used the race and ethnicity categories outlined by the U.S. Census. In addition, an "other" option was provided with the ability to explain or describe additional categorizations in a text box. Participants were asked to select all that apply. For gender, researchers provided participants with four options: "Male," "Female," "Diverse (e.g., trans, nonbinary, etc.; please specify)," and "I choose not to answer." For the "Diverse..." option, participants were provided with a text box to self-identify.

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Data availability

All materials needed to replicate this study are available via OSF: <https://osf.io/wqxfy/>. Simplified data and code for reproducing the analyses are also available via the Harvard Dataverse: <https://doi.org/10.7910/DVN/FCTPPM>.

Appendix A: Media sources most frequently selected by participants

The most popular outlets selected by participants were the network channel news programs ABC News (45% of the total sample selected) and CBS News (33% of the total sample selected). These were also the two media outlets most frequently selected by both Democrats and Republicans. Notably, these outlets have very high reliability scores and are close to center on their left-to-right media bias ratings.

The top 25 most frequently selected outlets are displayed in Table A1. For a full list of the sources and the number of participants who selected each, see the online supplementary materials.

Table A1. Top 25 most popular media sources based on total selections. Reliability and left-right bias ratings from 2021 and selections by Democratic and Republican voters in the study sample are displayed.

	Reliability	Bias	Selections by Democrats	Selections by Republicans	Total Selections	Percent of Democrats (n = 1435) that selected	Percent of Republicans (n = 986) that selected	Percent of all participants (n = 3276) that selected
ABC News	49.47	-1.85	811	367	1481	56.52	37.22	45.21
CBS News	47.06	-1.85	595	282	1087	41.46	28.60	33.18
CNN.com	42.22	-5.69	481	131	740	33.52	13.29	22.59
CNN Cable TV	36	-11.87	436	107	636	30.38	10.85	19.41
NBC News	46.39	-6.11	357	151	610	24.88	15.31	18.62
Fox News TV Cable Network	23.16	24.56	142	305	562	9.90	30.93	17.16
FoxNews.com	26.75	15.31	137	266	516	9.55	26.98	15.75
BBC	46.56	-3.03	295	71	454	20.56	7.20	13.86
CNBC	44.9	-1.5	257	108	452	17.91	10.95	13.80
Associated Press	51.98	-1.06	257	106	428	17.91	10.75	13.06
MSNBC	31.82	-20.87	281	56	385	19.58	5.68	11.75
New York Times	47.5	-4.01	215	43	305	14.98	4.36	9.31
NPR	49.9	-2.73	182	28	252	12.68	2.84	7.69
HuffPost	39.98	-11.64	158	40	241	11.01	4.06	7.36
BuzzFeed	43.2	-7.06	117	55	232	8.15	5.58	7.08
PBS	47.86	-2.37	155	43	231	10.80	4.36	7.05
Daily Mail	30.67	3.27	110	58	224	7.67	5.88	6.84
USA Today	46.07	-2.03	118	54	213	8.22	5.48	6.50
Washington Post	43.73	-4.18	131	31	188	9.13	3.14	5.74
Bloomberg	47.63	-0.85	98	38	155	6.83	3.85	4.73
Forbes	40.27	0.2	85	36	147	5.92	3.65	4.49
Time Magazine	42.7	-4.35	72	29	121	5.02	2.94	3.69
Wall Street Journal	48.33	1.89	64	38	120	4.46	3.85	3.66
Newsmax	33.15	13.61	7	80	107	0.49	8.11	3.27
Al Jazeera	49.47	-3.71	80	15	106	5.57	1.52	3.24

Appendix B: Predicting misinformed COVID-19 beliefs

This analysis uses the PROCESS Macro for R. The outcome variable for this analysis was misinformed COVID-19 belief (i.e., cmisinfo), the antecedent is participants' ideology on a liberal to conservative Likert-type scale (i.e., ideo), the mediator is the average left-to-right leaning media bias for participants' media selections (i.e., bias), and the moderator is the average reliability of those selections (i.e., reliable). We included several demographic variables as covariates, including age, education, male (as opposed to female), Black (i.e., participants who identify as Black regardless of whether they have other identifications), Hispanic (i.e., participants who identify as Hispanic or Latino/a/x, regardless of whether they have other identifications) and income. Participants with missing data (e.g., who failed to select any media sources, failed to provide answers to any one of the demographic questions, like age or gender) were deleted from the analysis automatically by the PROCESS macro (i.e., listwise deletion), thus leaving a sample size of 2,630. To ensure reproducibility of findings, we set a custom seed for the bootstrapping analysis of 31216.

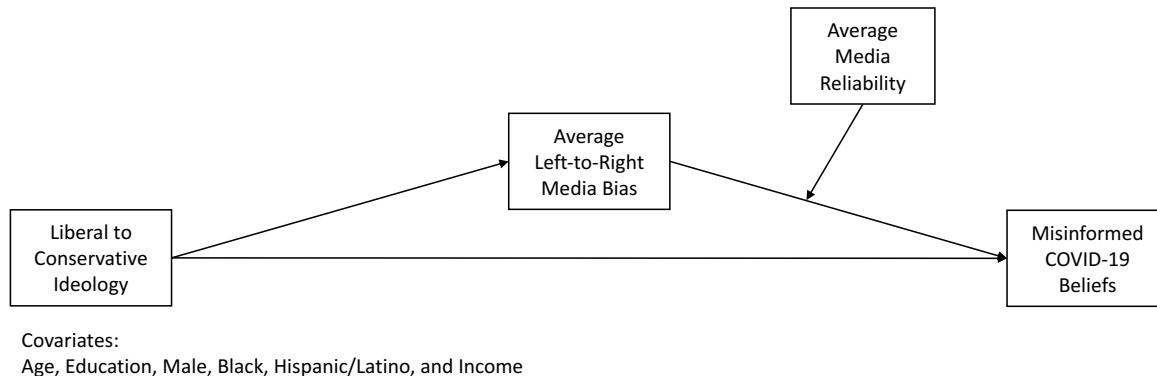


Figure B1. Model examined using PROCESS.

The first step of the PROCESS analysis predicts the mediator: the average left-to-right media bias (i.e., bias). This model is significant, $F(7, 2622) = 87.68, p < .001, R = 0.44, R^2 = 0.20, MSE = 58.11$. We find that the average bias for participants' media selections is significantly predicted by conservative political ideology (ideo), even when controlling for the potential effects of demographic variables. Table 1 summarizes the individual effects.

Table B1. Results for predicting the mediator (average left-to-right media bias).

	<i>b</i>	<i>se</i>	<i>t</i>	<i>p</i>	95% CI	
constant	-7.8186	0.7304	-10.7050	< .001	-9.2508	-6.3864
Ideology	2.8770	0.1237	23.2522	< .001	2.6344	3.1196
Age	-0.0052	0.0091	-0.5680	.570	-0.0230	0.0127
Education	-0.3726	0.1137	-3.2774	.001	-0.5955	-0.1497
Male	0.5606	0.3084	1.8175	.069	-0.0442	1.1653
Black	-1.5504	0.4865	-3.1869	.002	-2.5043	-0.5965
Hispanic	-0.7093	0.6053	-1.1717	.241	-1.8962	0.4777
Income	0.1394	0.0763	1.8269	.068	-0.0102	0.2890

The second step of the PROCESS analysis predicts the outcome, belief in misinformation about COVID-19 (i.e., cmisinfo). This model is significant, $F(10, 2619) = 67.93, p < .001, R = 0.45, R^2 = 0.21, MSE = 0.71$. We find that, in addition to political ideology, the left-to-right bias and reliability of participants' selected news

sources (and the interaction of the latter two variables) predict belief in misinformation about COVID-19, even when controlling for potential effects of demographic variables. Table 2 summarizes the individual effects.

Table B2. Results for predicting the outcome variable (misinformed COVID-19 beliefs).

	<i>b</i>	<i>se</i>	<i>t</i>	<i>p</i>	95% CI	
constant	1.0975	0.1580	6.9477	< .001	0.7878	1.4073
Ideology	0.0997	0.0151	6.5961	< .001	0.0701	0.1294
Bias	-0.0587	0.0099	-5.9391	< .001	-0.0780	-0.0393
Reliable	-0.0143	0.0031	-4.5803	< .001	-0.0204	-0.0082
BiasXReliab	0.0023	0.0003	7.6035	< .001	0.0017	0.0030
Age	-0.0133	0.0010	-13.1552	< .001	-0.0153	-0.0113
Education	-0.0439	0.0126	-3.4799	.001	-0.0686	-0.0191
Male	0.1973	0.0342	5.7743	< .001	0.1303	0.2643
Black	0.4133	0.0539	7.6633	< .001	0.3075	0.5191
Hispanic	0.1371	0.0669	2.0472	.041	0.0058	0.2683
Income	-0.0080	0.0085	-0.9440	.345	-0.0246	0.0086

Furthermore, the test of the higher order unconditional interaction between left-to-right bias and reliability on misinformed COVID-19 beliefs found that it was significant, $F(1, 2619) = 57.81, p < .001$, R-change = 0.02. To probe this interaction, PROCESS provides the effects of left-to-right bias on misinformed COVID-19 beliefs at multiple levels of outlet reliability (the moderator). These results are shown in Table 3.

Table B3. Conditional effects of average left-to-right media bias (i.e., bias) at different values of the moderator, average source reliability (i.e., reliable).

Reliable	effect	<i>se</i>	<i>t</i>	<i>p</i>	95% CI	
12.9700	-0.0282	0.0061	-4.6051	< .001	-0.0403	-0.0162
15.0232	-0.0234	0.0056	-4.2037	< .001	-0.0344	-0.0125
17.0763	-0.0186	0.0050	-3.6997	< .001	-0.0285	-0.0087
19.1295	-0.0138	0.0045	-3.0576	.002	-0.0226	-0.0049
21.1826	-0.0090	0.0040	-2.2301	.026	-0.0169	-0.0011
21.7505	-0.0076	0.0039	-1.9609	.050	-0.0153	-0.0000
23.2358	-0.0042	0.0036	-1.1599	.246	-0.0112	0.0029
25.2889	0.0007	0.0032	0.2053	.837	-0.0056	0.0070
27.3421	0.0055	0.0029	1.8715	.061	-0.0003	0.0112
27.4442	0.0057	0.0029	1.9609	.050	0.0000	0.0114
29.3953	0.0103	0.0028	3.7281	< .001	0.0049	0.0157
31.4484	0.0151	0.0027	5.5225	< .001	0.0097	0.0205
33.5016	0.0199	0.0029	6.9791	< .001	0.0143	0.0255
35.5547	0.0247	0.0031	7.9773	< .001	0.0187	0.0308
37.6079	0.0296	0.0034	8.5719	< .001	0.0228	0.0363
39.6611	0.0344	0.0039	8.8862	< .001	0.0268	0.0420
41.7142	0.0392	0.0043	9.0291	< .001	0.0307	0.0477
43.7674	0.0440	0.0049	9.0744	< .001	0.0345	0.0535
45.8205	0.0488	0.0054	9.0664	< .001	0.0383	0.0594
47.8737	0.0536	0.0059	9.0304	< .001	0.0420	0.0653
49.9268	0.0585	0.0065	8.9806	< .001	0.0457	0.0712
51.9800	0.0633	0.0071	8.9251	< .001	0.0494	0.0772

Lastly, PROCESS provides the direct and indirect effects of the antecedent, liberal-to-conservative political ideology (i.e., ideo) on the outcome variable, misinformed COVID-19 beliefs (i.e., cmisinfo). The direct effect is statistically significant (effect = 0.10, 95% CI [0.07, 0.13], $SE = 0.02$, $t = 6.60$, $p < .001$). Furthermore, bootstrapped confidence intervals for the conditional indirect effects of ideology on misinformed COVID-19 beliefs are summarized in Table 4. The index of moderated mediation is 0.007 (bootstrapped 95% CI [0.005, 0.009], bootstrapped $SE = 0.001$). That is, liberal-to-conservative ideology both directly and indirectly (via left-to-right bias of selected media) influences misinformed COVID-19 beliefs in our study sample.

Table B4. Bootstrapped conditional indirect effects of liberal to conservative ideology (through left-to-right media bias) on misinformed COVID-19 beliefs.

reliable	effect	Boot SE	Boot 95% CI
34.4850	0.0640	0.0091	0.0465 0.0824
42.6012	0.1188	0.0143	0.0917 0.1474
47.6400	0.1528	0.0185	0.1178 0.1901

Appendix C: Predicting misinformed vaccination beliefs

This analysis also uses the PROCESS Macro for R. The outcome variable for this analysis was misinformed vaccination beliefs (i.e., *vmisinfo*), the antecedent is participants' ideology on a liberal to conservative Likert-type scale (i.e., *ideo*), the mediator is the average left-to-right leaning media bias for participants' media selections (i.e., *bias*), and the moderator is the average reliability of those selections (i.e., *reliable*). We included several demographic variables as covariates, including age, education, male (as opposed to female or other), Black (i.e., participants who identify as Black regardless of whether they have other identifications), Hispanic (i.e., participants who identify as Hispanic or Latino/a/x, regardless of whether they have other identifications) and income. See Figure 1. As with the analysis shown in Appendix B, participants with missing data (e.g., who failed to select any media sources, failed to provide answers to any one of the demographic questions, like age or gender) were deleted from the analysis automatically by the PROCESS macro (i.e., listwise deletion), thus leaving a sample size of 2,630. To ensure reproducibility of findings, we set a custom seed for the bootstrapping analysis of 31,216.

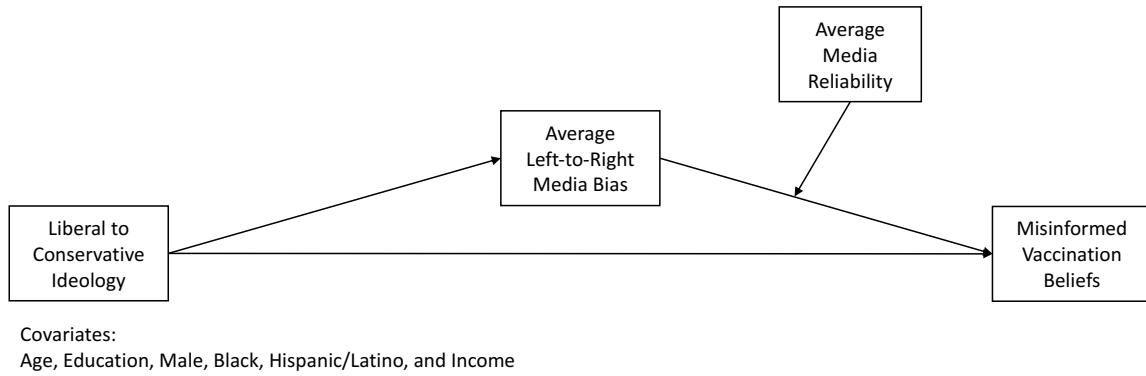


Figure C1. Model examined using PROCESS.

The first step of the PROCESS analysis predicts the mediator: the average left-to-right media bias (i.e., *bias*). This model is significant, $F(7, 2622) = 87.68, p < .001, R = 0.44, R^2 = 0.20, MSE = 58.11$. The analysis and results are identical to the model predicting misinformed COVID-19 beliefs in Appendix B: the average bias of participants' media selections is significantly predicted by political ideology (*ideo*), even when controlling for the potential effects of demographic variables. Table 1 summarizes the individual effects.

Table C1. Results for predicting the mediator (average left-to-right media bias).

	<i>b</i>	<i>se</i>	<i>t</i>	<i>p</i>	95% CI
constant	-7.8186	0.7304	-10.7050	< .001	-9.2508 -6.3864
Ideology	2.8770	0.1237	23.2522	< .001	2.6344 3.1196
Age	-0.0052	0.0091	-0.5680	.570	-0.0230 0.0127
Education	-0.3726	0.1137	-3.2774	.001	-0.5955 -0.1497
Male	0.5606	0.3084	1.8175	.069	-0.0442 1.1653
Black	-1.5504	0.4865	-3.1869	.002	-2.5043 -0.5965
Hispanic	-0.7093	0.6053	-1.1717	.241	-1.8962 0.4777
Income	0.1394	0.0763	1.8269	.068	-0.0102 0.2890

The second step of the PROCESS analysis predicts the outcome, misinformed vaccination beliefs (i.e., *vmisinfo*). This model is significant, $F(10, 2619) = 21.26, p < .001, R = 0.27, R^2 = 0.08, MSE = 0.72$. We find that the left-to-right bias and reliability of participants' selected news sources (and the interaction of the latter two variables) predicts misinformed vaccination beliefs, even when controlling for potential effects

of demographic variables. Left-to-right political ideology, however, does not significantly predict the outcome variable. Table 2 summarizes the individual effects.

Table C2. Results for predicting the outcome variable (misinformed vaccination beliefs).

	<i>b</i>	<i>se</i>	<i>t</i>	<i>p</i>	95% CI
constant	0.9678	0.1594	6.0710	< .001	0.6552 1.2804
Ideology	0.0194	0.0153	1.2727	.203	-0.0105 0.0493
Bias	-0.0436	0.0100	-4.3762	< .001	-0.0632 -0.0241
Reliable	-0.0087	0.0031	-2.7634	.006	-0.0149 -0.0025
BiasXReliab	0.0014	0.0003	4.5540	< .001	0.0008 0.0020
Age	-0.0059	0.0010	-5.7557	< .001	-0.0079 -0.0039
Education	-0.0818	0.0127	-6.4354	.001	-0.1068 -0.0569
Male	0.0575	0.0345	1.6679	.095	-0.0101 0.1251
Black	0.2398	0.0544	4.4051	< .001	0.1330 0.3465
Hispanic	0.1791	0.0676	2.6515	.008	0.0467 0.3116
Income	-0.0151	0.0085	-1.7725	.076	-0.0318 0.0016

Furthermore, the test of the higher order unconditional interaction between left-to-right bias and reliability on misinformed COVID-19 beliefs found that it was significant, $F(1, 2619) = 20.74, p < .001$, R^2 change = 0.007. To probe this interaction, PROCESS provides the effects of left-to-right bias on misinformed vaccination beliefs at multiple levels of outlet reliability (the moderator). It is notable that the effects are only significant at higher and lower values of average reliability (and not at the middle values). These results are shown in Table 3.

Table C3. Conditional effects of average left-to-right media bias (i.e., bias) at different values of the moderator, average source reliability (i.e., reliable).

Reliable	effect	<i>se</i>	<i>t</i>	<i>p</i>	95% CI
12.9700	-0.0252	0.0062	-4.0775	< .001	-0.0374 -0.0131
15.0232	-0.0223	0.0056	-3.9697	< .001	-0.0334 -0.0113
17.0763	-0.0194	0.0051	-3.8246	< .001	-0.0294 -0.0095
19.1295	-0.0165	0.0046	-3.6251	< .001	-0.0254 -0.0076
21.1826	-0.0136	0.0041	-3.3462	.001	-0.0216 -0.0056
23.2358	-0.0107	0.0036	-2.9521	.003	-0.0178 -0.0036
25.2889	-0.0078	0.0032	-2.3977	.017	-0.0141 -0.0014
26.5472	-0.0060	0.0031	-1.9609	.050	-0.0120 < 0.0001
27.3421	-0.0049	0.0030	-1.6444	.100	-0.0106 0.0009
29.3953	-0.0019	0.0028	-0.6978	.485	-0.0074 0.0035
31.4484	0.0010	0.0028	0.3503	.726	-0.0044 0.0064
33.5016	0.0039	0.0029	1.3461	.178	-0.0018 0.0095
34.9832	0.0060	0.0030	1.9609	.050	< 0.0001 0.0120
35.5547	0.0068	0.0031	2.1693	.030	0.0007 0.0129
37.6079	0.0097	0.0035	2.7877	.005	0.0029 0.0165
39.6611	0.0126	0.0039	3.2307	.001	0.0050 0.0203
41.7142	0.0155	0.0044	3.5439	< .001	0.0069 0.0241
43.7674	0.0184	0.0049	3.7667	< .001	0.0088 0.0280
45.8205	0.0213	0.0054	3.9278	< .001	0.0107 0.0320
47.8737	0.0243	0.0060	4.0466	< .001	0.0125 0.0360
49.9268	0.0272	0.0066	4.1359	< .001	0.0143 0.0401
51.9800	0.0301	0.0072	4.2044	< .001	0.0161 0.0441

Lastly, PROCESS provides the direct and indirect effects of the antecedent, liberal-to-conservative ideology (i.e., ideo) on the outcome variable, misinformed vaccination beliefs (i.e., vmisinfo). As stated above, unlike for predicting misinformed beliefs about COVID-19, left-to-right political ideology does not significantly predict the outcome variable here (misinformed vaccination beliefs; effect = 0.02, 95% CI [-0.01, 0.05], se = 0.02, $t = 1.27$, $p = .203$). However, there are significant indirect effects through which left-to-right political ideology may influence misinformed vaccination beliefs, particularly at the higher levels of reliability. Bootstrapped confidence intervals for the conditional indirect effects of ideology on vaccine misinformation belief are summarized in Table 4. The index of moderated mediation is 0.004 (bootstrapped 95% CI [0.003, 0.006], bootstrapped SE = 0.001).

Table C4. Bootstrapped conditional indirect effects of liberal to conservative ideology (through left-to-right media bias) on vaccine misinformation belief.

reliable	effect	Boot SE	Boot 95% CI	
34.4850	0.0152	0.0083	-0.0009	0.0319
42.6012	0.0483	0.0128	0.0236	0.0738
47.6400	0.0688	0.0164	0.0375	0.1016

Appendix D: Our participant sample compared with 2021 US Census values

The sample recruited for the study differs from the sociodemographic breakdowns of a nationally representative sample based on values from the U.S. Census: our sample was older, had more females, and had fewer people who identified as Black or Hispanic/Latino.

Table D1. Demographic variables collected compared to values from the 2021 Census.

	Our Sample	Census		Our Sample	Census
Female	58.04%	50.5%	College Degree	34%	33.7%
Black	10%	13.6%	Median Age	49	38.4
Hispanic/Latino	9%	18.9%			
Asian/ Asian American	5%	6.1%			