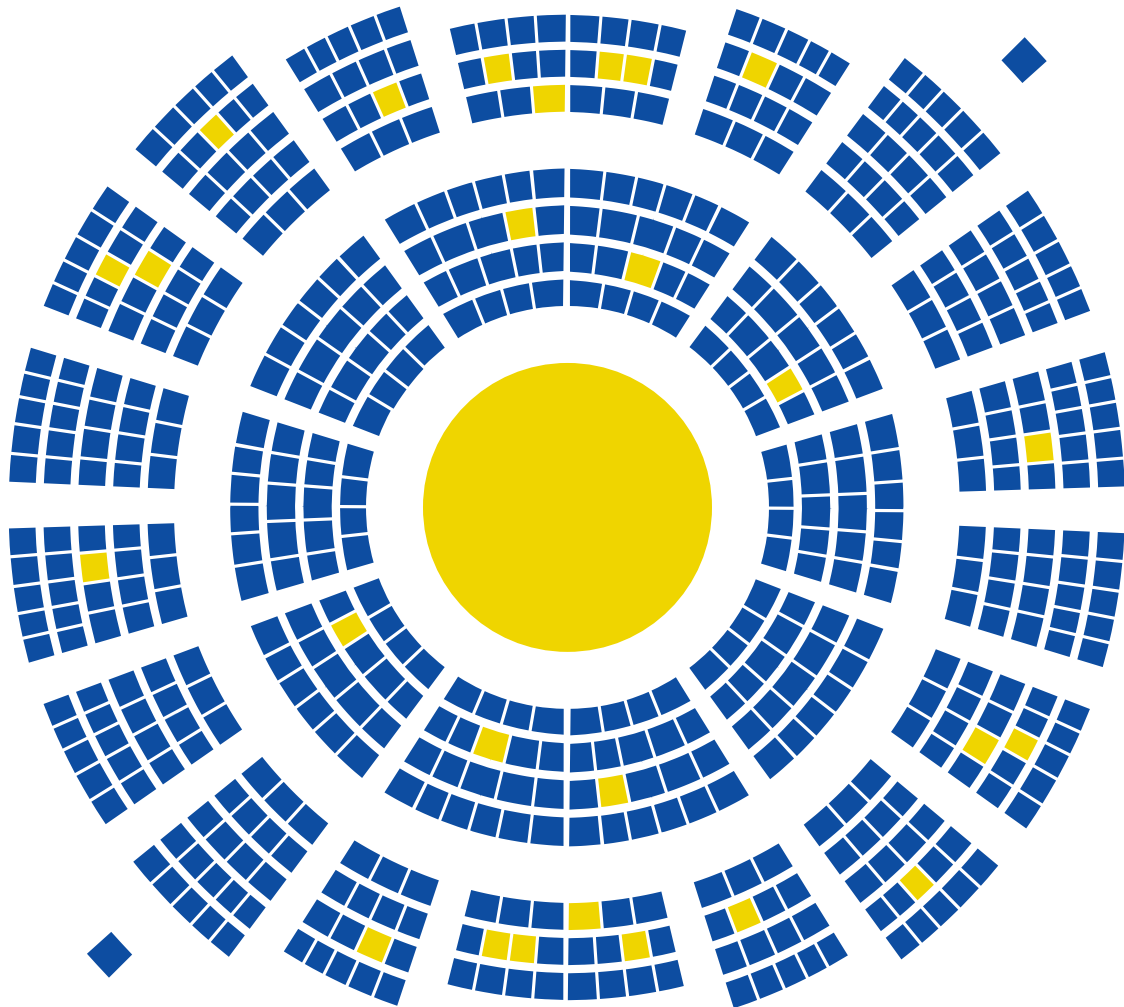# POLITICAL MISINFORMATION IN THE DIGITAL AGE DURING A PANDEMIC: PARTISANSHIP, PROPAGANDA, AND DEMOCRATIC DECISION-MAKING

EDITED BY: Andrea De Angelis, Christina E. Farhart, Eric Merkley and Dominik A. Stecula
PUBLISHED IN: Frontiers in Political Science and Frontiers in Psychology

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POLITICAL MISINFORMATION IN THE DIGITAL AGE DURING A PANDEMIC: PARTISANSHIP, PROPAGANDA, AND DEMOCRATIC DECISION-MAKING

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Editorial on the Research Topic

Political Misinformation in the Digital Age During a Pandemic: Partisanship, Propaganda, and Democratic Decision-Making

INTRODUCTION

With the world rushing to respond to the COVID-19 pandemic, an infodemic (van der Linden, 2022) of misinformation and conspiracy theories relating to COVID-19 has rapidly spread, exacerbating political conflicts (Osmundsen et al., 2021) with dire public health consequences (Swire-Thompson and Lazer, 2020). An alarming disconnect between public perceptions and the facts has affected debates surrounding the origins, prevention, and treatment of the disease, and inflamed issues such as mask wearing, social distancing, and perceptions of vaccine safety (Allcott et al., 2020).

Misinformation and conspiracy theories have thus continued to bedevil and politicize public health discussions and policy decisions globally. Contemporaneously, the growing prominence of social and digital media, and a high choice news media environment, make it increasingly difficult for citizens to judge the quality of the information they encounter in their daily lives (Choi et al., 2020). Understanding the mechanics of political misinformation and its connections with public opinion formation is therefore a vital challenge for democracy as high quality information is critical for its functioning.

In this Research Topic, we provide a forum for new perspectives to shed light on two critical challenges for the study of political misinformation during the COVID-19 pandemic. First, on the demand-side, questions remain around who is vulnerable to misinformation and how best to correct mistaken beliefs in the digital age. The articles in this Research Topic tackle the issue with a focus on vaccine-related misinformation, support for conspiracy theories, and the psychological profile of misinformation consumers. Second, on the supply-side, we lack an understanding of the mechanisms that generate and propagate political misinformation in traditional and digital media. This Research Topic brings together a group of accomplished social scientists who have begun to tackle these challenges in their research.

VULNERABILITY TO VACCINE-RELATED MISINFORMATION ABOUT COVID-19

Vaccines are critical to curbing the spread of pandemics like COVID-19, so vaccine hesitancy, or underlying skepticism and refusal to receive vaccines, presents a grave public health threat (Solís Arce et al., 2021). Palm et al. test whether vaccine communication strategies can combat vaccine hesitancy using a survey experiment conducted on a sample of US citizens. They compare the effects of multiple messages on vaccine hesitancy, finding that when communication focuses on vaccine safety and efficacy, self-reported vaccination intention increases. However, messages voicing reservations and vaccine skepticism, or discussing political influences on vaccine development, reduce self-reported vaccine intention.

Motta et al. complement this by conducting a survey experiment using a large representative sample of Americans to test whether public health messages related to the personal and collective health costs of the pandemic, or the economic consequences of failing to vaccinate, reduce vaccine hesitancy. They find that messages related to health costs had small positive effects on vaccine intention that surprisingly did not vary by the partisanship of the respondent or by the source of the message. Economic frames, however, appeared not to lift vaccine intention at all. These two works show us that some communication strategies hold promise to encourage vaccine uptake, but there is no game-changing silver bullet for combatting vaccine hesitancy.

CONSPIRACY THEORY BELIEFS AND COVID-19

Hartman et al. also examine the correlates of COVID-19 conspiracy endorsement. Using a representative sample from the UK, they find that underlying predispositions, including right-wing authoritarianism (RWA), social dominance orientation (SDO), and general conspiracy ideation, are associated with belief in conspiracy theories related to the virus. The authors find that the specific content or target of COVID-19 conspiracy theories determines which individuals are most likely to endorse them and engage in behaviors with potentially negative public health consequences.

Relatedly, Farhart and Chen evaluate how COVID-19 conspiracy theory beliefs, racial resentment, and white identity are associated with taking protective health behaviors like mask wearing, social distancing, and vaccination. They combine observational and experimental approaches to assess how aspects of the COVID-19 pandemic and related conspiracies have been racialized, and find that higher levels of conspiracy theory belief decrease compliance with recommended protective health behaviors. In addition, these findings support the view that framing the virus in racialized language alters the endorsement of COVID-19 conspiracy theories, contingent upon racial resentment and white identity levels.

Vitriol and Marsh likewise find in their survey data that COVID-19 conspiracy endorsement is associated with less belief in COVID-19 consensus information, while the latter is highly correlated with taking protective health behaviors. They conduct an experiment—an Illusion of Explanatory Depth paradigm—to observe whether asking respondents to elaborate on the logic of COVID-19 conspiracies undermines these beliefs by exposing them to the limits of their understanding. In fact, this exercise reinforced conspiracy endorsement for a sizable set of respondents, showing how such efforts may backfire in practice.

PSYCHOLOGICAL FOUNDATIONS OF THE INFODEMIC

Gramacho et al. focus on Brazil, one of the country's most heavily exposed to both the pandemic and the infodemic, as a case to explore the influence of political identity on COVID-19 misinformation. The authors find that supporters of the populist Brazilian President, Jair Bolsonaro, are both less knowledgeable about COVID-19 and more likely to believe in COVID-related conspiracies, showcasing the detrimental effects of the politicization of the pandemic in Brazil.

Stecula and Pickup build on previous findings linking news consumption on social media platforms to higher levels of misinformation and conspiracy theory endorsement. Their work examines the moderating role of cognitive reflection, finding heterogeneous associations between social media and conspiracy endorsement. The authors find that getting news from Facebook does increase conspiracy endorsement among respondents, but only among those that are low in cognitive reflection.

Cognitive and social psychology have long established that facts are subject to interpretation. Brotherton and Son rely on this notion to explore the cognitive processes leading to categorize various claims as fact- or opinion-based statements. The identification of these individual forms of metacognition extends the application of motivated acceptance/rejection theories: by assessing the epistemic foundations in the interpretation of claims, the authors unveil a correlation between the subjective agreement with a claim and its interpretation as a fact-based rather than an opinion-based statement.

De Coninck et al. extends the exploration of the psychological correlates of beliefs in conspiracy theories and misinformation about COVID-19. Using a large representative sample from eight countries and administrative regions (Belgium, Canada, England, Philippines, Hong Kong, New Zealand, United States, Switzerland) the authors focus on three alleged predictors of the credibility to COVID-19 misinformation: anxiety, depression, and trust/exposure to traditional and digital media. The study reveals intriguing correlations as well as relevant cross-national differences.

PRODUCTION AND PROPAGATION OF COVID-RELATED POLITICAL MISINFORMATION

A fuller understanding of the COVID-19 infodemic cannot overlook the specific mechanisms of generation and propagation of political misinformation in the digital age.

Hiaeshutter-Rice et al. investigate cross-platform differences in the emotional appeal of COVID-19 related content. The authors collect data from Facebook, Twitter, and YouTube and use computational methods to examine "alternative influencers" who spread misinformation on different social media platforms. The result is a rich, descriptive picture of the emotional and topical prevalence of content shared by these influencers.

Bridgman et al. scrutinize the cross-national propagation of misinformation, focusing on the infodemic pathways connecting the U.S. and Canada. By relying both on representative survey data of Canadian citizens and a large dataset covering Canadian Twitter users between January and July 2020, the authors reveal that most COVID-19 misinformation-related stories retweeted by Canadian Twitter users originated from U.S. accounts. In addition, the authors find that exposure to U.S. information is associated with more engagement with misinformation on social media and higher levels of misinformation endorsement. They also identify an important conditional relationship: the oft-found association between social media usage and misinformation endorsement was strongest among those with a preference for U.S. news.

Disentangling the role of dispositional and contextual factors in the prevalence and acceptability of political misinformation about the COVID-19 pandemic is a critical research challenge of our times. Our Research Topic moves one step forward toward the goal of understanding online and offline political misinformation diffusion, by bringing together diverse approaches and perspectives across the fields of public opinion, political psychology, social psychology, communication, media and social network studies. While the world can expect the COVID-19 virus and pandemic to decline and eventually become endemic (Telenti et al., 2021), we must continue to examine the ways in which social and digital media amplify and accelerate the diffusion of misinformation and conspiracy theories in the information environment so that they subside and do not become endemic as well.

AUTHOR CONTRIBUTIONS

ACKNOWLEDGMENTS

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Encouraging COVID-19 Vaccine Uptake Through Effective Health Communication

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Context: Overcoming the COVID-19 pandemic will require most Americans to vaccinate against the virus. Unfortunately, previous research suggests that many Americans plan to refuse a vaccine; thereby jeopardizing collective immunity. We investigate the effectiveness of three different health communication frames hypothesized to increase vaccine intention; emphasizing either 1) personal health risks, 2) economic costs, or 3) collective public health consequences of not vaccinating.

Methods: In a large (N = 7,064) and demographically representative survey experiment, we randomly assigned respondents to read pro-vaccine communication materials featuring one of the frames listed above. We also randomly varied the message source (ordinary people vs. medical experts) and availability of information designed the "pre-bunk" potential misinformation about expedited clinical trial safety.

Findings: We find that messages emphasizing the personal health risks and collective health consequences of not vaccinating significantly increase Americans' intentions to vaccinate. These effects are similar in magnitude irrespective of message source, and the inclusion of pre-bunking information. Surprisingly, economic cost frames have no discernible effect on vaccine intention. Additionally, despite sharp partisan polarization in public vaccination intentions, we find that these effects are no different for Democrats, Republicans, and Independents alike.

Conclusion: Health communicators hoping to encourage vaccination may be effective by appealing to the use personal and collective health risks of not vaccinating.

Keywords: COVID-19, misinformation, health communication, political psychology, vaccine skepticism, public opinion, public health, COVID-19 vaccine

INTRODUCTION

Ending the SARS-CoV-2 (COVID-19) pandemic will require unprecedented collective action, on a global, national, and sub-national scale. In addition to social distancing and practicing other pro-social health behaviors (e.g., wearing masks in public places), hundreds of millions of Americans must choose to receive a COVID-19 vaccine, once it becomes widely available. By some estimates, up to 70 percent of Americans may need to develop antibodies to the disease -- either through contracting (and recovering from) the disease and/or through inoculation -- in order to put the virus' spread into decline (Bartsch et al., 2020; Britton et al.,2020; Kwok et al., 2020).

Many Americans, however, may refuse a vaccine for COVID-19 once it becomes available. According to recent public opinion research, somewhere between one fifth and one third of Americans do not plan to vaccinate, and many more remain unsure (Callaghan et al., 2020; Thigpen and Funk, 2020). This puts the nation in jeopardy of failing to hit herd immunity thresholds. Consequently, devising health communication strategies that effectively encourage Americans to vaccinate against COVID-19 could have critically important implications for public health. The effectiveness of pro-vaccine health communication messaging tactics could play a key role in determining how quickly the United States is able to resume life "as normal." What these messages might look like, however, and whether or not they will be effective is an open question.

In this paper, we report the results of a novel survey experiment -- embedded in a large and demographically representative survey (N = 7,064) -- which tests the effectiveness of three pro-vaccine messaging tactics ("frames"). Based on previous insights from social psychology, health communication, and political science research, we suspect that Americans will be more likely to vaccinate if they are presented with information highlighting the personal health risks (i.e., the possibility of getting seriously sick), economic costs (i.e., the financial burdens associated with the economy "shutting down" in order to contain the virus' spread), and/or the collective public health consequences (i.e., the possibility of infecting others; including vulnerable populations) of failing to vaccinate.

Additionally, we recognize that these messages -- if and when they are implemented outside of the controlled survey environment -- are likely to vary in both communication source (e.g., whether messages originate from medical experts vs. lay sources) and the amount of information they provide about the process of determining vaccine safety and efficacy via clinical trials (i.e., whether or not they preempt or "pre-bunk" concerns that a vaccine developed in an accelerated timeframe will not be safe and effective). Consequently, we provide a series of exploratory tests investigating whether or not certain sources are more effective at communicating each of the aforementioned frames than others, and whether or not information about the rigors of clinical trials might also increase message receptivity.

Consistent with our theoretical expectations, we find that messages highlighting the personal health risks and collective public health consequences of failing to vaccinate positively and significantly increase vaccination intentions. Exploratory analyses reveal little evidence that the source and/or presence (vs. absence) of clinical trial information influences the effectiveness of these frames. Interestingly, however, we find that economic loss frames are ineffective at moving vaccine intention.

Further, we report preliminary evidence suggesting that, while personal and collective health risk frames are effective at increasing vaccination intentions in the general public, they have (at best) a limited influence in doing the same for those already skeptical about the vaccine's eventual safety and efficacy. This suggests that efforts to influence skeptics' receptiveness to vaccination, ought to consider new and stronger efforts to highlight the vaccine's safety and efficacy.

Our results offer a potential path forward for health communicators hoping to devise messaging strategies aimed at increasing vaccine uptake. In general, our results recommend focusing on either the personal or community health risks of the failure to vaccinate; noting that the latter may be particularly effective at increasing intention among those least likely to vaccinate. Additionally, while messages originating from expert sources are not necessarily less effective, our results consistently document that messages from ordinary Americans' are effective at increasing intended vaccine uptake via these two messaging strategies.

Moreover, in addition to the practical health communication applications of our research, our work substantively advances previous scholarly research on pro-vaccine messaging. Typically, scholars study the efficacy of communication strategies that encourage vaccination against illnesses that have existed for many years, such as childhood vaccines for the measles or vaccines against seasonal influenza. Whether or not insights from previous studies hold amid rapidly changing pandemic conditions, and in response to this particular and novel public health threat, is an open question. Support for our theoretical expectations may help further highlight the generalizability of results from previous social science research. We conclude by discussing how government, non-profit, and other actors might co-opt these lessons into future efforts to increase public willingness to vaccinate against COVID-19.

THE COVID-19 PANDEMIC AND VACCINE HESITANCY

Since its initial introduction to the human population in Wuhan China in 2019, the COVID-19 pandemic has imposed considerable health, economic, and social costs on populations across the globe. By early August in 2020, over eighteen million people worldwide had been confirmed to have contracted the virus, with over 600,000 attributed fatalities in the first six months after widespread transmission (COVID-19 Dashboard, 2020). The United States has faced a disproportionate share of this burden with the most confirmed cases worldwide, and the Centers for Disease Control and Prevention estimating that actual case counts could be somewhere between 6-24 times higher than the confirmed count (Havers et al., 2020).

To combat the growing pandemic, public health officials around the globe have pursued health communication and mitigation strategies to slow the spread of the disease. These efforts have included educating individuals about appropriate hand washing, social distancing, and the symptoms of COVID-19, as well as pressuring politicians at all levels of government to mandate that individuals wear masks (CDC Centers for Disease Control and Prevention, 2020). Critically, however, even with these efforts in place, the disease continues to spread. For that reason, many scholars have suggested that the virus is likely to continue to spread–with disastrous consequences for human health and the economy–until herd immunity is reached through either widespread infection or widespread inoculation

with a novel COVID-19 vaccine (Britton et al., 2020; Callaghan et al., 2020; Kwok et al., 2020).

Perhaps unsurprisingly then, there has been considerable global interest in the development and worldwide dissemination of a successful COVID-19 vaccine. As of July 21, 2020, there were 24 vaccine candidates in clinical evaluation and 142 candidates in preclinical evaluation (WHO World Health Organization, 2020). Despite this considerable effort by the scientific community, however, there is growing concern in the United States that COVID-19 vaccine hesitancy might jeopardize reaching the levels of vaccination needed to achieve herd immunity and end the pandemic. Estimates suggest that somewhere between 40 to 70 percent of Americans will need to develop antibodies to the disease–ideally through a COVID-19 vaccine (Bartsch et al., 2020; Britton et al., 2020; Kwok et al., 2020). Yet, mounting evidence suggests that up to half of Americans either do not intend to pursue a COVID-19 vaccine or are not yet sure about their vaccination intention (Callaghan et al., 2020; Cornwall, 2020).

While research on COVID-19 vaccine hesitancy is in its infancy, early work suggests that COVID-19 vaccine hesitancy is related to but distinct from hesitancy towards other vaccines. Individuals who endorse the anti-vaccine label or who are less trusting of the safety of vaccines generally are more likely to refuse an eventual COVID-19 vaccine (Lunz Trujillo and Motta, 2020). Notably however, large segments of the United States population who are otherwise trusting of vaccines are also hesitant about the COVID-19 vaccine (Lunz Trujillo and Motta, 2020).

COVID-19 vaccine hesitancy is driven by several factors, including concerns about the safety and efficacy of a vaccine developed with unprecedented speed, imprecise messaging from the Trump administration (i.e. Operation Warp Speed), and continual efforts by anti-vaccine advocates to sow doubt in the general public (Cohen, 2020; Hastline, 2020). To this point, research suggests that COVID-19 vaccine hesitancy is highest in the United States among Blacks, women, and conservatives. Conversely, those who place more trust in experts and have been tested for COVID-19 are less likely to be vaccine hesitant (Callaghan et al., 2020).

OVERCOMING VACCINE HESITANCY THROUGH EFFECTIVE HEALTH COMMUNICATION

How Personal, Economic, and Collective Health Risk Frames Could Influence Vaccine Compliance

Overcoming widespread COVID-19 vaccine hesitancy will take a concerted public health messaging campaign that encourages hesitant individuals to vaccine. Past science communication and vaccine hesitancy research offers useful guidance as we work towards identifying effective health messages to increase COVID-19 vaccination intention.

For example, research suggests that the presentation of vaccine safety information from the CDC can reduce misinformation

about vaccination (Nyhan and Reifler, 2015; Vraga and Bode, 2017). Other research suggests that highlighting medical consensus about vaccine safety can also be effective at reducing public concern about vaccination, decreasing belief in misinformation about a link between childhood vaccines and autism, and increasing public support for vaccination (Van der Linden et al., 2015).

Existing research also suggests that efforts to change the attitudes and behaviors of skeptics are more likely to be successful when they recognize and validate the concerns of the individuals that persuasion attempts are aimed at (Kahan, 2010). Demonstrative of this point, recent research suggests that tailored communication strategies can be particularly effective in moving the vaccine hesitant. Specifically, presenting the public with tailored pro-vaccine messages that appeal to (rather than attempt to debunk) psychological aversions to vaccination can be effective at reducing vaccine misinformation (Lunz Trujillo et al., 2020). In the case of COVID-19, this would suggest that efforts to improve vaccination intention may be most successful when they focus not only on the science of vaccine safety and efficacy, but on framing the importance of vaccination in response to issues that Americans think about on a regular basis. In what follows, we consider the potential effectiveness of pro-vaccine messages that appeal to the personal, collective, and economic risks associated with the novel coronavirus.

First, personal risk is a factor that may encourage many Americans to vaccinate, even those who are typically vaccine hesitant. COVID-19 is a highly contagious virus linked with a number of adverse outcomes, including hospitalization, pneumonia, blood clots, septic shock, lung and organ damage, heart failure, acute respiratory failure, and death, among others (Cascella et al., 2020; Long et al., 2020). In the United States, COVID-19 is currently the third leading cause of death, behind only heart disease and cancer (Bean, 2020). Notably, Americans are aware of the adverse effects of COVID-19, and a majority are worried that they will contract the virus (Newport, 2020). Many fear contracting the disease and experiencing negative medical consequences, such as hospitalization or death, particularly for those who are older, have co-morbidities, or work in a profession where COVID-19 exposure risk is higher (Adams and Walls, 2020; Taylor et al., 2020).

Consequently, vaccination messages highlighting the personal health risks associated with the novel coronavirus may encourage vaccine uptake. Personal risk frames are common health communication strategies used to promote healthy behaviors, such as smoking cessation. These strategies are rooted in fears over harm and death. Terror Management Theory (TMT) argues that people engage in predictable psychological coping mechanisms when mortality is salient, i.e., when people are aware that death is inevitable and can happen at any time (Becker, 1973; Greenberg et al., 1986). Existing research finds that highlighting the potential for death or harm in oneself and others will push people to adopt healthier attitudes and behaviors when the trigger (in our case: COVID-19) is consciously linked with the threat of death or bodily harm (e.g., Arndt and Goldenberg, 2017; Haglin et al., 2019).

Therefore, we expect that a frame highlighting personal risk should be effective in bolstering intention to receive the COVID-19 vaccine:

> H1: Exposure to messages highlighting personal risk of failing to vaccinate against COVID-19 will increase the intention to vaccinate against COVID-19, on average, compared to exposure to a control message.

Similarly, we also expect that frames highlighting how a COVID-19 vaccine will minimize risk to the collective health of the population will be effective in increasing people's intention to vaccinate. This is particularly true given that the serious complications related to contracting COVID-19 disproportionately affect certain at-risk subsets of the population. Members of the public who are not part of these groups may feel less motivation to vaccinate against COVID-19. Therefore, vaccination uptake may also depend on eliciting pro-social sentiments in the general public. A previous study encouraging influenza vaccination found that individuals exposed to pro-social messages–in the form of describing potential flu victims who could have serious adverse effects if others do not vaccinate–were more likely to intend to vaccinate; , including those who had previously refused to vaccinate (Li et al., 2016). Similarly, those who are more self-transcendent (more likely to put others' needs before their own) are more likely to engage in social distancing measures to prevent the spread of COVID-19 (Motta and Goren, 2020; see also; Van der Linden et al., 2020).

Consequently, engaging people's sympathies to think about the consequences of failing to vaccinate as a risk to vulnerable populations may be effective in shifting COVID-19 vaccination intention:

> H2: Exposure to messages highlighting the collective health consequences of failing to vaccinate against COVID-19 will increase the intention to vaccinate against COVID-19, on average, compared to exposure to a control message.

Finally, we expect that highlighting the economic risks of failing to receive a COVID-19 vaccine will be effective in increasing people's intention to vaccinate. The economic impact of COVID-19 has been devastating, with millions of Americans forced into unemployed at rates surpassing the Great Recession and leaving many states with little choice but to pause reopening the economy due to a recent surge of the virus (Kochar, 2020; Reimann, 2020).

Most behavioral health research on vaccinations has focused on providing positive economic incentives to entice individuals to vaccinate. For example, research suggests that economic incentives can be a powerful motivator for vaccination behavior, pushing the hesitant and complacent towards vaccinating (Betsch et al., 2015; Bohm et al., 2016). Similarly, in a review, Kane et al. (2004) found that incentives (e.g., cash payments, gifts, lotteries) can influence behavior when the tasks participant are asked to complete are simple (i.e. immunization) versus more complex like maintaining a diet. Although less work has focused on the effects of economic loss on vaccine uptake,

insights from Prospect Theory–i.e., the idea that people tend to place higher value on losses compared to equally sized gains (see: Kahneman, 2011 for a review)–lead us to suspect that insights gleaned from research on positive incentives also apply to *negative* economic outcomes. Consequently, we expect that emphasizing link between a failure to vaccinate and an individual's economic security (e.g., being able to go back to work, stimulating the macro-economy) rather than an economic incentive message could encourage individuals who are hesitant to receive a COVID vaccine to get one when one becomes available.

> H3: Exposure to messages highlighting the economic risks of failing to vaccinate against COVID-19 will increase the intention to vaccinate against COVID-19, on average, compared to a control message.

Taken together, existing research offer several possible paths forward for reducing COVID-19 vaccine hesitancy. Our analysis serves as a first investigation of some of these strategies in the context of the pandemic–studying the potential influence of frames that highlight either personal health risks, the collective health risks, or the economic imperatives of vaccinating.

How the Source of Pro-vaccine Messages Could Influence Compliance

In addition to the aforementioned differences in pro-vaccination arguments (frames), we recognize that messages are also likely to vary in their source (i.e., who is responsible for communicating the message). Doctors and other medical experts may seem like intuitive and potentially effective communicators for messages emphasizing the medical and broader social benefits of a COVID-19 vaccine. However, the reality may be more complex. On the one hand, most Americans trust their personal physicians and the broader medical community to provide them with accurate information about COVID-19 (Funk, 2020; Sanger-Katz, 2020).

On the other hand, however, trust in scientific experts is far from unanimous (Gauchat, 2012; Motta, 2018), and those who distrust scientific experts have been shown to be particularly resistant to evidence-based messaging originating from expert sources (e.g., Merkley, 2020). Correspondingly, as White House Coronavirus Task Force Director Dr. Anthony Fauci recognized in a May 2020 interview, anti-science attitudes pose a potential threat to expert-sourced health communication about a vaccine for COVID-19 (Cohen 2020). Therefore, the CDC plans to -- in Fauci's words -- present Americans with pro-vaccine messages from "people they can relate to in the community."

Although we think it is important to account for differences in message source when testing the effectiveness of different pro-vaccine arguments, we are somewhat agnostic as to whether or not expert (e.g., medical doctors presenting scientific facts) or lay (e.g., ordinary people recounting their experiences with the virus) sourced arguments will be more effective at encouraging vaccine uptake. With that in mind, we propose RQ1a-b.

RQ1: Will expert (vs. lay) sourced pro-vaccine messages (a) be more effective at increasing intention to vaccinate across message frames, and/or (b) when paired with specific message frames?

Additionally, we recognize that messages are likely to vary in the amount of information they provide about the safety and efficacy of clinical trials. Operation Warp Speed is promising to deliver a COVID-19 vaccine for public consumption in a record time frame (Cohen, 2020), and has raised public concerns about whether or not the final product (s) may be "rushed" to market (Hastline, 2020). As a result, communicators may try to preempt this concern via inoculation (McGuire, 1961), also referred to as "pre-bunking."

In a pre-bunking communication paradigm, communicators recognize the potential for the public to be misinformed about (in this case) the rigors of clinical trials, and attempt to provide them with information to the contrary. Pre-bunking has been shown to be effective at reducing misinformation about climate change (Cook et al.,2017; Van der Linden et al., 2017) and public health (see: Compton et al., 2016 for an extensive review), and has been suggested as a potential communication mechanism for combating misinformation about the novel coronavirus (Habersaat et al., 2020; Van Bavel et al., 2020).

However, pre-bunking necessarily implies providing the public with the very misinformation it hopes to counteract (similar to inoculation on a biological level). It therefore risks potentially "backfiring;" e.g., that people accept the misinformation presented; see (Caulfield, 2020). Additionally, it is unclear whether or not pre-bunking efforts are successful at moving opinion about the novel coronavirus; for which concerns about the rigors of clinical trials, given widespread public attentiveness to the virus (Jurkowitz and Mitchell, 2020), may already be highly salient. Further, some studies suggest that fact-based (as opposed to logic-based) pre-bunking efforts may fail to move opinion (e.g., Vraga et al., 2020).

Consequently, it is unclear whether or not messages that attempt to preempt concerns about the speed of vaccine development will be effective at increasing vaccine intentions. It is also unclear whether or not pro-vaccine messages paired with that information might be comparatively more effective than messages not including that information. With this in mind, we propose RQ2:

RQ2: Will pre-bunking efforts (a) be more effective at increasing intention to vaccinate across frames, and/or (b) when paired with specific message frames?

Could Partisan Polarization in Vaccination Intentions Moderate Treatment Effects?

Finally, as some recent perspectives on the 2020 US general election have noted (e.g., Motta, 2020; Tyson et al., 2020), COVID-19 vaccination intentions have become highly politicized (see also: Callaghan et al., *n.d.*). Whereas about three quarters of Democrats and Republicans alike planned to receive a vaccine at the pandemic's early stages (April 2020), Republicans' intentions to

vaccinate dropped off substantially from June through September (Motta, 2020; see also O'Keefe, 2020).

This trend appeared to *reverse* however, by early Fall, as partisan elites came to take clearer positions on vaccine-related issues. Following an uptick in elite polarization in vaccine-related rhetoric–e.g., President Trump's (the Republican candidate) frequent promise to deliver a vaccine by Election Day; Senator Harris' (the Democratic candidate's running mate) apprehension to receive a vaccine approved by the Trump administration, as noted in the cycle's Vice Presidential Debate; and concerns that the Trump administration might pressure government agencies to pursue emergency use authorization for a vaccine prior to the conclusion of clinical trials–Republicans' vaccination rebounded, while Democrats' intentions fell sharply, in October 2020 (Motta, 2020).

Consequently, we might ask whether or not the treatment effects we expect to observe (see above) might vary by political partisanship. As our study was conducted in mid June 2020 (more on this shortly), we might expect Republicans to be less receptive than Democrats to our messages. This possibility could have important and negative consequences for vaccine uptake, as it would imply that a substantial portion of the American population might miss our efforts to encourage vaccination. Consequently, we pose the following research question:

RQ 3: Will the efficacy of pro-vaccination messages that vary in source, frame, and/or the inclusion of pre-bunking information be more effective for Democrats, vs. Republicans?

Experimental Design

To test our theoretical expectations, we devised a large survey experiment varying three different aspects of COVID-19 vaccine promotion messages. Respondents were randomly assigned to read a short pro-vaccine opinion piece, varying 1) the frame (personal health risks, collective public health consequences of not vaccinating, and economic costs), 2) the message source (i.e., lay vs. expert sources), and 3) the presence or absence of pre-bunking information highlighting the rigors of clinical trials prior to reading the opinion piece. A final group of respondents, serving as our control group, were randomly assigned to receive none of these messages, and instead read a short story about baseball.

All respondents not assigned to the control group were told that we would like them to "read a short newspaper opinion piece about the importance of receiving a COVID-19 vaccine, when it becomes available." Respondents assigned to receive pre-bunking information about the rigors of clinical trials were also told that "even though the vaccine is likely to be developed in an accelerated time frame," that it will nevertheless undergo rigorous clinical testing. In those conditions, we told respondents that "this means that scientists will observe whether or not people experience side effects from the vaccine right away, as well as over the course of several months."

Table 1 summarizes the key elements of our experimental design, including the number of respondents assigned to each of the twelve conditions (a 3 × 2 × 2 design), and the title of each opinion piece. Full text for each experimental treatment

TABLE 1 | Experimental design summary

Frame	Source (lay)	Source (expert)

Personal health risk
    No clinical trial info
    N = 504 (lay)
    N = 522 (expert)
	Thinking about skipping the COVID-19 vaccine? Take it from someone who had the virus: That's a bad idea	Thinking about skipping the COVID-19 vaccine? You're putting your health at risk

Clinical trial info
(pre-bunk)
    N = 497 (lay)
    N = 546 (expert)
	Corey Miller is an accountant from Austin, TX, who suffered complications from the novel coronavirus in March 2020	Dr. Corey Miller is a Medical Doctor at the University of Texas – Austin

Economic costs
    No clinical trial info
    N = 505 (lay)
    N = 485 (expert)
	Thinking about skipping the COVID-19 vaccine? Take it from someone who lost their job: That's a bad idea	Thinking about skipping the COVID-19 vaccine? Prepare for a slower economic recovery

Clinical trial info
(pre-bunk)
    N = 510 (lay)
    N = 471 (expert)
	Corey Miller is an accountant from Austin, TX, who suffered job loss as a result of the novel coronavirus in March 2020	Dr. Corey Miller is a Professor in the Department of Economics at the University of Texas–Austin

Collective health
consequences
    No clinical trial info
    N = 496 (lay)
    N = 506 (expert)
	Thinking about skipping the COVID-19 vaccine? Tell that to people who depend on you to get vaccinated	Thinking about skipping the COVID-19 vaccine? Prepare for more deaths and hospitalizations

Clinical trial info
(pre-bunk)
    N = 493 (lay)
    N = 533 (expert)
	Corey Miller is an accountant from Austin, TX, who is currently undergoing chemotherapy treatments for lung cancer	Dr. Corey Miller is an Austin, TX based Pharmaceutical Consultant for Johnson and Johnson, a United States. company developing a vaccine for COVID-19

condition can be found in the **Supplementary Material**. Note also that we gave all fictitious sources the same name, one that we selected as to not clearly identify the communicator's gender. We also attributed all sources to be from the same geographic location (Austin, Texas) in order to standardize perceptions of "on the ground" COVID prevalence in each area; e.g., because communicators discussing personal risks may be more/less likely to be dismissed, based on whether or not they live in a place where COVID is comparatively more prevalent. As a "blue" (politically liberal) city in a "red" (politically conservative) state, Austin also helps us avoid the possibility of source/message discrediting on the basis that the disease' prevalence and severity is a "blue" or "red" area problem -- a point of popular contention at the time we fielded this study (e.g., Bump, 2020).

In addition to the design elements summarized in **Table 1**, we clarify that this is an *intent to treat* experimental design. We required that all respondents–irrespective of experimental condition, and including those assigned to the control condition–spend at least 15 seconds on the page containing our short opinion piece (or the baseball story, in the case of the control).

Finally, balance tests included in the **Supplementary Material** (Supplementary Figure S1) reveal that our randomization protocol produced treatment groups that were highly similar in both demographic composition (e.g., age, race, gender, educational attainment), and their prior attitudes toward COVID vaccine safety. We find statistically significant evidence of imbalance in just two out of twelve conditions (both of the personal health risk appeals originating from medical experts), and on just one demographic dimension (gender). Consequently, (Supplementary Table S3) in the **Supplementary Material**, we replicate all analyses presented in

the main text conditioning on respondents' gender, and uncover an identical pattern of effects.

Data and Measures
Data for this study come from a demographically representative survey sample of N = 7,064 United States adults, recruited between July 8-20, 2020. Respondents were invited to participate in our survey via Lucid Theorem's large online opt-in panel via quota sampling, in order to ensure demographic representativeness on respondents' age, race, gender, educational attainment, income, and geographic region. Lucid initially invited N = 10,020 individuals to participate in this study, yielding a completion rate of 70%. Further, Lucid data has been found replicate demographic and experimental findings, and that Lucid samples are more nationally representative than traditional convenience samples on various demographic, political, and psychological factors (Coppock and McClellan, 2019). Researchers in public health and health politics have previously published papers using Lucid data (e.g., Callaghan et al., 2019; Lunz Trujillo et al., 2020).

The key outcome variable in our analyses is an indicator of whether or not respondents intend to vaccine against COVID-19, once a vaccine becomes available. Respondents were asked "When a vaccine for the novel coronavirus (COVID-19) becomes widely available, how likely are you to request to be vaccinated?" Respondents then indicated whether or not they are "very likely," "somewhat likely," "not too likely," or "not likely at all" to vaccinate. We score this variable to range from 1-4, such that a score of 4 indicates being "very likely" to vaccinate.

We note that just 42% of respondents indicated that they were "very likely" to get vaccinated, while an additional 30% indicated

FIGURE 1 | Independent effects of frame, source and clinical Info. Cue (pooled). Note. Ordered logistic regression coefficients presented, with 95% confidence intervals. Outcome variable is an ordinal indicator of COVID-19 vaccine intention (with higher scores reflecting increased intention to vaccinate). Coefficients which do not intersect with the dashed red line are statistically significant from control group effects at the p < 0.05, level (two-tailed). Results are derived from three models (denoted by different shapes, in the figure) which regressing vaccine intention on indicators denoting assignment to each design element listed on the left-hand side of the figure; pooled across all other design elements.

that they are somewhat likely to do so. Note also that we include the term "request" in this question, as vaccinating against COVID-19 entails, for most adults, actively choosing to vaccinate, during a period designated by state and local governments, and making appropriate logistical preparations therein.

The primary independent variables in our analyses are binary indicators of the experimental conditions to which respondents were randomly assigned (see: **Table 1**). To study the effects of each design element in isolation, we at times pool (or "collapse") these indicators across all other design elements. For example, combined indicators denoting assignment to each of the three frames we varied pool across both sources and the presence/absence of a pre-bunking text. To study the effects of each design element *in context,* we create twelve dichotomous indicators of assignment to each of the cells listed in **Table 1**, with the control serving as a reference group in all analyses.

Finally, to assess whether or not our messaging strategies are effective at encouraging vaccination among those most skeptical of a potential COVID vaccine's safety and efficacy, we asked respondents: "When a vaccine for the novel coronavirus (COVID-19) becomes widely available, do you think that its potential benefits will outweigh potential risks, that its potential risks might outweigh potential benefits, or haven't you thought much about it?" This question was administered prior to our experimental treatments. For analytical simplicity, and to preserve a sufficiently large sample size in each experimental

treatment condition, we dichotomize respondents as being "COVID vaccine skeptics" if they either indicate that the vaccine's risks will outweigh its benefits, or if they haven't thought much about the issue. Scored this way, 54% of our sample are skeptical of the vaccine's safety.

RESULTS

Pooled Framing Effects

We begin our analysis by offering an assessment of whether or not each framing tactic–independently of each other design element alteration–was effective at increasing the general public's intentions to get vaccinated against COVID-19. In this initial and "fully aggregated" approach, we isolate the effects of each framing alteration by pooling all other varied elements together.

Figure 1 displays the results of an ordered logistic regression model regressing the four-point vaccine intention variable on an indicator of experimental framing condition assignment (rows 1–3), pooled across source and clinical trial information manipulations. These serve as an initial test of Hypotheses 1–3. Hollowed circles correspond to the unique effects of each frame, with 95% confidence intervals extending from each one. Estimates which fall to the right of the dashed line, and whose confidence intervals do not intersect with it, suggest a statistically significant increase in vaccine intention.

We replicate this approach to isolate the unique effects of message source (rows 5–6) and whether or not the message included information about the rigors of clinical trials (rows 7–8). These serve as initial tests of RQ1a and RQ2a. The presence of significant effects in these more-exploratory analyses could point us in the direction of potential message effectiveness moderators to consider when disaggregating design elements, later on. We note that all p values presented in the pages that follow are two-tailed.

Figure 1 demonstrates that both the personal health risk frame (B = 0.19, $p < 0.01$) and collective public health consequences frame (B = 0.14, $p = 0.05$) are positively and significantly associated with increased intention to vaccinate. This provides strong evidence in favor of H1 and H2.

Of course, ordered logistic regression coefficients provide little sense of the substantive magnitude of these effects. Consequently, we present predicted probabilities that reflect the increase in indicating that respondents are "very likely" to vaccinate in each of these treatments (vs. the control). We focus on the "very likely" ordinal category, as we expect these individuals to be the most likely to intend to vaccinate, once a vaccine becomes available.

Substantively, assignment to the personal health risk frame (pooled across conditions) is associated with a 5% increase in the likelihood that respondents are "very likely" to pursue the vaccine; from 39% in the control group, to 44% to those assigned to read messages with this frame. Likewise, assignment to the collective health consequences condition is associated with a 4% increase in indicating that respondents are "very likely" to receive the vaccine, from 39% in the control to 43% in this frame.

Surprisingly, and contrary to our expectations, we find no evidence that economic frames are effective at moving vaccine intention. While the economic frame did nudge respondents in a

FIGURE 2 | Fully Disaggregated treatment Effects. Note. Ordered logistic regression coefficients presented, with 95% confidence intervals. Outcome variable is an ordinal indicator of COVID-19 vaccine intention (with higher scores reflecting increased intention to vaccinate). Coefficients which do not intersect with the dashed red line are statistically significant from control group effects at the p < 0.05, level (two-tailed). Results are derived from a model regressing vaccine intention on indicators denoting assignment to each source, by frame, by clinical information manipulation listed on the left-hand side of the figure.

Disaggregated Framing Effects

Next, we consider the possibility that the framing effects observed in **Figure 1** may be more efficacious when originating from expert or lay sources (RQ1b), and/or when featuring (or not featuring) pre-bunking information about the rigors of clinical trials (RQ2b). **Figure 2** presents the results of an ordered logistic regression model regressing vaccine intentions on our fully disaggregated treatment indicators (see: **Table 1**), and is otherwise analogous in interpretation to **Figure 1**.

The results suggest that, among conditions that featured no pre-bunking information, appeals to the personal health risks of not vaccinating were positively and significantly associated with increased vaccine intention for both expert (B = 0.28, $p < 0.01$) and lay (B = 0.22, $p = 0.03$) sources. Both of these effects were substantively similar in size, leading to a 7% and 6% increase in the likelihood of being "very likely" to receive the vaccine, respectively.

Additionally, among the conditions featuring no pre-bunking manipulation, we find that while both expert (B = 0.08) and lay (B = 0.20) sourced messages about the collective health risks of failing to vaccinate are associated with increased vaccine intentions, the effects are only statistically significant for the latter ($p = 0.05$). Exposure to lay messages about the collective health risks of not vaccinating are associated with a 5% increase in the likelihood of being "very likely" to vaccinate.

Among conditions that do feature pre-bunking information, we uncover only one statistically significant increase in vaccine intention across variations on the source and arguments presented in each message. In this case, only messages emphasizing the collective health risks of failing to vaccinate, sourced by ordinary people, produced statistically significant increases in vaccine intention (B = 0.19, $p = 0.05$). This is perhaps unsurprising, given the slight decrease in message effectiveness we noted when addressing RQ2a when presenting pooled experimental effects in **Figure 1**. Further, as we might also expect based on the pattern of results presented in **Figure 1**, we uncover no statistically significant effects of messages including frames concerning the economic costs of not vaccinating.

Taken together, the disaggregated results suggest that the effectiveness of messages emphasizing personal health risk–and, to a lesser degree, collective health risks–are consistent across message sources. However, the addition of information designed to assuage respondents' potential fears about the safety of expedited clinical trials appear to have weakened treatment effects across the board. Of course, we hesitate to discredit messaging strategies on the basis of post hoc conclusions about differential source or clinical trial information, and recognize that our messaging strategy is just one of many that health communicators might employ.

Of course, we caveat that the effects observed in **Figures 1**, **2** increase the likelihood that people opt to vaccinate by just a handful of percentage points. While we recognize that these effects are small in substantive magnitude, we also recognize that–as noted earlier–the rate at which Americans intend to vaccinate aginst COVID-19 is precariously close to the compliance threshold necessary to achieve population immunity. Consequently, we believe that even effects that are small in substantive magnitude could play an instrumental role in putting the spread of COVID-19 into decline.

pro-vaccination direction (B = 0.02), the effect was not statistically distinguishable from zero ($p = n.s.$).

Concerning our research questions, **Figure 1** presents no evidence in favor of the idea that sources originating from expert (vs. lay) sources -- pooled across all other design elements -- vary in their effectiveness (RQ1a). Vaccination intention was not significantly different from that of the control group for respondents assigned to read messages from either lay or expert sources (in both cases, B = 0.12, $p = n.s.$).

Moreover, while we find that pre-bunking information (RQ2a) is positively associated with increased vaccination intention (B = 0.10), the effects were not statistically significant ($p = n.s.$). In fact, we find some evidence in favor of the idea that *not* including pre-bunking information is associated with increased vaccination intention, versus the control group (B =0.13, $p < 0.05$). However, we caution that these differences do not necessarily *rule out* the potential effectiveness of pre-bunking; given the overlapping confidence intervals presented in **Figure 1**.

On balance, then, across the results presented in **Figures 1**, **2**, we conclude that–based on how we formulated each design element in the present study–messages emphasizing the personal and collective health risks of not vaccinating are particularly efficacious at increasing vaccine intention; especially if those messages originate from non-expert sources, and avoid discussing attempting to preempt concerns about the rigors of clinical trials.

Moderation by Political Partisanship?

Additionally, given documentation of COVID-19 vaccine politicization, we ask (RQ3) whether or not the effects documented thus far might be substantively and/or statistically *stronger* for self-identified Democrats (vs. Republicans). To test this, we interacted each treatment indicator presented in **Figures 1**, **2** with a standard seven-point measure of partisan identification (ranging from 1 = Strong Democrat to 7 = Strong Republican).

In analyses (**Supplementary Table S4**) presented in the **Supplementary Material**, we find no evidence that our treatment effects were moderated by political partisanship. Across both the pooled (see: **Figure 1**) or fully disaggregated models (see: **Figure 2**), all interactions fail to even approach statistical significance at the p = 0.10 level, two-tailed. Consequently, while it is certainly the case that vaccine intentions were a politically polarizing issue at the time we conducted our study, we find no evidence that these differences influenced treatment effectiveness.

Subgroup Analyses for COVID Vaccine Skeptics

Finally, we conclude our analysis by considering whether or not any of the experimental manipulations presented thus far might be effective at winning over individuals who are skeptical that a vaccine for COVID-19 will be safe and effective. As this group may be particularly likely to refuse vaccination, we think that is important to consider whether or not some messages may be more effective than others at winning over this group.

Supplementary Tables S2 replicates the models used to build **Figures 1**, **2** (respectively), limiting analysis to just individuals who express hesitation about the relative benefits of a COVID-19 vaccine, relative to its potential risks. Note that we do not interact our binary indicator of COVID vaccine skepticism with assignment to each experimental condition, as we are less interested in whether or not treatments are comparatively more or less effective for this group; we would expect skeptics, across the board, to be less receptive to persuasive messaging attempts of all varieties than those who are less skeptical. Instead, we aim to determine whether or not any of these messaging strategies are effective at all at increasing vaccination intentions for this group.

Both the pooled and disaggregated (**Supplementary Tables S1**) results suggest that our treatments had a limited influence on vaccination intentions for vaccine skeptics. We find that just one treatment–messages originating from lay sources, emphasizing the collective health risks of failing to vaccinate, and that feature pre-bunking information about the rigors of expedited clinical

trials–was significantly associated with increased vaccination intention (B = 0.27, p = 0.04).

These results suggest that, while personal and collective health risk frames are generally effective at convincing Americans to consider vaccinating against COVID-19, these effects are likely limited to those who do not question the vaccine's potential safety and efficacy. As a result, efforts to bolster public trust in the vaccine, once it becomes available, could prove critical in influencing public receptiveness to the types of messages we study in this research. Consistent with this view, we note that the lone manipulation successful at moving vaccination intention for skeptics is one that provided information about the safety and efficacy of expedited clinical trials.

CONCLUSION

In this study, we find that messages emphasizing the personal risks of failing to vaccinate against COVID, as well as the potential collective public health consequences of low vaccine uptake, are effective at convincing Americans to plan to get a COVID vaccine, once one becomes available. These effects are similar for Democrats, Republicans, and Independents alike. Consequently, we recommend that health communicators aiming to boost COVID vaccine uptake consider employing one or both of these frames as part of their strategic communication efforts.

Exploratory analyses reveal that both lay and expert sources can communicate these messages effectively, although we find some evidence in favor of the idea that "ordinary people" may be comparatively more effective. In addition, we note that attempts to preempt (via pre-bunking) concerns about the rigors of clinical trials offer no discernible benefit above not providing this information, and find preliminary evidence suggesting that pre-bunking may limit the effectiveness of personal and public health frames. Finally, we find little evidence that frames highlighting the economic costs of failing to vaccinate are effective at increasing vaccine intention. This is somewhat surprising, given the pandemic's far-reaching economic consequences, and the effectiveness of similar appeals documented in previous research.

Of course, we want to be cautious and note some important limitations of this study, and our recommendations for future health communication efforts. First, our study is necessarily limited in not only the message design elements it alters (framing, source, and pre-bunking appeals), but also in the design of each of those elements themselves. While we are confident that the personal and collective health risk frames presented in this piece are indeed effective, we of course cannot rule out the possibility that 1) other variations of these frames are equally or more effective, 2) that messages similar to ours communicated by different expert vs. lay sources might differ from the disaggregated results presented in **Figure 2** (e.g., by varying expert/lay sources within frames), and/or 3) that other frames not considered in this piece might also be effective at moving intention.

Relatedly, we cannot, in this piece, offer up a particular communication approach as being comparatively more effective

than others that we find to be effective in boosting vaccination intentions. As **Figures 1**, **2** demonstrate, several communication efforts boost vaccination intentions more than we would expect by random chance. However, none of the efforts we deem effective at boosting vaccination intentions are statistically distinguishable from one another. Consequently, although effect sizes may differ in magnitude, we consider all statistically significant treatment effects to have a similar substantive effect on vaccination intentions, relative to taking no action at all.

We also caution that the language that expert vs. non-expert sources use in these messages necessarily varies across treatments. Consequently, we cannot definitively rule out the possibility that effects related to message source that we observe may be influenced in part by rhetorical style. In particular, our study cannot guarantee that effects attributed to messages sourced by ordinary people may be, at least in part, the result of those messages being more personal in their substantive focus. While our treatments avoid the use of medical and statistical jargon in the experimental conditions (please see the **Supplementary Material** for full treatment text), we nevertheless urge caution when interpreting these results; especially those related to message source.

Despite these limitations, we are able to make recommendations about what does effectively increase vaccine intention. However, we are hesitant to rule out the possibility that what does not appear to do so in our study might be more effective under other conditions. We see our research as not the final word on how to effectively boost COVID vaccine uptake, but instead as a starting point for future efforts to unpack the conditional effectiveness of personal and collective public health risk frames, and to consider altering other design elements not presented in this paper. Conjoint experiments may be a particularly useful route for testing these possibilities in future research by varying exposure to dozens of different design elements -- paired with alterations within each design element -- to a sufficiently large sample.

Given the importance of widespread vaccination against COVID-19, several additional directions for future research are particularly important to pursue. First, while our analysis suggests that messages from ordinary Americans and experts can both be effective (with slightly better outcomes for ordinary individuals), more work is needed to determine if certain types of communicators within each category are better at conveying messages that others. On the non-expert side, understanding the value of contextual cues of the messenger (e.g., gender, partisanship, and race) will be critical to identifying the best communicators for the importance of vaccination. So too might the role of celebrity endorsements for pro-vaccine messages; a tactic the CDC has considered pursuing. On the expert side, it will be similarly important to understand for example if a message from Dr. Anthony Fauci is perceived as more or less effective than a message from the CDC, Dr. Deborah Birx, or any of the other experts involved in COVID-19 health communication.

Beyond message sources, additional research is also needed to determine how repeated message exposure and exposure to countervailing messages influence vaccination intention. While our experimental design is useful for isolating the effectiveness of specific pro-vaccine messages, we cannot capture the complexities of an information environment in which people will be presented with competing pro and anti-vaccination messages. Future research would benefit from exploring how COVID-19 vaccination messages interact and influence behavior.

Finally, it is critical to acknowledge that our experimental design did little to alter the planned behavior of individuals who were skeptical of the vaccine's safety and efficacy. Improving vaccination among those most hesitant could prove vital to reaching the immunization rates needed to achieve herd immunity. Future research should explore additional messaging strategies to improve vaccination intention in this group. Prior research by Lunz Trujillo et al. (2020) suggests that it could be particularly valuable to understand *why* skeptics are hesitant to vaccinate and to design targeted interventions to appeal specifically to these harder to move individuals. Given the safety and efficacy concerns of individuals in this hesitant group, particular emphasis could be placed on interventions designed to ease safety and efficacy concerns.

Even with these limitations and directions for future research however, our study provides a critical step forward in our understanding of how to improve COVID-19 vaccination compliance. Our research suggests that both lay and expert health communicators can improve vaccination rates by highlighting the personal health risks and collective public health consequences of COVID-19 vaccination, while suggesting that economic arguments may be less effective. Consequently, we hope to help to inform strategic health communication efforts to encourage the widespread vaccination necessary to stop the spread of COVID-19 and end the global pandemic.

DATA AVAILABILITY STATEMENT

The datasets generated for this study can be found here: https://osf.io/2t9zb/

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Utah Valley University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MM, SS, TC, and KL-T were Responsible for project conceptualization, research design, and manuscript writeup. MM was also responsible for data cleaning, analysis, and preparation of the supplementary materials.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.630133/full#supplementary-material.

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Metacognitive Labeling of Contentious Claims: Facts, Opinions, and Conspiracy Theories

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Congenial information is often judged to be more valid than uncongenial (but otherwise equivalent) information. The present research explores a related possibility concerning the process by which people label a claim as fundamentally factual (open to proof or disproof) or opinion (a matter of personal preference not amenable to falsification). Rather than merely being more skeptical of uncongenial claims, uncongenial claims may be metacognitively categorized as more opinion than factual, while congenial claims may be more likely to be categorized as factual. The two studies reported here attempt to trace a preliminary outline of how claims are categorized as fact, opinion, or some mix of the two in the context of mundane claims, contentious political issues, and conspiracy theories. The findings suggest that claims are more likely to be labeled factual (and, to a lesser extent, are less likely to be labeled opinion) to the extent that one subjectively agrees with the content of the claim. Conspiracy theories appear to occupy a middle-ground between fact and opinion. This metacognitive approach may help shed light on popular debate about conspiracy theories, as well as seemingly intractable political disagreements more generally, which may reflect fundamental differences in the perceived epistemic foundations of claims rather than simple disagreement over the facts of the matter. Given limitations of the stimuli and participant samples, however, it remains to be seen how generalizable these findings are.

Keywords: conspiracy theories, metacognition, beliefs, politics, misinformation, motivated cognition

1. INTRODUCTION

> "I had to deny knowledge in order to make room for faith."
> —Immanuel Kant, *Critique of Pure Reason*, 1781

> "You are very fake news."
> —T-shirt slogan, 2018

Information and experiences are frequently open to interpretation. Hastorf and Cantril (1954) demonstrated that a rough college football game was interpreted substantively differently by supporters of each side; one side tended to see a fair game while the other saw unsporting behavior from the rival team. Kahan et al. (2012) demonstrated a similar phenomenon experimentally, using video footage of a politically contentious protest and manipulating participants' understanding of the protesters' stance. Participants' perceptions of the protest tended to align with their prior

political convictions. Those who disagreed with the stance of the protesters saw their behavior as unacceptably disruptive, and potentially even violent, while those who agreed with the stance of the protesters saw it as a non-violent exercise of freedom of speech. This kind of motivated political reasoning has been demonstrated in many studies (Ditto et al., 2019). Diverging interpretations of information arguably reflects *motivated* cognition, in which prior beliefs influence the perceived meaning or validity of information (e.g Dunning, 2015). Yet *meta*cognition may also play a role. Rather than simply questioning the validity of uncongenial facts, partisans may categorize uncongenial claims as fundamentally less *matters of fact* (which can be proven or disproven) than articles of *opinion* or *faith* (expressions of personal preference or ideology which cannot be proven or disproven). Similarly, congenial opinions or ideological statements may take on the appearance of fact. To date, little research has investigated the metacognitive processes underlying the subjective categorization of statements as fact and opinion. How does one determine whether a claim one encounters—or a belief of one's own—is factual knowledge, personal opinion, or an article of faith? The current research attempts to trace a preliminary outline of this metacognitive belief-categorization process in the context of mundane claims, contentious political issues, and conspiracy theories.

Kant (1781) articulated the traditional wisdom that there are three ways of believing something to be true: possessing factual knowledge (Wissen), holding an opinion (Meinen), and maintaining faith (Glauben) (see Stevenson, 2003). Contemporary psychological research provides evidence that such a distinction is psychologically meaningful and consequential. Children as young as five differentiate statements of fact, opinion, and religious belief, allowing that different people can hold differing opinions but that in disagreements over matters of fact typically only one person can be right (Heiphetz et al., 2013). Children and adults also perceive the different categories of expression as revealing different qualities about the speaker and about the world. For example, "The Nile is the longest river," is judged to reveal something about the world, but little about the personal characteristics of the claimant. "The Nile is the most beautiful river," appears less informative about the world, but more revealing about the preferences of the claimant (Heiphetz et al., 2014). Correspondingly, opinions are judged to be more biologically-based while factual beliefs are seen as learned (Heiphetz et al., 2017). Religious claims, such as "God answers prayers," appear to occupy a middle-ground between fact and opinion, intermediate in terms of their perceived basis in biology, openness to disagreement, and providing information both about the world and about the characteristics of the speaker (Heiphetz et al., 2013, 2014, 2017; see also Van Leeuwen, 2014; Levy, 2017).

Such research supports the distinction between modes of belief articulated by Kant (1781), and raises questions about *how* individuals categorize statements as factual, opinion, or a matter of faith. Metacognition, at its core, is knowledge about one's own knowledge; i.e., a person's ability to evaluate their own thoughts and to organize the information that they receive (Dunlosky and Bjork, 2008; Metcalfe et al., 2020). Our metacognition faculties

allow us to discriminate between what we know and do not know (Metcalfe and Son, 2012; Kornell and Finn, 2016), what we can learn and what may be impossible to learn (Son and Sethi, 2010; Bae et al., 2020), what is real and what is imagined (Buda et al., 2011; Dehaene et al., 2017), and in the current examination, what is fact and what is opinion.

Research examining the developmental trajectory of the ability to differentiate factual, opinion-based, or religious statements has used deliberately simple, unambiguous stimulus statements (Heiphetz et al., 2013, 2014, 2017). In everyday life, labeling claims as factual or opinion is more challenging, presenting opportunities for miscategorization. A survey by the Pew Research Center examined Americans' perceptions of realistic political statements (Mitchell et al., 2018). Participants were asked, "Regardless of how knowledgeable you are about the topic, would you consider [each] statement to be a factual statement (whether you think it is accurate or not) OR an opinion statement (whether you agree with it or not)?" Despite the clear distinction, respondents frequently miscategorized factual claims as opinion and vice-versa. For example, 44% labeled the factual statement "Spending on Social Security, Medicare, and Medicaid make up the largest portion of the US federal budget" an opinion. Likewise, 29% labeled the opinion statement "Democracy is the greatest form of government" as factual. Moreover, respondents' partisanship influenced how they labeled claims. Democrats were more likely than Republicans to mislabel "Increasing the federal minimum wage to $15 an hour is essential for the health of the US economy" as a factual claim, while Republicans were more likely to mislabel "Government is almost always wasteful and inefficient" as factual.

(Perceived) political misinformation presents an even more contentious epistemic domain. The term "fake news" has become a popular method of contesting the epistemic status of uncongenial claims. Studies obtaining top-of-mind associations (van der Linden et al., 2020) and using experimental methods (Harper and Baguley, 2019) suggest that partisans across the political spectrum use the term in an ideologically-motivated way, to dispute the factuality (not merely the veracity) of uncongenial information. Likewise, liberals and conservatives tend to selectively question the credibility of scientific findings when they find the conclusions disagreeable (Washburn and Skitka, 2018).

Conspiracy theories—unproven claims about the existence of nefarious secret plots (see Brotherton, 2013)—present another divisive epistemic domain. Endorsement of conspiracy theories is widespread (Oliver and Wood, 2014) and a product, in part, of ubiquitous and adaptive psychological phenomena, such as the attribution of agency to ambiguous events (e.g., Brotherton and French, 2015; Douglas et al., 2016), yet conspiracy theorizing is popularly portrayed as misguided at best, if not outright ridiculous and dangerous at worst (e.g., Boot, 2020). Given that claims of conspiracy inherently concern ostensibly hidden information, conspiracy theories necessarily blend factual claims about known events with speculation about concealed actions and the alleged conspirators' motives. Moreover, adherents are in at least some cases somewhat open to mutually-contradictory narratives (Wood et al., 2012), and endorsement of fictitious

and historically accurate allegations of conspiracy are strongly correlated (Wood, 2016), suggesting that acceptance or rejection of conspiracy theories may depend on individuals' broader conspiracist *ideology*. This blending of factual claims, ideological conviction, and opinionated speculation may position conspiracy theories somewhere between pure fact and pure opinion.

Conspiracy theories and political misinformation more broadly may hold a stronger appeal during times of crisis (van Prooijen and Douglas, 2017), including the Covid-19 pandemic. Contemporaneous research suggests that support for public health recommendations and vaccine-uptake intentions, for example, are predicted by attitudes toward related misinformation and conspiracy theories, as well as by generic conspiracist ideation (Enders et al., 2020; Fazio et al., 2020; Miller, 2020; Romer and Jamieson, 2020; Uscinski et al., 2020). The true prevalence (Freeman et al., 2020a,b; Sutton and Douglas, 2020) and behavioral effects (Earnshaw et al., 2020) of such beliefs are difficult to establish. Yet given the potential influence of conspiracy theories and misinformation on the course of a public health crisis, and on trust and participation in the political process more generally (Invernizzi and Mohamed, 2019), it is important to understand not just who endorses and who rejects such claims, but how people metacognitively categorize the claims. Are conspiracy theories and misinformation seen as more fact-like, more opinion-like, or a mixture of the two, as other ideological claims appear to be (Heiphetz et al., 2013, 2014, 2017)? The distinction may have implications for strategies to address mistaken beliefs; fact-checking has been shown to be a somewhat successful strategy for correcting specific mistaken factual beliefs (Wood and Porter, 2019), though less impactful in changing people's broader ideological positions (Nyhan et al., 2019).

In sum, the challenge of labeling one's own beliefs, or someone else's statements, as fact or opinion is a pervasive, under-acknowledged, and potentially consequential aspect of metacognition. Important questions remain about how this metacognitive process operates. A question of particular interest, given the existing literature on motivated reasoning, is the extent to which labeling claims as factual depends not solely on their epistemological amenability to (dis)confirmation, but on the degree to which one agrees or disagrees with the statement. The exploratory studies reported here are intended as a preliminary examination of these questions.

2. STUDY 1

This initial study was intended as a first step toward examining the perception of statements as variously factual or opinion-based, and how this corresponds to subjective agreement and knowledge of the claims, outside of the contentious context of politics. Whereas, previous research has used unambiguously factual or opinion-based statements as stimuli, this study used intentionally broad statements which could feasibly be seen as fact and opinion (e.g., "Hard work pays off"). We have participants rate each statement according to how factual or

opinion-based it is, as well as obtaining ratings of the participants' own agreement and knowledge of the claim.

This allows us to descriptively address several preliminary questions. First, are the labels *fact* and *opinion* categorical distinctions or a matter of degree? That is, are *fact* and *opinion* ratings on a numerical scale normally distributed, or, on the contrary, bimodal distributions clustered at each end of the rating scale. Relatedly, are the labels mutually exclusive? That is, can a statement be perceived as both somewhat factual and somewhat opinion-based? Lastly, to what extent are fact/opinion ratings influenced by participants' agreement with each statement, and their self-rated knowledge of the general topic?

2.1. Method
2.1.1. Participants
Participants were recruited via Barnard College's Introduction to Psychology undergraduate research participation pool.[1] A total of 211 participants provided complete data (16 participants did not complete the procedure). As participants were exclusively undergraduate students, 88% were aged between 18 and 21 (age information was missing for three participants). As Barnard College is a women's college, 86% of participants were female (gender information was not provided by one participant; male participants are accounted for by Columbia University students who can enroll in Barnard courses). Most participants (74%) indicated USA as their nationality.

2.1.2. Materials
Fifty statements were written to serve as stimuli. The statements were intended to reflect a wide range of claims and beliefs, e.g., "Smoking causes lung cancer"; "Money is power"; "Swearing is bad" (see **Figure 1** for full wording of all statements).

Every participant rated each statement four times, each time using a different 7-point rating scale. For *factual* ratings, the scale endpoints were labeled "This is not a fact," and "This is a fact." For *opinion* ratings, the scale endpoints were labeled "This is not an opinion," and "This is an opinion." For *agreement* ratings, the scale endpoints were labeled "I completely disagree," and "I completely agree." For *knowledge* ratings, the scale endpoints were labeled "I know very little about this topic," and "I know a lot about this topic."

Demographic questions asked participants to indicate their age (in years), nationality (USA, Korea, or other), and gender (female, male, or non-binary/other).

2.1.3. Procedure
After providing informed consent and answering the demographic questions, participants were asked to read the following instruction:

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[1]All stimuli and response scales were also translated into Korean by bilingual English and Korean speakers, and a separate sample of 215 participants was recruited in South Korea. The trends were largely consistent with those reported here, with some differences in item descriptives and correlation magnitudes. It is unclear whether such differences reflect meaningful psychological differences or idiosyncrasies of how the stimuli and instructions function across the two languages. As it neither adds nor detracts from the conclusions that can be drawn, analysis of this data is presented as **Supplementary Material**.
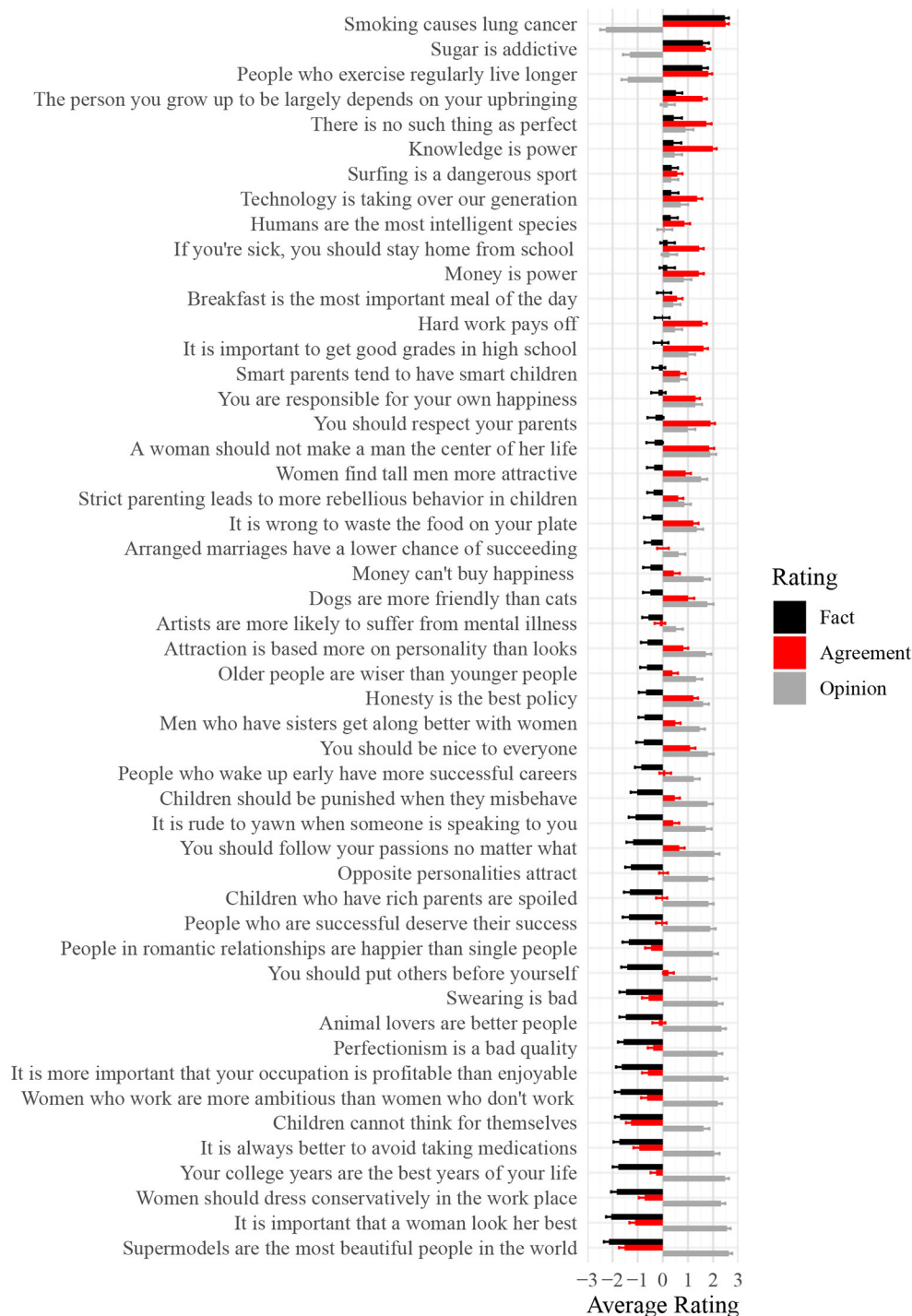
FIGURE 1 | Average fact, opinion, and agreement ratings for each of the fifty statements used in Study 1. Scores of −3 and +3, respectively correspond to the labels "This is not a fact" and "This is a fact" for Fact ratings; "This is not an opinion" and "This is an opinion" for Opinion ratings; and "I completely disagree" and "I completed agree" for Agreement ratings.

In this study, we are interested in how people respond to the things other people say. You will read about some things that someone else might say. After you read about what each person says, please use the scales provided to indicate your response.

Participants were then presented with stimuli statements, one at a time, via a computer-based Qualtrics survey. Each statement was prefaced with "Someone says that," i.e., "Someone says that women find tall men more attractive." Each statement was
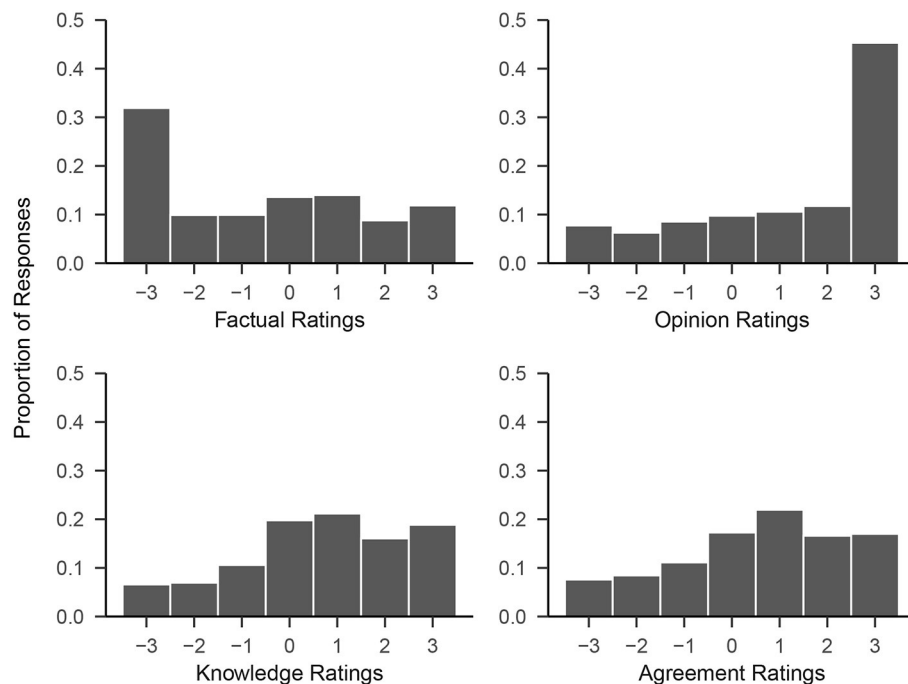
FIGURE 2 | Histograms of responses to all 50 statements across Fact, Opinion, Knowledge, and Agreement rating scales in Study 1. Scores of −3 correspond to the labels "This is not a fact," "This is not an opinion," "I know very little about this topic," and "I completely disagree," respectively. Scores of +3 correspond to the labels "This is a fact," "This is an opinion," and "I know a lot about this topic," and "I completely agree." Intermediate scale points were not verbally labeled.

repeated a total of four times, once for each of the four rating scales. Statements were presented in blocks according to the rating scales. Each block began with an instruction in the form "In this section of the study, we would like to know how much you think what each person says is a FACT. Please use the scales provided to indicate how much you think what each person says is a fact." The repeated presentation of statements with separate rating scales (as opposed to simply bundling the four ratings in a single presentation of each statement) was intended to disentangle ratings, avoiding any potential implication that the rating scales should be treated as mutually exclusive.

The *factual*, *opinion*, and *agreement* blocks were presented in random order. The *knowledge* block was always presented last. This was intended to mitigate a potential order effect whereby having participants reflect on their knowledge of a claim could influence their *factual*, *opinion*, or *agreement* ratings. Within blocks, statement order was random.

After completing the procedure, participants were thanked and debriefed.

2.1.4. Data Analysis
We used R (Version 4.0.0; R Core Team, 2019) for all our analyses.

2.2. Results and Discussion
Responses to the 7-point *factual*, *opinion*, *knowledge*, and *agreement* rating scales were re-coded by subtracting four points

from each, so that scores were centered on zero and ranged from −3 to +3.

We first produced histograms of every participant's ratings for each of the four rating blocks to visualize the distributions of ratings (see **Figure 2**). As each participant provided 50 ratings per rating scale, the total number of data points for each histogram is $N * 50 = 10,550$. Self-rated knowledge and agreement were approximately normally distributed, with slight negative skew, and centered around a rating of 1, just above the mid-point of the scale. *Factual* ratings were strongly positively skewed; ∼32% of ratings were the lowest possible scale value (which had the verbal designation "This is not a fact"). *Opinion* ratings were strongly skewed in the opposite direction; 45% of all ratings were the highest possible response option (labeled "This is an opinion."). This suggests that the labels *fact* and *opinion* were to a substantial (but not complete) extent used categorically; participants often rated statements as entirely opinion and entirely non-factual. That said, participants did display some openness to the idea of varying degrees of opinion- and fact-ness. The various intermediate options combined accounted for more than half of all *factual* and *opinion* ratings, respectively.

As an initial summary of the associations among the different ratings we obtained for each statement, we calculated each statement's average rating within each of the four rating blocks. **Figure 1** shows averages for the *factual*, *opinion*, and *agreement* blocks (*knowledge* ratings omitted for visual clarity). Higher *opinion* ratings appear to generally correspond to lower *factual* ratings, suggesting that on the whole participants used the

TABLE 1 | Pearson's correlation coefficients for Studies 1 and 2.

Pairwise comparison of ratings	Study 1	Study 2		
		Type of statement		
		Fact	Opinion	Conspiracy
Factual × Opinion	−0.52	−0.76	−0.82	−0.81
Factual × Knowledge	0.22	0.08	*0.04*	*0.02*
Factual × Agreement	0.52	0.35	0.31	0.27
Opinion × Knowledge	−0.13	*−0.02*	*−0.01*	0.06
Opinion × Agreement	−0.38	−0.24	−0.17	−0.12
Knowledge × Agreement	0.22	0.09	0.10	*0.04*

Given the exploratory nature of the analyses, Pearson's correlation values are given as a descriptive statistic here. For completeness, however, we note that, given the large number of rating pairs per pairwise comparison (10,550 for Study 1; 1,451–1,458 for Study 2), all correlations for Study 1 are statistically significant at the level $p < 0.05$. For Study 2, correlations greater than $r \approx 0.05$ are significant at the level $p < 0.05$. Non-significant correlations ($p > 0.05$) are shown in italics.

labels as mutually-exclusive categories (these visual trends are supported by the correlation coefficients presented in **Table 1**). The graph also suggests a correspondence between the extent that a statement is perceived to be factual, on average, and the degree to which participants subjectively agree with it. At the extremes, "Smoking causes lung cancer" was rated as strongly factual ($M = 2.47$) and garnered equally strong average agreement ($M = 2.50$); "Supermodels are the most beautiful people in the world" was rated as strongly not factual ($M = -2.15$), and garnered strong disagreement ($M = -1.53$). However, there were some statements for which participants leaned toward agreement while seeing the statement as not factual, on balance (e.g., "Dogs are more friendly than cats": $M_{factual} = -0.50$; $M_{agreement} = 1.00$). *Opinion* ratings appear to be more extreme than *factual* ratings overall. Approximately half of the 50 statements garnered average *opinion* ratings approaching or exceeding 2 (out of a maximum re-coded score of 3). Only three of the 50 statements garnered similarly extreme *factual* ratings.

Next, bivariate correlations were computed to establish the strength of relationships between pairs of ratings. Pearson's r correlation coefficients were calculated for all six possible pairwise combinations of the four rating scales, using every pair of 10,550 ratings from all 211 participants (see **Table 1**). To visualize these pairwise associations and further clarify the trends and skews within the data, we generated a 2-dimensional histogram for each of the six pairwise comparisons (see **Figure 3**). The shading of each square represents a count of the number of observations within a particular area of the 2-dimensional space. Linear fit lines are also shown. There was a moderate negative correlation between *fact* and *opinion* ratings (**Figure 3C**), confirming that the labels are to some extent used in a mutually exclusive way. That is, the more a claim is seen as factual, the less it is seen as an opinion, and vice versa. Yet this appears to be due, to a large extent, to the large number of instances in which a participant rated a statement as completely opinion and not at all factual (close to 25% of all rating pairs). In comparison, participants rated a statement as

both maximally opinion *and* factual <3% of the time. Focusing on the role of subjective agreement in labeling a claim as factual or opinion (**Figures 3B,E**), the correlations suggest that agreeing with a claim predicts labeling it more factual and less of an opinion. This association was stronger for *factual* ratings, however; participants were more willing to call something they agreed with an opinion than to call something they disagreed with factual, suggesting potential asymmetry in how agreement predicts perceptions of the extent to which a statement is factual or opinion. Participants' self-rated knowledge also played a role in labeling claims as factual or opinion (**Figures 3A,D**), with greater knowledge correlating positively with factual ratings and negatively with opinion ratings, though to a lesser extent than subjective agreement. There was also a weak positive correlation between self-rated knowledge and agreement with the statements (**Figure 3F**).

In sum, the main findings of note to emerge from Study 1 were, first, that people appear to use "fact" and "opinion" as somewhat categorical and mutually-exclusive labels. Second, there was a moderate-to-strong correlation between agreement and fact ratings, and a negative (albeit weaker) correlation between agreement and opinion ratings. That is, people are more inclined to call a statement factual the more they agree that it is true. Likewise, people are more inclined to call a statement opinion when they disagree with it.

However, it is unclear whether the skew toward labeling statements as opinion and not factual represents a general preference for calling ambiguous statements opinions, or the statements used simply leaned toward opinion rather than fact. Importantly, the wording of the *factual* rating scale may have also influenced judgments by failing to make clear the intended definition of *factual* (as in *a statement amenable to proof or disproof*) as distinct from colloquial use which equates *fact* and *true statement*. The correlation between subjective agreement and perceived factuality may reflect this interpretation of the word *fact* rather than metacognitive mislabeling driven by subjective (dis)agreement.

3. STUDY 2

This second study was intended to examine whether the relationships observed in Study 1 hold for a different set of stimuli statements, and with clarified instructions intended to disentangle being *factual* from being *true*. Whereas, Study 1 employed relatively neutral statements, this study employed overtly political statements. Additionally, whereas the statements used in Study 1 were intended to be of somewhat ambiguous epistemic footing, this second study followed previous research in using statements which were definitively factual or opinion-based, according to criteria used in previous research (factual statements are able to be proven or disproven using objective evidence, whereas opinion statements are not; Mitchell et al., 2018).

To improve upon Study 1, efforts were made in both the general instructions to participants and the wording of the rating scales to make this working definition clear, emphasizing that
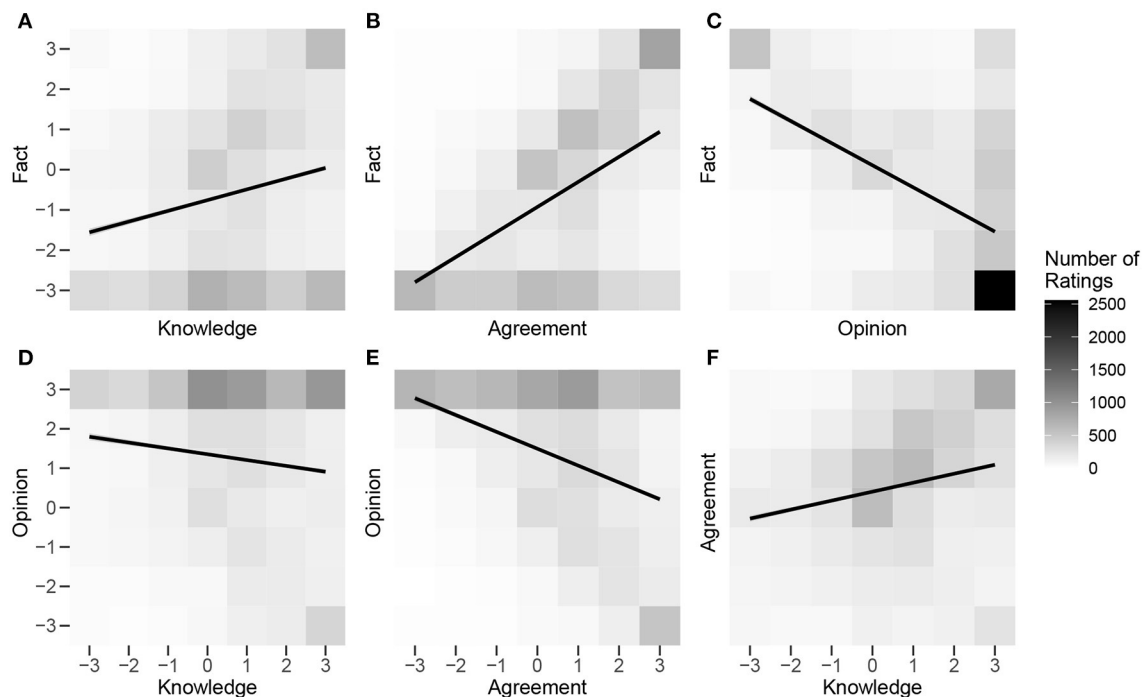
FIGURE 3 | Two-dimensional histograms of pairwise associations between Fact × Knowledge **(A)**, Fact × Agreement **(B)**, Fact × Opinion **(C)**, Opinion × Knowledge **(D)**, Opinion × Agreement **(E)**, and Agreement × Knowledge **(F)** rating scales for Study 1. The shading of each cell represents the number of paired ratings falling into that category, with darker cells representing more ratings. Scores of −3 and +3 correspond to the labels "This is not a fact" and "This is a fact" for the Fact rating scale; "This is not an opinion" and "This is an opinion" for the Opinion rating scale; "I know very little about this topic" and "I know a lot about this topic" for the Knowledge rating scale; and "I completely disagree" and "I completely agree" for the Agreement rating scale. Intermediate scale points were not verbally labeled.

a statement one perceives to be *wrong* could still be classified as *factual*.

Moreover, the current study included a third category of statement: conspiracy theories (statements which refer to the secret, nefarious actions of a group of people; see Brotherton, 2013). This addition was intended to shed light on whether conspiracy theories are generally seen as claims of fact, of opinion, or as a distinct category occupying the space between fact and opinion, akin to religious claims in previous work (Heiphetz et al., 2013, 2014, 2017).

3.1. Method
3.1.1. Participants
Participants were recruited via Barnard College's Introduction to Psychology undergraduate research participation pool students participated in return for course credit. A total of 146 participants provided complete data (Of 183 people who began the survey, five did not complete the procedure; 27 failed an attention check and were excluded).

As participants were exclusively undergraduate students, 95% were aged between 18 and 21. As Barnard College is a women's college, 92% of participants were female (male participants are accounted for by Columbia University students who can enroll in Barnard courses.) Most participants (88%) indicated USA as their nationality.

Politically, the sample leaned toward liberal ideology; 40% said they identified as a "Strong liberal," 38% as a "Moderate liberal,"

18% as "Independent," 4% said they identified as a "Moderate conservative," and 0% identified as a "Strong conservative."

3.1.2. Materials
A total of 60 statements were generated to serve as stimuli for this study (see **Supplemental Material** for full wording of all statements). These spanned 10 topics (e.g., immigration, gun control, climate change). For each topic, two statements of fact, two statements of opinion, and two statements of conspiracy were written. For example, "Global temperatures have risen more than 2 degrees Fahrenheit since 1900" (statement of fact); "Climate change is an existential threat" (statement of opinion); "The scientific consensus about climate change is distorted by scientists' own interests" (statement of conspiracy). The two versions of each type of statement were intended to be approximate negations of one another: "Global temperatures have risen less than 2 degrees Fahrenheit since 1900" (fact); "Climate change is not an existential threat" (opinion); "The scientific consensus about climate change is not distorted by scientists' own interests" (conspiracy). Which version of a statement a participant saw was manipulated between-participants; i.e., each participant saw one or the other version. Given the expected ideological homogeneity of the participant sample, this was intended to maximize variability in the data by ensuring a range of agreement and disagreement across the two versions of each statement.

Participants rated each statement on four rating scales, presented in the following order: *Knowledge* (How KNOWLEDGEABLE are you about this topic?); *Agreement* (Regardless of how knowledgeable you are about the topic… How much do you AGREE with the statement/think it is ACCURATE?); *Factual* (Regardless of whether you agree/think it is accurate or not… Would you consider this statement to be a FACTUAL statement?); and *Opinion* (Regardless of whether you agree/think it is accurate or not… Would you consider this statement to be an OPINION statement?). Each scale was rated on a scale from 1 (Not at all) to 5 (Completely).

Additional questions asked participants to indicate their age (in years), nationality, gender, and political ideology (phrased as "Do you consider yourself politically…" followed by the options Strong liberal, Moderate liberal, Independent, Moderate conservative, Strong conservative).

3.1.3. Procedure

To clarify the meaning of the "factual" and "opinion" rating scales for the purposes of the study, participants were asked to read the following instructions, modeled on those of Mitchell et al. (2018):

> Generally, a statement would be considered a FACTUAL statement to the extent that you think that the statement could be proved or disproved based on objective evidence, regardless of whether you think the statement is accurate or not.
>
> A statement would be considered an OPINION statement to the extent that you think that it was based on the values and beliefs of the person making the statement and could not definitively be proved or disproved based on objective evidence, regardless of whether you agree with the statement or not.
>
> So, for example… "The Hudson River is the world's longest river."
>
> …would be more of a FACTUAL statement, even though it is not true, because it could be proved or disproved.
>
> "The Hudson River is the world's most beautiful river."
>
> …would be more of an OPINION statement, since it is based on someone's values or beliefs and could not be definitively proved or disproved.
>
> In this study you will see a series of statements that you might hear someone say.
>
> For each statement, we will ask you to rate it according to the four questions below, asking how KNOWLEDGEABLE you are about the topic; how much you AGREE with the statement/think it is ACCURATE; how much you consider it a FACTUAL statement; and how much you consider it an OPINION statement.
>
> There are no right or wrong answers - we are interested only in your intuitive response to each statement.

This was followed immediately by an attention check question. The four rating scales were presented, but the instructions read "If you have read and understood these instructions, please select Completely (5) for each of the four questions here, and then click next to move on with the study." As noted, 27 participants failed the attention check (16% of the sample).

Participants were then shown the stimuli statements, one at a time, via a computer-based Qualtrics survey. While Study 1 prefaced statements with "Someone says that…," for this study statements were merely enclosed within quotation marks, i.e., "The pharmaceutical industry has the largest lobby in congress." The four rating scales were presented together, on the same page as the statement itself. The statements were presented in random order. As noted, which version of each statement a participant saw was also randomized (so that each participant saw and responded to half of the full set of 60 statements).

3.2. Results and Discussion

First, we produced plots showing the separate distributions of responses for each of the three statement types on each of the four rating scales (**Figure 4**). As each participant provided 10 ratings per statement type for each rating scale, the maximum number of data points for each distribution is $N * 10 = 1,460$ (<1% of data was missing per distribution; the actual range was 1,454–1,460).

Factual and *opinion* ratings were strongly skewed. For statements of fact, *factual* ratings were negatively skewed; the highest two response options account for the majority of responses. *Opinion* ratings skew in the opposite direction. Conversely, for statements of opinion, *factual* ratings were positively skewed and *opinion* ratings negatively skewed, though the skew is less pronounced than for statements of fact. In short, this suggests that participants more often than not accurately labeled statements of fact as factual and statements of opinion as opinion-based.

Statements of conspiracy exhibit skew in the same direction as statements of opinion, though the skew is substantially less pronounced. That is, in terms of the sheer number of ratings across the *factual* and *opinion* scales, conspiracy theories appear to occupy a middle ground between statements of fact and statements of opinion.

For the *knowledge* and *agreement* ratings scales, no strong skew is evident, and differences between the three statements types are less pronounced. The most noteworthy trend was for participants to claim most knowledge about statements of opinion; slightly less in regards to statements of conspiracy, and the least knowledge of statements of fact. This may be because our statements of fact generally made more specific claims than the statements of opinion, frequently involving statistics likely to be unfamiliar to most. As far as *agreement*, participants agreed most strongly with the statements of opinion overall, least strongly with the statements of conspiracy, with statements of fact in between.

Next, bivariate correlations were computed to establish the strength of association between pairs of ratings. Pearson's *r* correlation coefficients were calculated for all six possible pairwise combinations of the four rating scales, using every complete pair of ratings for each statement type (see **Table 1**).

To visualize these pairwise associations, we generated scatterplots for each of the six pairwise comparisons (**Figure 5**). In this study, knowledge appeared to play little role in labeling
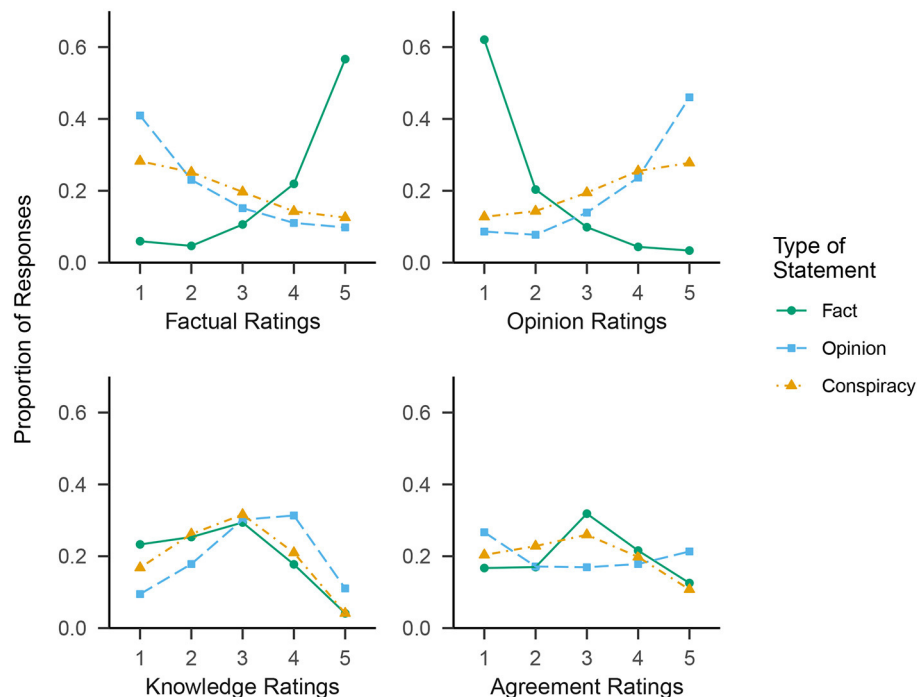
FIGURE 4 | Proportions of ratings at each point on the 5-point response scale to each of the Factual, Opinion, Knowledge, and Agreement rating scales in Study 2. The three separate lines in each panel represent the three different types of stimulus statement: Fact, Opinion, and Conspiracy.

a statement as factual or opinion (**Figures 5A,D**). The most noteworthy trend is that greater self-rated knowledge weakly predicted stronger agreement with the claim—though visual inspection of the scatterplot (**Figure 5F**) suggests that knowledge may in fact polarize agreement ratings; participants who selected the highest rating for knowledge tended to indicate either strong agreement *or* strong disagreement, while largely neglecting the intermediate scale points.

Agreement does appear to play a role in labeling statements as factual or opinion-based (**Figures 5B,E**). There was a small-to-moderate positive correlation between agreement and *factual* ratings, and a weaker negative correlation for *opinion* ratings. That is, subjectively perceiving a claim to be true predicted rating it more strongly as factual and less strongly as opinion. The different magnitude of these relationships suggests, as in Study 1, an asymmetry between perceptions of factuality and opinion.

The strongest correlations were between *factual* and *opinion* ratings. Correlations for the various statements types ranged from $r = -0.76$ to $r = -0.82$. Thus, to an even greater extent than in Study 1, the labels appear to be used as mutually exclusive. This is illustrated visually in the strong clustering of points along the diagonal of the scatterplot (**Figure 5C**).

Perhaps most noteworthy, comparing the respective correlations across each type of statement shows no major differences (visually represented in the largely parallel slopes on each scatterplot). In other words, the trends do not differ depending on the type of statement in question. The main difference between statement types appears to be in the intercept

of the lines, or the average values of the ratings. Again, the most consistent trend is that statements of fact are rated as more factual, on average, while statements of opinion were rated as more opinion, suggesting that participants were overall able to accurately label the statements. (This is evident visually in the scatterplots, where green *statements of fact* dots cluster toward higher ratings on the *factual* rating scales, while blue *statements of opinion* dots cluster toward lower ratings, and vice versa on the *opinion* rating scales.) Statements of conspiracy (orange dots in the scatterplots) consistently appear to occupy a middle ground between statements of fact and opinion, though generally leaning more toward opinion. Thus, whether one agrees or disagrees with a conspiracy theory, it is seen neither as a purely factual claim nor as mere opinion, but as something between the two.

In sum, this study suggests that, in the context of political claims of fact, opinion, and conspiracy, the more an individual perceives a claim to be factual, the less they see it as an opinion, and vice versa. This metacognitive labeling process appears to be related to how much one personally agrees with the claim. While people are generally able to correctly distinguish factual and opinion statements, a claim is more likely to be regarded as factual to the extent one is favorably disposed toward it, whereas a claim one disagrees with is more likely to be labeled an opinion. As compared with Study 1, the magnitude of the correlation is attenuated. That the relationship persists despite the efforts to clarify the orthogonality of *truth* and *factualness* in our instructions and rating scales, however, suggests that the relationship cannot be entirely accounted for by participants

FIGURE 5 | Scatterplots of bivariate relationships between Factual × Knowledge **(A)**, Factual × Agreement **(B)**, Factual × Opinion **(C)**, Opinion × Knowledge **(D)**, Opinion × Agreement **(E)**, and Agreement × Knowledge **(F)** rating scales in Study 2. The three different types of stimulus statement (Fact, Opinion, and Conspiracy) are represented as differently colored and shaped points. Linear trend lines are included, with different line types representing trends for the three types of stimulus statement.

interpreting *factual* in the colloquial sense of *true*. Rather, it may reflect a metacognitive bias whereby the perceived factuality of a claim is a product of one's subjective agreement with its content. As in the previous study, however, there are important limitations of the stimuli and procedure which call the generalizability of the results into question.

4. GENERAL DISCUSSION

This study builds on the growing body of research examining the motivated acceptance or rejection of controversial claims (Hastorf and Cantril, 1954; Kahan et al., 2012; Dunning, 2015; Ditto et al., 2019) by examining the metacognitive processes behind labeling claims as factual or opinion-based. In two studies, using both political and non-political stimulus statements, the extent to which a statement was perceived to be factual or an opinion was related to the degree to which one personally agreed or disagreed with the claim. This suggests that rather than dismissing uncongenial facts as merely mistaken, people may construe them as fundamentally less factual and more a matter of fact (see Mitchell et al., 2018; Washburn and Skitka, 2018; Harper and Baguley, 2019; van der Linden et al., 2020).

Beyond routine claims of fact and opinion, this study also examined how claims of conspiracy are rated within the fact/opinion paradigm. Claims of conspiracy were consistently situated between claims of fact and opinion. This placement appears similar to previous findings that religious claims occupy a middle-ground between fact and opinion in terms of how biologically based, personally-revealing, and open to personal differences such claims are (Heiphetz et al., 2013, 2014, 2017). This also aligns with research suggesting that conspiracy thinking is driven in a top-down way by a mindset which posits that any "official stories" are not to be trusted (e.g., Wood et al., 2012). In this sense, it is possible that an individual's engagement with conspiracy theories, and perhaps "fake news" and political misinformation more broadly, is more akin to an article of ideological faith than a claim of factual knowledge or personal opinion.

Whether individuals would agree that their stance on such matters is ideological is another question. In professing to deny knowledge in order to make room for faith, Kant (1781) suggested that some domains of belief, such as religious faith— are unamenable to the same epistemological standards as objective knowledge or personal opinion. However, this perhaps reflects an idealized epistemology in which clear distinctions between fact, opinion, and faith can be drawn. In everyday

reasoning, the boundaries may be more malleable. While endorsement of conspiracy theories, allegations of fake news, and other contested claims may be to some extent ideological, it may not appear so to the percipient. In the current data, labeling conspiracy theories as factual or opinion was associated with the percipient's subjective agreement with the claim to the same extent as for statements of pure fact and opinion. However, the possibility of explicitly labeling claims as ideological is not directly addressed by the current data. Future research might productively expand on this by having participants rate the extent to which a statement reflects an article of faith/ideology in addition to rating it as factual or opinion.

Future research might also explore in greater depth the role of ability and motivation in classifying claims as fact or opinion. Our research simply shows how people might categorize facts and opinions; it does not address the question of whether people care to be correct. Previous research suggests that individuals differ in accuracy motives (Pennycook et al., 2014, 2020). That is, some people may be more dispositionally inclined to seek to hold accurate beliefs rather than seeking the validation of reinforcing existing beliefs. Perhaps this extends to seeking to correctly classify claims as factual or opinion. Other research suggests that susceptibility to partisan fake news may be better explained by lack of reasoning than by motivated reasoning (Pennycook and Rand, 2019). Classifying the epistemic nature of complex statements is undoubtedly cognitively taxing. In situations of ambiguity, people may simply decline to give the issue much thought. Exploring such questions would add much to the research reported here, particularly given that it used convenience samples of undergraduates. College students may have different epistemologies and related motivations than the average member of the mass public, and are regularly evaluated on the quality and accuracy of their beliefs. How transferable such qualities are to the judgments of mundane and political statements presented in the current studies remains to be seen, as does the extent to which more representative samples of the public would result merely in different intercepts rather than a different model entirely.

In sum, the current research suggests that, while people make accurate distinctions between statements of fact and of opinion on the whole, the process by which we categorize a claim is influenced by our subjective agreement with the claim. If the findings reported here are generalizable, there are potential implications for understanding seemingly intractable political debates, particularly when it comes to hotly contested claims, such as conspiracy theories. Such debates may represent not just disagreement over the facts, but different perceptions of whether any particular claim or counter-claim is fundamentally factual. When a factual claim is disagreeable it may be seen not merely as wrong, but as biased conjecture. On the other hand, when an opinion is congenial, it may be seen not as an opinion open to differing points of view but as a matter of objective fact not up for debate. Understanding contentious claims, such as conspiracy theories and accusations of "fake news" on these terms may help understand why and for whom such claims are more or less evidentially vulnerable (*cf.* Van Leeuwen, 2014; Levy, 2017). The limited influence of "fact-checking" efforts (Nyhan et al., 2019) may be due, in part, to differing perceptions of what information is factual and what is opinion.

Yet it must be reiterated that the studies reported here are exploratory and descriptive by design, rather than setting out to confirm specific hypotheses. The findings should thus be considered preliminary and subject to further examination. Limitations of the *ad-hoc* stimuli and the politically and demographically homogeneous participant samples, in particular, prohibit strong claims of generalizability. More systematic research is required to further map the contours of how we think about facts, opinions, and conspiracy theories. The current tentative findings suggest that exploring metacognition may be a productive avenue for further research.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Boards of Barnard College and Ajou University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RB and LS contributed equally to the conception and design of the work, the acquisition, analysis, and interpretation of data, and to drafting and revising this manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.644657/full#supplementary-material

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Infodemic Pathways: Evaluating the Role That Traditional and Social Media Play in Cross-National Information Transfer

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The COVID-19 pandemic has occurred alongside a worldwide infodemic where unprecedented levels of misinformation have contributed to widespread misconceptions about the novel coronavirus. Conspiracy theories, poorly sourced medical advice, and information trivializing the virus have ignored national borders and spread quickly. This information spread has occurred despite generally strong preferences for domestic national media and social media networks that tend to be geographically bounded. How, then, is (mis)information crossing borders so rapidly? Using social media and survey data, we evaluate the extent to which consumption and propagation patterns of domestic and international traditional news and social media can help inform theorizing about cross-national information spread. In a detailed case study of Canada, we employ a large multi-wave survey and a massive data set of Canadian Twitter users. We show that the majority of misinformation circulating on Twitter that is shared by Canadian accounts is retweeted from U.S.-based accounts. Moreover, exposure to U.S.-based media outlets is associated with COVID-19 misperceptions and increased exposure to U.S.-based information on Twitter is associated with an increased likelihood to post misinformation. We thus theorize and empirically identify a key globalizing infodemic pathway: disregard for national origin of social media posting.

Keywords: social media, infodemic, COVID-19, Canada, misinformation, Twitter, information ecosystem, news media

1. INTRODUCTION

The COVID-19 pandemic has been accompanied by a worldwide infodemic. Unprecedented levels of misinformation have contributed to widespread misconceptions about the novel coronavirus. Conspiracy theories, poorly sourced medical advice, and information trivializing the virus have ignored national borders, spreading rapidly and globally. This infodemic has the capacity to change important attitudes and behaviors that in turn can impact transmission patterns (Larson, 2018; Kim et al., 2019). Ultimately, it can change the scale and lethality of a pandemic. Infodemic information can come from a range of sources, but there is reason to be particularly concerned about the role played by social media, such as Facebook and Twitter. These platforms have been found to be a key pathway by which medically misleading information has entered into more mainstream discourse (Jang et al., 2019).

There are some indications that this has been particularly true in the Canadian context during the COVID-19 pandemic. Canadians have been exposed to consistent messaging from traditional media and elected political elites emphasizing the importance of significant action to combat the pandemic (Merkley et al., 2020). Despite these elite cues, misperceptions seem to have rooted themselves in a sizable portion of the Canadian population (Pennycook et al., 2020). Given the importance of elite cues to attitude formation (Zaller, 1992; Lenz, 2013), how can these misperceptions be best explained? We employ survey and social media data to argue that these attitudes are partially the result of massive Canadian consumption of U.S.-based information, with those on social media being particularly exposed.

We have two principal objectives: (1) we characterize following and sharing patterns in the Canadian social media space, comparing Twitter followership and engagement of U.S.-based vs. Canada-based accounts; (2) identify associations between U.S. account followership and the spread of misinformation on Twitter, as well as between U.S. news exposure and COVID-19 misperceptions in the mass public. In doing so, we identify an important infodemic pathway and highlight how studying a single country's information ecosystem requires an empirical strategy that properly accounts for the porousness of national boundaries.

1.1. Infodemic Pathways

An infodemic can spread through a variety of information channels. It can be shared through traditional media where journalists, politicians, or thought leaders adopt inaccurate and misleading positions (e.g., Jamison et al., 2020). It can also be spread via peer-to-peer transmission, with rumors and unfounded conspiracies often accompanying pandemics (e.g., for HIV and AIDS see Smith et al., 1999) and issues of health more generally (e.g., on vaccines Larson, 2020). However, increased visibility into peer-to-peer interactions on social media has led to an explosion of research on how misinformation is generated and spreads on these platforms. Health information appears uniquely vulnerable to broader trends in misinformation (Krishna and Thompson, 2019), with medical information-seeking from non-official sources very common (e.g., Guess et al., 2020). Moreover, misleading medical information has been extensively documented on social media platforms, notably related to vaccines (Radzikowski et al., 2016), Ebola (Fung et al., 2016), Zika (Sharma et al., 2017), and COVID-19 (Bridgman et al., 2020). There is also evidence that false news generally spreads faster than factual news, in part due to its novelty and its capacity to generate emotive responses (Vosoughi et al., 2018).

While disinformation campaigns intended to sow confusion and uncertainty regarding COVID-19 have been documented (Swan, 2020), the infodemic appears to be sustained by a broader set of online political participants who propagate misinformation inadvertently. This "paradox of participation" is well-documented; those who are politically active online share information and can produce peer-to-peer misinformation transmission, with enthusiastic political participants being the most likely to share misinformation (Valenzuela et al., 2019). This tendency is compounded by users often adding misleading commentary and/or misrepresenting the facts as reported in the news (Anspach and Carlson, 2020). This fuels a second dynamic wherein social media users are more likely to further propagate information from those that they trust (Buchanan and Benson, 2019), more likely to believe in its veracity (Sterrett et al., 2019), more likely attribute importance to the issue (Feezell, 2018), and more likely to later trust the source (i.e., external website) of the information (Turcotte et al., 2015). Content that is widely endorsed (i.e., through likes, retweets, or shares) is more likely to be trusted still (Luo et al., 2020) through a "bandwagon heuristic" (Sundar, 2008). These effects are further compounded by an "illusory truth effect" wherein individuals have greater confidence in the truthfulness of a claim given past exposure—a dynamic observed even in evaluations of fake news (Pennycook et al., 2018). Together, these psychological and behavioral phenomena can produce trust in websites and information where more caution is warranted. Ultimately, these dynamics can contribute to an infodemic and widespread misperceptions.

1.2. U.S. Information Influence Over Canada

The Canada-U.S. relationship has been described by former Prime Minister Pierre Trudeau as "sleeping with an elephant …one is affected by every twitch and grunt." This continues to ring true more than 50 years after it was first uttered, with Canadian culture and media being heavily influenced by the elephantine United States media market. There is a long history of theorizing this relationship and speculating on its importance (e.g., Grant, 1965; Beattie, 1967; Barnett and McPhail, 1980; Collins, 1990; Nguyên-Duy, 1995). And indeed, fear of U.S. cultural influence has been a linchpin of a wide variety of public policies in Canada designed to protect Canadian media and culture, such as: 1) the creation of the National Film Board and the Canadian Radio Broadcasting Corporation (later the CBC); and 2) Canadian content regulation by the Canadian Radio-television and Telecommunications Commission that requires radio and television broadcasters to air a certain share of content that is partly written, produced or contributed to by Canadians (Salter and Odartey-Wellington, 2008).

In part due to this range of government interventions, there continues to be high levels of consumption of domestic news sources for print, radio, and television media (Owen et al., 2020). Many Canadians, however, consume U.S.-based entertainment media and read, watch, or listen to U.S. news media. Unfortunately, empirical research identifying effects of U.S. information streams on the Canadian mass public has been limited (but see Trussler, 2018).

Canadians are heavy users of social media platforms, with approximately 5 in 6 having a Facebook account, 1 in 2 having an Instagram account, 2 in 5 having a Twitter account, and high usage of YouTube, LinkedIn, Pinterest, Snapchat, messaging apps, etc. (Gruzd and Mai, 2020). Borders between countries likely mean less on these platforms, with peer-to-peer networks quickly traversing national boundaries as people find

like-minded individuals around the world. Given the shared language, special cultural relationship, and significant population imbalance, we expect Canadians to follow more U.S.-based accounts and engage more with the content produced by these accounts than Canada-based accounts.

We are interested in descriptively measuring U.S. influence on Canadian social media space and how this may vary depending on the content in question. The potential influence of U.S.-based information presents a unique Canadian vulnerability during a pandemic, where Canadian elites, medical professionals, scientists, and journalists may be comparatively less able to reach and inform Canadian residents given the noise generated by U.S.-based information. Equally importantly, any information circulating in the U.S. will also impact Canadians through social media channels.

We do not have strong expectations about whether domestic Canadian COVID-19 information is more or less likely to be propagated by Canadians. On one hand, the pandemic in the United States has been more severe than in Canada which, given strong preferences for negative news consumption and sharing (Bachleda et al., 2020), may mean that Canadians have spent even more time sharing information from the U.S. On the other hand, Canadians may be more likely to focus on how COVID-19 is spreading in their communities and thus prefer local information (something that has been documented more generally on social media, e.g., Al-Rawi, 2017). Legitimate information about COVID-19 also shares space with misinformation in social media spaces, and has been often promoted by right-wing news outlets in the U.S. (Motta et al., 2020). Social media can serve as a gateway to access this information. This discussion leads us to two research questions:

RQ1: *Do Canadians engage with U.S.-based information more than Canadian-based information?*

RQ2: *How do these patterns vary by content type (i.e., all content, COVID-19 information, and COVID-19 misinformation)?*

1.3. The U.S. as a Super-Spreader of COVID-19 Misinformation

The second objective of this paper is to identify a possible relationship between U.S. information exposure and COVID-19 misinformation or misperceptions. As noted, it is difficult for Canadians to escape the influence of U.S. media. We have reason to expect that the heavy influence of U.S.-based information has resulted in the cross-border spread of COVID-19 misinformation, particularly in social media spaces.

Canada has seen a remarkable degree of elite consensus on the severity of the COVID-19 pandemic and Canadian political elites have not been important sources of COVID-19-related misinformation (Merkley et al., 2020). The political climate in the U.S. is vastly different. We see a high degree of elite polarization on the severity of COVID-19 (Green et al., 2020); this has trickled down into public opinion, with important partisan gaps emerging between Democrats and Republicans in COVID-19 risk perceptions, social distancing practice, and mask usage

(Allcott et al., 2020; Clinton et al., 2020; Kushner Gadarian et al., 2020).

Further, COVID-19 misinformation has spread well-beyond the confines of social media and alternative news websites. It is being reinforced by American media and political figures. Right-wing news outlets are propagators of COVID-19 misinformation (Motta et al., 2020), as are Republican political elites (Uscinski et al., 2020). Misinformation communicated by elite sources has the potential to reverberate throughout the entire information ecosystem; it is not just consumers of partisan media who will encounter these messages. Many Americans will be incidentally exposed to misinformation from partisan media (Lelkes et al., 2017), while mainstream sources may carry elite-sponsored misinformation to the mass public in their normal coverage of elite debate. It is not as easy for journalists to ignore communication from the President and his allies as compared to random, often times anonymous, profiles on Twitter.

Moreover, journalists may face incentives to give elite voices considerable air time. They may elevate messages featuring misinformation in a misguided attempt to maintain "balance" (Merkley, 2020). And perhaps most importantly, mainstream news outlets have increasingly found themselves in competition with partisan news outlets for viewers and readers in the U.S. This creates heightened incentives to carry polarizing messages from extreme sources (Wagner and Gruszczynski, 2018; Padgett et al., 2019). In short, American political discourse is saturated with COVID-19 misinformation to a far greater extent than peer countries, and we anticipate that this will spill over into the Canadian social media space. Consequently, U.S.-based information exposure is likely to be associated with more engagement with misinformation on social media and misperceptions related to COVID-19 in the mass public, which motivates our first hypothesis:

H1: *Exposure to U.S. based information is associated with more engagement with COVID-19 misinformation on social media (A) and with COVID-19 misperceptions in the mass public (B).*

It is also possible that U.S. news exposure conditions the relationship between social media usage and misperceptions. Social media usage has been linked to COVID-19 misperceptions because of the proliferation of related misinformation on these networks (Bridgman et al., 2020). Social media also facilitates access to U.S. information streams by breaking down national boundaries in peer-to-peer transmission. Given that these U.S. information streams are comparatively more saturated with elite-sponsored misinformation, social media users with a preference for U.S. news content are more likely to be exposed to COVID-19 misinformation than those without such a preference. We anticipate important downstream implications for their (mis)perceptions related to COVID-19.

H2: *The association between social media usage and misperceptions is stronger among those with a preference for U.S. news.*

2. MATERIALS AND METHODS

To assess potential infodemic pathways into Canada, we examine exposure to, and preferences for, non-Canadian information in traditional and social media among survey respondents alongside descriptive statistics of a massive dataset of Canadian Twitter users. These two methodological approaches provide visibility into infodemic dynamics that a single method could not. They also address common concerns with self-reported information consumption (e.g., Guess, 2015) as well as differing dynamics across social media platforms (e.g., Yarchi et al., 2020).

2.1. Social Media Data

We use a massive multi-faceted Twitter dataset that captures actual behavior: tweets, retweets, and follow behavior of approximately 200,000 Canadian Twitter users active in 2020[1,2].

We began with a labeled set of Canadian politician, journalists, and media organizations from across the media landscape in Canada[3]. We collected their follower network (both those they followed and those that followed them) which yielded 6,569,634 distinct users. We pulled the location and biography information for all these users. Every character sequence that appeared 10 or more times in the location fields was put through the GoogleMaps API with country data extracted to identify Canadian locations (e.g., University of Toronto is correctly placed in Toronto, Ontario). This 2-step process yielded 747,158 self-identified Canadian-based accounts. We began collecting the tweets from this population in January 2020. In September 2020, we computed the most active 200,000 accounts as measured by tweeting volume for the period from January 1 to July 31, 2020. We then collected every account that these Canadian users followed[4] yielding 9,118,496 unique users who were followed by at least one of the Canadian accounts. We collected the location of those users and ran the same location-identifying process described above. This allows us to construct an intra-country follower and retweet network across a massive set of active self-identifying Canadian Twitter accounts. **Figure 1** shows the Twitter data collection process.

We examine descriptive statistics on follow and tweeting behavior for the large Canadian Twitter population. Following someone on Twitter means that a user is more likely to see their content and is taken to be a signal of interests and preferences (Barberá, 2015); it is also a commonly-used measure of exposure to information (e.g., Bail et al., 2018). Retweets are the re-sharing of information from another user to your followers and has been found to generally indicate interest, trust, and agreement with the contents of the original tweet (Metaxas et al., 2015). Tweets themselves are the precise words of the user and thus give the best indication of their attitudes and beliefs.

To identify tweets and retweets for both all COVID-19 content and COVID-19 misinformation retweets we draw upon an English-language dictionary developed by Evanega et al. (2020)[5,6]. COVID-19 tweets are identified by strings "covid," "coronavirus," and "pandemic," while misinformation-associated tweets are identified by strings like: "plandemic," and "bioweapon." A dictionary approach does not allow us to identify whether a particular tweet is propagating or debunking misinformation, however it does allow us to detect tweets concerning the misinformation conversation more broadly with reasonable accuracy. We run the dictionary over the corpus of 70,996,766 geolocated retweets, yielding a total of 5,911,452 COVID-19 related retweets, of which 239,422 retweets contain terms associated with misinformation. We also run the COVID-19 and misinformation dictionaries over all 146,631,572 tweets posted from the Canadian sample and identify 154,179 that contain terms associated with misinformation.

2.2. Survey Data

In addition to our social media data, we use surveys to characterize the relationship between U.S. news exposure and COVID-19 misperceptions. Our survey data come from the Media Ecosystem Observatory, which has been surveying Canadians on their COVID-19 attitudes and behaviors continuously since March 2020. In waves 9 through 15 of the survey, fielded from June 15 to August 9, 2020 ($N = 17,331$), a question was asked related to U.S. news media consumption. Each survey wave has an approximate sample size of 2,500 with quotas set on gender, age, Canadian region (i.e., Atlantic, Quebec, Ontario, West) and language (i.e., French, English) to match population benchmarks from the 2016 Canadian census. We further weight our data within region by age and gender using an iterative proportional fitting algorithm. More details on sample characteristics can be found in **Supplementary Table 1**.

2.3. Survey Variables

We ask our respondents "Over the past week, which of the following news media outlets did you watch, read, or listen to for news about politics? Please select all that apply." Sources

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[1]Twitter is the only social media platform where location information at the account level is readily available and where networks can be mapped. Whether the patterns identified here exist on other social media platforms is an important and unaddressed research question that cannot be effectively answered with current data access granted to academic researchers.

[2]All data was collected using the Twitter Standard API v1.1 as documented at: https://developer.twitter.com/en/docs/twitter-api/v1 (accessed February 16, 2021).

[3]Specifically, this included every Member of Parliament and every Senator with a Twitter account alongside a list of 799 journalist and media Twitter accounts manually compiled by research assistants to be as comprehensive and representative as possible.

[4]The follow relationships for the users were collected in October 2020 and 5,641 accounts were no longer active.

[5]The Canadian Twitter conversation occurs in both English and French. We expect French-language users to be less likely to follow and propagate U.S.-based information, so have excluded them from the analysis. Survey results include both English and French-speaking Canadians.

[6]Dictionary-based approaches are comprehensible and straightforward methods by which text can be classified. Classifying text using a dictionary-based approach is more efficient than manual annotation and can be used for large volumes of text, but the creation of the keyword list remains a subjective step in the process (Guo et al., 2016). We have amended the dictionary developed by Evanega et al. (2020) based on human annotation of a sample of tweets to ensure the list is representative of our dataset. We validated this amended dictionary through manual coding of a random selection of 500 tweets that the dictionary classified as being about misinformation, with 44% being explicitly misinformation, 39% being about misinformation (including debunking it), and only 17% not concerning misinformation at all. See **Supplementary Material** for the full dictionary and additional dictionary-related analyses.

FIGURE 1 | Twitter data collection method.
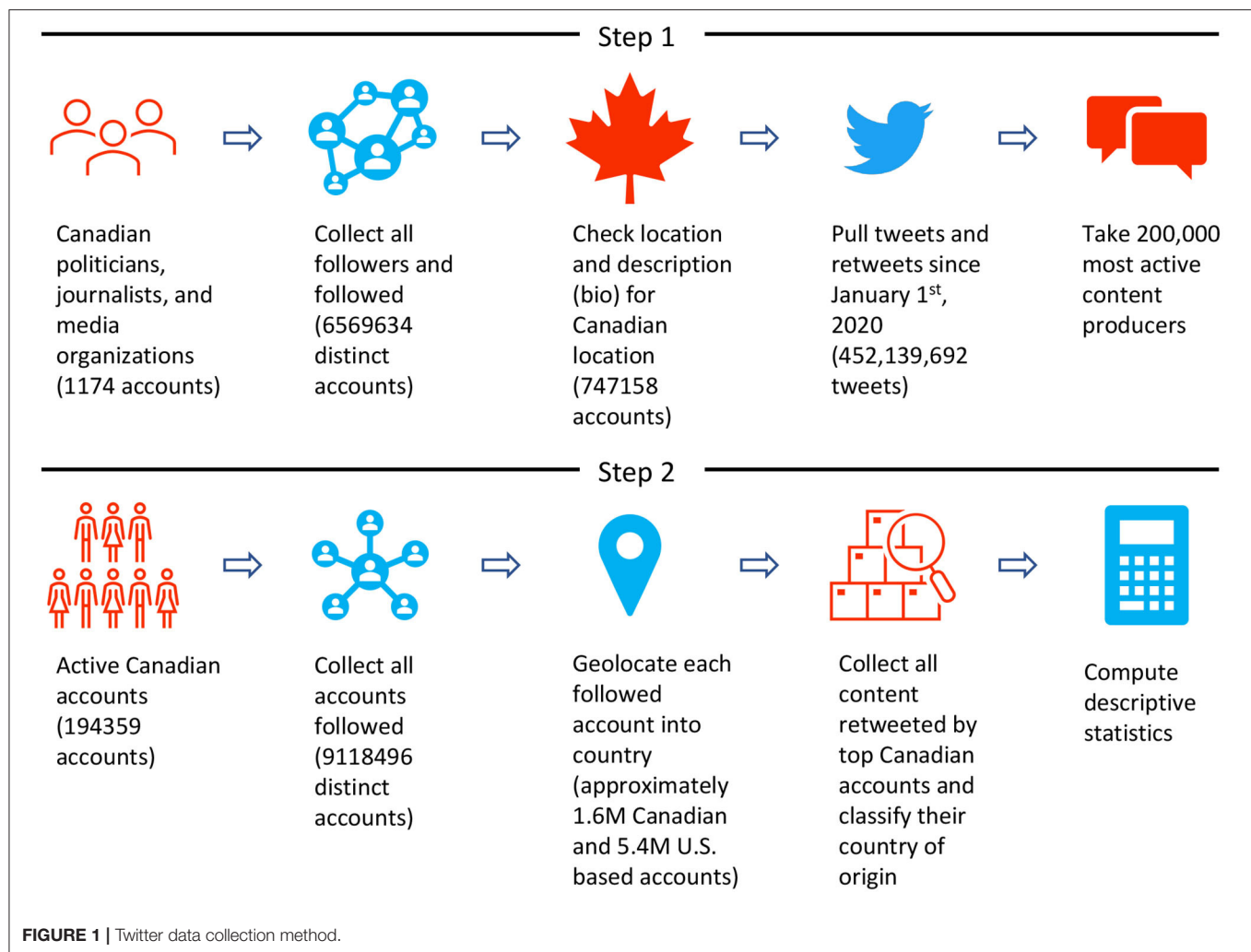
include the New York Times, Washington Post, Wall Street Journal, ABC, NBC, CBS, Fox News, CNN, MSNBC, Brietbart News, Daily Kos, NPR, Politico, The Atlantic, Bloomberg, and respondents were given the option to select none of the above. We ask a similar question for Canadian news outlets. As **Table 1** shows, American news outlets command respectable audiences from the Canadian public, though domestic sources are still preferred. We construct indices of U.S. and domestic news consumption by summing the outlets selected and taking the log to account for extreme values. Results of the following analysis are robust to constructing a 4-category binned ordinal measure of U.S. news exposure, the results of which are displayed in **Supplementary Table 3**.

We evaluate social media usage by asking respondents the following question: "Over the past week, which of the follow social media applications did you use to watch, read, or listen to news about politics? Please select all that apply." Respondents could indicate their usage of Facebook, Twitter, Instagram, YouTube, Reddit, LinkedIn, Tumblr, Whatsapp, Snapchat, WeChat, other, or none of the above. We construct an index of social media exposure by summing the applications

selected and taking the log to account for extreme values. Our media items are rescaled to 0–1 from the minimum to the maximum. Results of the following analysis are robust to constructing a 4-category binned ordinal measure of social media exposure as well as an item asking respondents how frequently they used social media over the past week (response categories: several times a day, every day, almost every day, a few times, once, never). The results of these robustness tests are displayed in **Supplementary Tables 3, 4**.

We measure COVID-19 misperceptions by asking respondents to rate the following claims as definitely false, probably false, uncertain, probably true, or definitely true:

1. The coronavirus is no worse than the seasonal flu;
2. Drinking water every 15 min will help prevent the coronavirus;
3. The Chinese government developed the coronavirus as a bioweapon;
4. Homeopathy and home remedies can help manage and prevent the coronavirus;
5. The coronavirus was caused by the consumption of bats in China;

U.S. sources		Domestic Canadian sources	
CNN	33.2	CBC	52.2
New York Times	15.7	CTV	52.0
CBS	13.7	Global News	42.3
NBC	12.7	CityNews	20.2
Washington Post	11.7	Globe and Mail	14.6
Fox News	11.3	Toronto Star	12.4
ABC	10.2	National Post	11.7
MSNBC	7.4	Toronto Sun	6.2
Bloomberg	6.6	Rebel Media	2.5
Wall Street Journal	5.6	True North News	1.7
Atlantic	3.3	APTN	1.6
Politico	2.3	The Tyee	1.2
NPR	2.3	Post-Milennial	1.1
Breitbart	1.2	Press Progress	1.0
Daily Kos	0.5	National Observer	1.0
		Other	10.1
None of the above	41.3	None of the above	13.3

6. Vitamin C can ward off the coronavirus;
7. There is a vaccine for the coronavirus that national governments and pharmaceutical companies won't release;
8. High temperatures, such as from saunas and hair dryers, can kill the coronavirus.

These items are then used to construct a 0–1 index of misperceptions.

2.4. Survey Models

Our first expectation is that U.S. news exposure is associated with COVID-19 misperceptions because of the proliferation of elite-led misinformation in that national context. We test this expectation by estimating a model using Ordinary Least Squares (OLS) regression where we regress our COVID-19 misperception index on U.S news exposure and controls (X) for domestic news exposure, political discussion, political knowledge, political interest, education, age, gender, and region. More details on our controls can be found in **Supplementary Table 2**:

$$misperceptions = \alpha + \beta_1 U.S.\ news + X + \epsilon \qquad (1)$$

Our second expectation is that an association between social media exposure and COVID-19 misperceptions should be strongest among those who consume a lot of U.S. news since, as we will show, misinformation is coming primarily from U.S. sources on social media. We estimate the following model with OLS controlling for demographics, domestic news exposure and other indicators of democratic engagement and political sophistication:

$$misperceptions = \alpha + \beta_1 social\ media + \beta_2 U.S.\ news$$
$$+ \beta_3 social\ media * U.S.\ news + X + \epsilon \qquad (2)$$

3. RESULTS

We begin by descriptively characterizing following and sharing patterns cross-nationally. We find that Canadians follow far more accounts based outside of Canada than inside of Canada. Across the 187,088 English-language Canadian accounts examined here, Canadians follow a median of 36 Canadian accounts, 88 accounts from the United States, and 25 accounts from other countries. While only approximately 20% of follows that can be geolocated were identified as Canadian, 55% were based in the United States. Looking at the distribution of the ratio between U.S.:Canadian follows shows an even more dramatic pattern. As shown in **Figure 2**, 71% of Canadians follow more Americans than Canadians on Twitter and approximately 18% of Canadians follow more than 10 times as many Americans as Canadians. Canadians are exposed to more U.S.-based information on social media as compared to domestic content.

Given this follow behavior, Canadians on Twitter are likely to be receiving a lot more U.S.-based information than Canadian information. However, do they consider this information more important or does it interest them more than Canadian content, as measured by retweet volume? **Figure 3** shows, from left-to-right, the proportions of Canadian follows, retweets, COVID-19 retweets, and tweets containing misinformation keywords.

In addition to Canadians following far more non-Canadian accounts, they also retweet a large volume of material from the United States. Across all geolocated retweets from Canadian accounts, a full 45% are cascading U.S.-based content (only 6.8% are Canadian-Canadian retweets). For COVID-19 related information, Canadians are more likely to retweet Canadian accounts (9.1% of overall volume) but also more likely to do so for U.S.-based content (47% of overall volume). Thus, while there is some relative preference for local health information as compared to all information (a result largely driven by retweeting of political and health leadership across the country), Canadians are also deeply interested in COVID-19 information coming from the United States and are still far more likely to retweet that information. Canadians are also far more likely to retweet U.S.-based misinformation. When Canadians retweet a tweet containing misinformation or about the misinformation debate, it is from a U.S.-based account 53% of the time (Canada-based accounts represent only 7.5% of volume)—a percentage far higher than both all information and COVID-19 specific information and all content regardless of topic.

We thus answer our research questions: Canadians are far more likely to follow and engage with U.S.-accounts than those from other countries, including Canada. This is particularly true for COVID-19 misinformation, though it is slightly less apparent for COVID-19 information more generally[7].

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[7]We also find that social media usage is associated with U.S. news exposure among our survey respondents. We estimate model regressing U.S. news exposure on social media usage and our controls. The estimates are provided in **Supplementary Table 4**. Social media provides a gateway for Canadians to access U.S. news media.

FIGURE 2 | Ratio of U.S.: Canada Twitter accounts followed by Canadian Twitter sample.
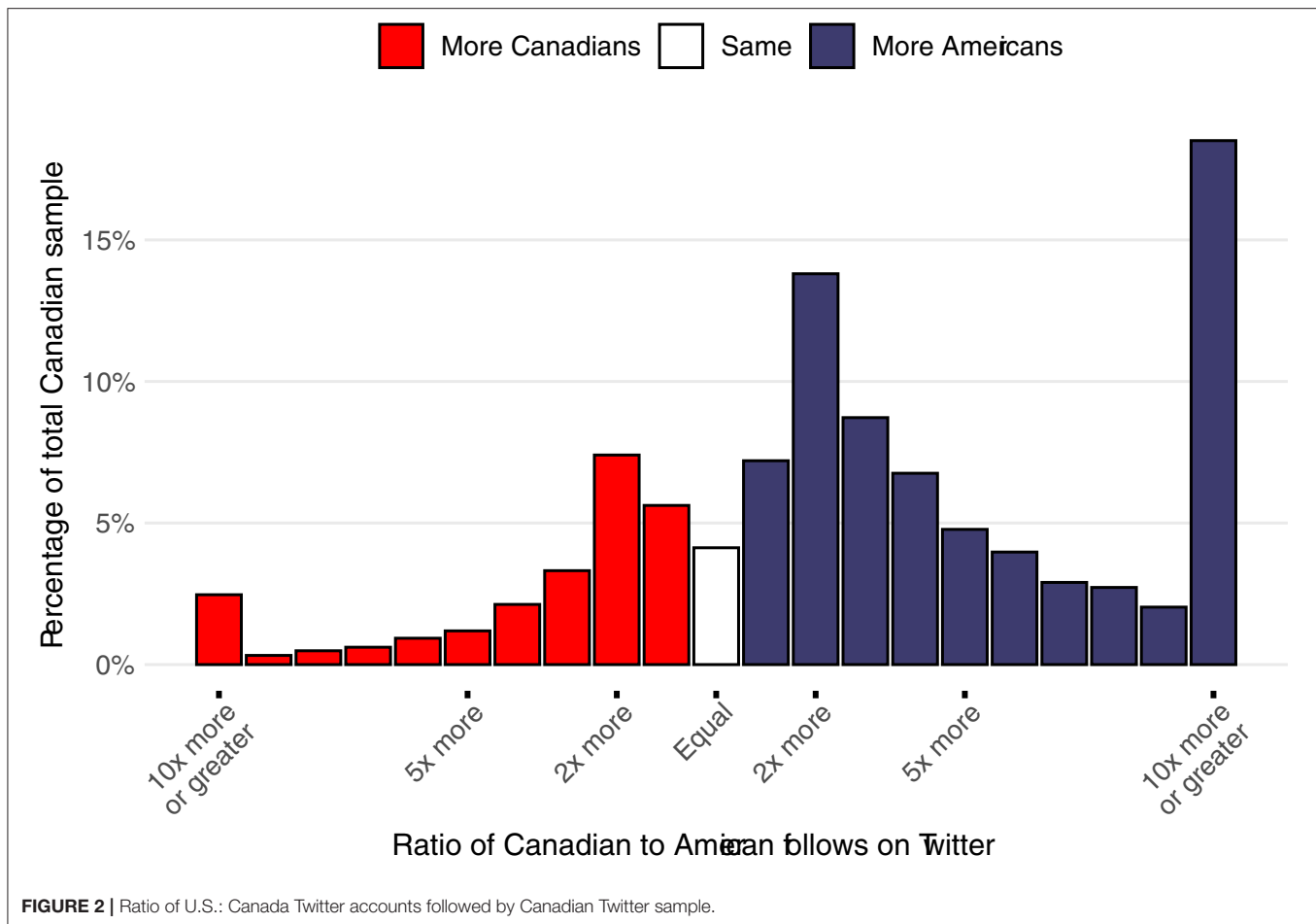
3.1. Hypothesis Testing

To evaluate the relationship between exposure to U.S.-based information and direct propagation of COVID-19 misinformation (*H1A*), we examine actual user-produced content. We calculated the percent of COVID-related tweets from each individual in the Canadian sample that contained misinformation and correlated that with the percentage of their geo-located follows that are based in the United States. We find that a 1 standard deviation increase in U.S. follows is associated with 0.061 ($p < 0.001$) standard deviation increase in misinformation tweeting. We find evidence for *H1A*: exposure to U.S. based information is associated with more direct engagement with COVID-19 misinformation on social media.

We find that exposure to U.S. Twitter accounts is associated with posting tweets containing COVID-19 misinformation. There may be downstream effects of U.S. information exposure on misperceptions related to COVID-19 (*H1B*). The results of Equation (1) are presented in column 1 of **Table 2**. An individual with maximum level of U.S. news exposure is expected to score 0.05 points higher on the 0-1 COVID-19 misperceptions index, which amounts to 0.27 standard deviations on this measure ($p < 0.001$). *H1B* is supported. U.S. news exposure is associated with more COVID-19 misperceptions after controlling for domestic news exposure and other indicators of political engagement.

The link between social media and misperceptions observed elsewhere (Bridgman et al., 2020) may be strongest among those with preference for U.S. news (*H2*)[8]. We provide the model estimates for Equation (2) in column 3 of **Table 2** and present the marginal effects in **Figure 4**. U.S. news exposure conditions the effect of social media on COVID-19 misperceptions. For those with no U.S. news exposure, the consumption of social media only increases COVID-19 misperceptions by 0.12 points on a 0–1 scale. But among those with the highest level of U.S. news exposure, the observed effect of social media consumption increases more than 3-fold. In short, social media exposure is related to COVID-19 misperceptions in large part because of its capacity to amplify the impact of content coming from the U.S. information environment.

4. DISCUSSION

Misinformation about COVID-19 has quickly traversed the globe, undermining efforts to contain the pandemic. For

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[8]We observe a similar correlation in the data used here as well. We estimate a model regressing COVID-19 misperceptions on social media exposure and our controls in **Supplementary Table 5** and find a strong association between social media usage and misperceptions.

FIGURE 3 | Proportion of follows and retweets for Canadian Twitter users highlighting U.S.-orientation with total number of follow relationships and retweets above the bars.
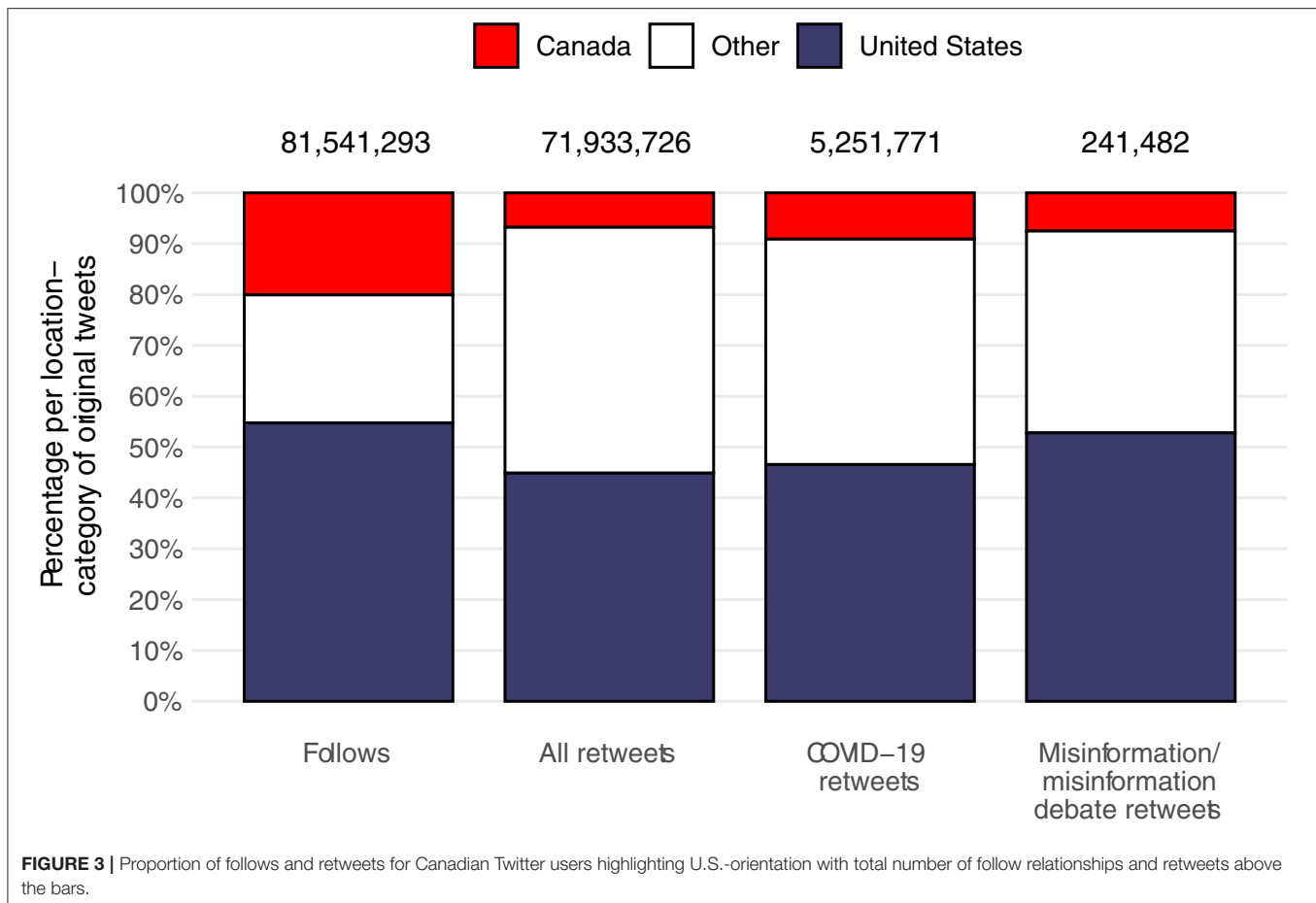
TABLE 2 | Regression estimates for survey-based models.

	H1B		H2	
	Coef.	SE	Coef.	SE
U.S. news exposure	0.053**	0.008	−0.056**	0.009
Social media exposure			0.119**	0.010
Social media * U.S. news			0.232**	0.027
Domestic news exposure	−0.091**	0.010	−0.131**	0.010
Political discussion	0.133**	0.008	0.097**	0.008
Political knowledge	−0.145**	0.006	−0.128**	0.006
Political interest	0.019*	0.008	0.004	0.007
Education	−0.149**	0.008	−0.141**	0.008
Age	−0.058**	0.002	−0.037**	0.002
Female	−0.024**	0.003	−0.024**	0.003
Ontario	0.029**	0.006	0.028**	0.006
Quebec	0.025**	0.006	0.026**	0.006
West	0.019**	0.006	0.019**	0.006
Constant	0.518**	0.009	0.465**	0.010
R^2	0.18		0.22	
N	16,216		16,216	

*DV = COVID-19 misperceptions; *$p < 0.05$, **$p < 0.01$.*

the Canadian case, we have shown: (1) Canadians who use social media are relatively more exposed to U.S.-based (mis)information than domestic sources of (mis)information; (2) this exposure can be linked to increased propagation of misinformation and embrace of misperceptions related to COVID-19. We have provided evidence that social media is a key conduit by which misinformation can spread cross-nationally.

These findings come with some limitations. First, we have evaluated follow and propagation patterns on Twitter as it is the only social media platform where the geographic data of users can be reasonably relied upon. We expect cross-national information transfer to be stronger on platforms with looser geographic networks (e.g., Reddit, Parler, Instagram), and weaker on platforms where geographic networks are more prominent (e.g., Facebook, Nextdoor). Existing limitations on data access make such cross-platform research difficult and more direct access to these platforms' data would be required.

Second, we have utilized a dictionary-based approach to process the enormous and diverse corpus of tweets and retweets examined here. Manual coding of the dictionary-classified content indicates that misinformation was identified alongside more general discussions of misinformation and content explicitly combating misinformation. We thus focus broadly on the misinformation conversation in this paper, but more research
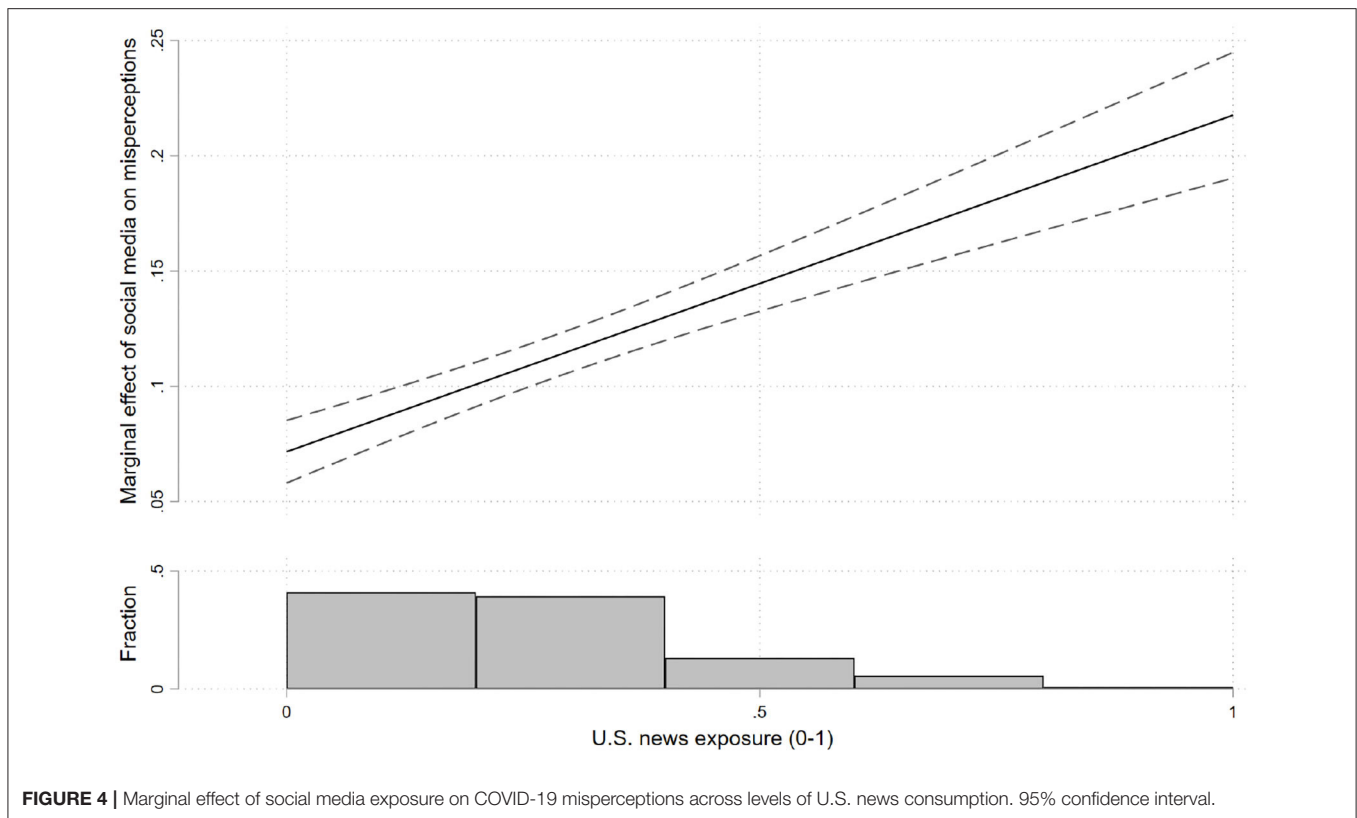
FIGURE 4 | Marginal effect of social media exposure on COVID-19 misperceptions across levels of U.S. news consumption. 95% confidence interval.

is needed to both better identify misinformation and understand the impacts of ambiguous or anti-misinformation messages (see also Li, 2020).

Third, our data is observational and drawn from a single country case study. As such, we cannot and do not make a causal or universal argument here. However, given the enormous sample sizes and similar dynamics observed across self-reported and actual behavior, we are confident that we have accurately identified a key mechanism behind the COVID-19 infodemic in Canada. The degree to which our findings travel to other countries is likely bound by the cultural affinity, proximity, and similarity between country pairs. Canada has a uniquely close cultural relationship with the United States, with the majority of consumed popular and high culture in Canada having American origins. The degree to which such similarity and proximity is necessary to generate the information pathways described in this paper is worthy of future research.

Fourth, it must be noted that Canadians are opting into this content on social media platforms, with news consumption, follows, and retweets being active choices. However, social media platforms are likely playing a key role in deepening this exposure by saturating information streams with U.S.-based news. Granting that Canadians choose to have a high interest in U.S.-based information, the content actually shown to users is algorithmically determined by social media platforms themselves. These algorithmic systems remain hidden from view, making it nearly impossible for researchers to incorporate the effects of this filtering in analyses of information exposure.

This is a broad limitation to both this study and to fully understanding and providing democratic oversight over the information ecosystem. As a result, we can't know whether the observed exposure to U.S.-based misinformation is because Canadians care deeply about all news coming from the United States or because the platform itself elevates the importance of this conversation. The latter is at least partially true and governments wishing to limit infodemic spread might consider the algorithmic ways in which social media platforms incidentally push out-of-country information to the top of news feeds.

Previous work on the information ecosystem during the Canadian election found little evidence of mis- and disinformation flowing north from the U.S. (e.g., Owen et al., 2020). We speculate that this is simply because there was not much content on the Canadian election produced in the United States. By contrast, an international event like the COVID-19 pandemic is of shared importance, with information produced in the United States of interest to news consumers in Canada. Additional research needs to be done to evaluate whether other international issues, such as immigration, refugee crises, climate change, or international relations are subject to similar dynamics. We can speculate, however, that Canadian discourse in these areas of shared interest is similarly saturated with U.S.-based (mis)information.

Our work thus has important implications for policy makers who wish to confront the deleterious effects of misinformation. Around the world, democratic governments are exploring

legislative and regulatory solutions to limit the spread of misinformation. However, their reach does not easily extend to producers of content and users of social media platforms who exist outside of their borders. Our research shows that these out-of-country sources can be a key source and conduit of misinformation. Thus, if policy makers are looking to limit future waves of misinformation or encourage greater nationally-bounded deliberation on social media, a focus on the information pathways for topics that easily transfer between countries is warranted.

DATA AVAILABILITY STATEMENT

Data and replication materials are available at https://doi.org/10.7910/DVN/Y0RP9J.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of Toronto Social Sciences, Humanities and Education REB, protocol #00038251. The patients/participants provided their written and informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FUNDING

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.648646/full#supplementary-material

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Corrigendum: Infodemic Pathways: Evaluating the Role that Traditional and Social Media Play in Cross-National Information Transfer

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A Corrigendum on

Infodemic Pathways: Evaluating the Role that Traditional and Social Media Play in Cross-National Information Transfer
by Bridgman, A., Merkley, E., Zhilin, O., Loewen, P. J., Owen, T., and Ruths, D. (2021). Front. Polit. Sci. 10:648646. doi: 10.3389/fpos.2021.648646

This corrigendum concerns a data error discovered while working on an extension of the *Infodemic pathways* paper. A large number of Canadian and American Twitter users were excluded from the set of users where additional location data was collected. As location data was not available for these users, any follow or retweet relationships to them were not computed and included in the paper's analysis. The net result was an incorrect estimation of the number of follow and retweet relationships exhibited by the Canadian Twitter users examined. This corrigendum corrects these data errors and reproduces the relevant analyses. Notably, we find that Canadians actually follow more Canadian accounts than American ones and have a preference for domestic COVID-19 information.

However, the original findings of the paper concerning the significant role that U.S.-based COVID-19 misinformation plays in the Canadian information ecosystem are strengthened by the corrected data. Specifically, while Canadians follow more Canadian accounts and retweet more COVID-19 specific Canadian content, a majority of the misinformation tweets retweeted by Canadian accounts that could be geolocated come from U.S.-based accounts. Moreover, following U.S.-based accounts continues to be associated with a greater likelihood to produce original content that contains misinformation. These updated results more clearly highlight that the U.S. is a source of misinformation for reasons that go beyond population size and Canadians' general proclivity for U.S.-based information. The U.S. does not only play a significant role—it is the dominant source of Twitter-based COVID-19 misinformation for Canadians.

CORRECTION

To fix the error, we started from the full follower network and collected information for every account that was excluded from the original collection. A small number of accounts could not be retrieved from the Twitter API in either the original or secondary pull due to deletion or privacy

FIGURE 2 | Ratio of U.S.:Canada twitter accounts followed by Canadian Twitter Sample.

FIGURE 3 | Proportion of follows and retweets for Canadian Twitter users highlighting U.S.-orientation with total number of follow relationships and retweets above the bars.
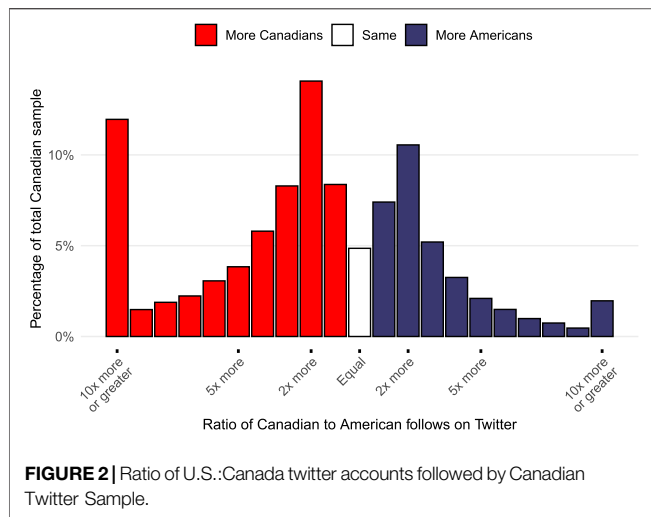
settings (representing 1.5% of total accounts queried). We then recalculated the geographic network of follows for each individual user in the sample. We also recalculated retweet and tweet behavior with the complete dataset of location data of all those whose content was retweeted/were followed.

Across the 187,225 English-language Canadian accounts with publicly available follower data examined here, Canadians follow a median of 148 Canadian accounts, 89 accounts from the United States, and 27 accounts from other countries. Approximately 47% of follows that can be geolocated were identified as Canadian, while 36% were based in the United States. See the updated **Figure 2**, which shows that only 34% of Canadians follow more Americans than Canadians on Twitter.

In addition to Canadians following many American accounts, they also retweet a large volume of material from the United States. See the updated **Figure 3**.[1,2] Across all geolocated retweets from Canadian accounts, a full 47% are cascading U.S.-based content (only 40% are Canadian-Canadian retweets, despite the larger followership). For COVID-19 related information, Canadians are far more likely
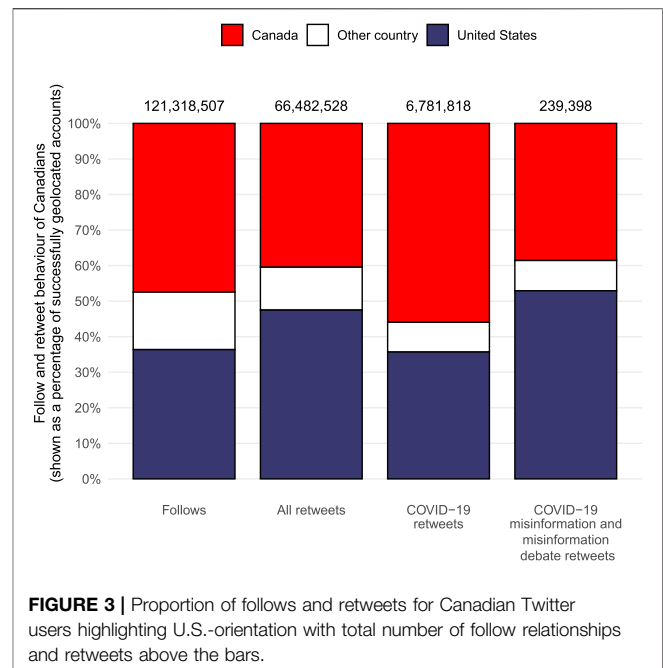
to retweet Canadian accounts (56% of overall volume) and are comparatively less likely to retweet U.S.-based content (36% of overall volume). Thus, there is a relative preference for local health information as compared to all information (a result largely driven by retweeting of political and health leadership across the country). Canadians, while also interested in COVID-19 information coming from the United States, are comparatively less likely to retweet that content as compared to all content. Most importantly, and despite a large interest in Canadian-based COVID-19 information, Canadians are also far more likely to retweet U.S.-based COVID-19 misinformation. When Canadians retweet a tweet containing misinformation or about the misinformation debate, it is from a U.S.-based account 53% of the time (Canada-based accounts represent only 39% of volume)—a percentage far higher than content regardless of topic and COVID-19 specific information.

Canadians engage heavily with U.S.-based accounts—far more than those from other countries. They also retweet content and particularly COVID-19 misinformation coming from U.S. accounts at rates higher than their followership behavior would suggest. However, Canadians do express a preference for domestic COVID-19 content that does not contain misinformation keywords.

To evaluate the relationship between exposure to U.S.-based information and direct propagation of COVID-19 misinformation (H1A), we had also examined actual user-produced content. We calculated the percent of COVID-related tweets from each individual in the Canadian sample that contained misinformation and correlated that with the percentage of their geo-located follows that are based in the United States. Despite the larger number of Canadian follows, we find that these results hold. A 1 standard deviation increase in U.S. follows (as percentage of overall follows) is associated with 0.06 ($p < 0.001$) standard deviation increase in

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[1]The Figure has been updated to exclude those accounts and follows where the country could not be identified. In the original manuscript, both other country and locations that could not be identified (but where information was provided) were grouped together. This update gives a clearer picture of the extent to which Canadian information on Twitter is driven by Canadian and U.S.-based accounts. [2]This Figure shows a significantly higher number of follow relationships than that in the original paper. The original paper used a dataset of user_id—location—country that consisted of 12,689,685 observations (including 1,727,005 Canadians and 5,427,131 Americans), whereas the corrected collection procedure yielded a dataset of 13,316,136 rows (including 2,327,924 Canadians and 5,436,678 Americans). Many of these missing accounts were among the most active and followed voices on Canadian Twitter. Despite the higher number of follows, the total geographically-identifiable number of retweets is actually lower—this is due to the aforementioned split of the category "Other" into "Other country" and "Unknown" for accounts that could not be identified with their location. The overall number of Canadian retweets is considerably higher (26,893,727 Canadian retweets vs. 4,126,648 in the original version).

misinformation tweeting—these results hold to the percentage of U.S. follows (0.28, p < 0.001).

CONCLUDING REMARKS

Overall, this corrigendum highlights a data error in the original paper that caused an under-count of the number of Canadian accounts followed by Canadians. Instead of showing a 3:1 ratio between U.S. and Canadian follows, we find that Canadians follow approximately 31% more Canadians than Americans.

Despite this, the core findings of the paper hold and indeed are strengthened. Canadians, despite having a preference for domestic COVID-19 information, retweet COVID-19 misinformation coming from U.S.-based accounts at a rate disproportionate to both follow or overall retweet behaviors. Moreover, following more Americans on Twitter is still found

be associated with a greater propensity to produce tweets that contain misinformation. The survey results are unchanged and continue to show a strong association between social media use, U.S. news consumption, and misperceptions regarding COVID-19.

Beliefs in Conspiracy Theories and Misinformation About COVID-19: Comparative Perspectives on the Role of Anxiety, Depression and Exposure to and Trust in Information Sources

OPEN ACCESS

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While COVID-19 spreads aggressively and rapidly across the globe, many societies have also witnessed the spread of other viral phenomena like misinformation, conspiracy theories, and general mass suspicions about what is really going on. This study investigates how exposure to and trust in information sources, and anxiety and depression, are associated with conspiracy and misinformation beliefs in eight countries/regions (Belgium, Canada, England, Philippines, Hong Kong, New Zealand, United States, Switzerland) during the COVID-19 pandemic. Data were collected in an online survey fielded from May 29, 2020 to June 12, 2020, resulting in a multinational representative sample of 8,806 adult respondents. Results indicate that greater exposure to traditional media (television, radio, newspapers) is associated with lower conspiracy and misinformation beliefs, while exposure to politicians and digital media and personal contacts are associated with greater conspiracy and misinformation beliefs. Exposure to health experts is associated with lower conspiracy beliefs only. Higher feelings of depression are also associated with greater conspiracy and misinformation beliefs. We also found relevant group- and country differences. We discuss the implications of these results.

Keywords: COVID-19, conspiracy beliefs, misinformation beliefs, information sources, pandemic, conspiracy theories

INTRODUCTION

While the SARS-CoV-2 virus—responsible for causing the COVID-19 disease—spreads aggressively and rapidly across the globe, many societies have also witnessed the spread of other seemingly viral phenomena such as fake news, conspiracy theories, and general mass suspicions about what is really going on. Some of the most prevailing narratives are the ones claiming that the virus is caused by 5G cellular technology (Vincent, 2020) or that Bill Gates uses the virus to enslave humanity by enforcing a global vaccination and surveillance program (Shahsavari et al., 2020). Even though most of these stories were quickly debunked and proven untrue, the pervasiveness of misinformation and conspiracy theories on social media and in the news cycle has led the Director-General of the World Health Organization (WHO) to warn that "*We're not just fighting an epidemic; we're fighting an infodemic. Fake news spreads faster and more easily than this virus, and is just as dangerous*" (WHO, 2020a).

The spread of false and/or misleading information is not new. A brief peak into the twentieth century provides us with examples such as Joseph Goebbels's machinery of *Public Enlightenment*. However, today's information ecosystem has drastically changed the ways in which mis- and disinformation are produced, disseminated, and consumed (Benkler et al., 2018; Törnberg, 2018). Social media platforms and digital technologies have facilitated high-speed information sharing between news media producers and consumers, as well as cross-platform information cascades (Shu et al., 2016; Vosoughi et al., 2018). Within these online environments, false and fake narratives tend to outperform real news in terms of popularity and audience engagements (Silverman, 2016). As a result, narratives of conspiracy theories and misinformation spread quickly (Venturini, 2019; Gallotti et al., 2020; Garfin et al., 2020). This is especially the case in times of societal crises such as the COVID-19 pandemic (van Prooijen and Douglas, 2017; De Coninck et al., 2020; Imhoff and Lamberty, 2020; Knuutila et al., 2020), as rumors, conspiracy theories, and "alternative truths" tend to thrive in environments of high fear, low confidence, and low trust (Shahsavari et al., 2020). There is a rich body of literature discussing what exactly constitutes "fake news" (Farkas and Schou, 2018; Tandoc et al., 2018) or "misinformation" (Benkler et al., 2018). It is beyond the scope of the current study to review this literature. We consider misinformation (or fake news) as "*publishing wrong information without meaning to be wrong or having a political purpose in communicating false information,*" and disinformation (or conspiracy theories) as '*manipulating and misleading people intentionally to achieve political ends*' (Benkler et al., 2018, p. 24). More specifically, disinformation and conspiracy theories "are attempts to explain the ultimate causes of significant social and political events and circumstances with claims of secret plots by two or more powerful actors" (Douglas et al., 2019, p. 4).

While some hold the belief that misinformation and conspiracy theories are fringe phenomena or mundane (digital) artifacts with small impact on real-world actions, several events during the COVID-19 pandemic across different countries demonstrate the opposite. For example, in reaction to the conspiracy theories that claim that 5G cellular network is the cause of the disease[1], over 200 incidents have been reported of attacks against telecom workers in the U.K. (Vincent, 2020), and numerous mobile telecom masts were set on fire in the Netherlands (Wassens, 2020). Furthermore, previous studies have shown that exposure to disease-related conspiracy theories is associated with lower vaccination intentions (Jolley and Douglas, 2014), lower levels of trust in governmental and health institutions (Lutkenhaus et al., 2019), and less willingness to follow restrictive measures to curtail further propagation of the disease (Imhoff and Lamberty, 2020). Evidence from England also shows that COVID-19-related conspiracy thinking is associated with less adherence to all government guidelines and less willingness to take diagnostic or antibody tests or to be vaccinated (Freeman et al., 2020). To highlight the potentially far-reaching and damaging effects of mis- and disinformation, Saiful Islam et al. (2020) estimate that widespread misinformation on social media on the consumption of highly concentrated alcohol that could disinfect the body and kill the coronavirus, resulted in approximately 800 deaths and 5,800 hospitalizations worldwide. It is therefore argued that the COVID-19 crisis is one of the first deeply mediatized global pandemics (Hepp, 2020), following earlier bird flu and Ebola epidemics (Joffe, 2011).

Previous findings show that conspiracy thinking is associated with an avoidance of established and traditional media (television, radio, newspapers) and with a tendency to acquire information mainly through digital media, including the internet and social media (Vosoughi et al., 2018; Boberg et al., 2020; Humprecht et al., 2020). The digital media ecosystem—with its socially networked architecture, trolls, and automated bots (Zannettou et al., 2018)—rather than the traditional news media, has been considered a hotbed for mis- and disinformation, such as conspiracy theories (Shu et al., 2016; Vosoughi et al., 2018). In line with this literature, we expect that exposure to digital media will be associated with greater conspiracy (H1a) and misinformation (H1b) beliefs. Exposure to traditional media, which regularly undertake efforts to debunk conspiracy theories and misinformation (Hollander, 2017), is expected to be associated with lower conspiracy (H2a) and misinformation (H2b) beliefs.

Aside from effects of mere exposure, trust in these media are also expected to play a role. Research has shown that distrust in traditional news media leads to selective exposure to news (Swire et al., 2017) and increases the use of alternative sources, such as digital media that distribute disinformation (Boberg et al., 2020). In other words, in environments in which distrust in traditional news media is higher, people are less likely to be exposed to different sources of political information and to critically evaluate these sources (Benkler et al., 2018; Humprecht et al., 2020). Based on this reasoning, it can be assumed that resilience to conspiracies and misinformation is lower in societies where distrust in professional news media is high. Thus, we expect that the effect of exposure to information sources on

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[1]There are several 5G-corona conspiracy theories circulating. Some advance the idea that the cellular network weakens the immune system and makes people therefore more susceptible to the virus. Others claim that the 5G masts are actively broadcasting the virus through the cellular infrastructure (see Vincent, 2020).

conspiracy and misinformation beliefs is moderated by trust in these sources (H3).

Self-evidently, in times of a global health emergency, such as the COVID-19 pandemic with its rapid spread and the high mortality rate, people are confronted with a monumental state of uncertainty and threat. In numerous recent studies it has been demonstrated that this continuous and unprecedented sense of uncertainty is inevitably related to increased levels of stress and psychological distress (Barzilay et al., 2020; Salari et al., 2020). Recent Chinese data have shown that during the COVID-19 pandemic 34.13% of the people experienced moderate to severe stress symptoms (Qiu et al., 2020). Furthermore, the typical stress levels associated with the pandemic have even appropriated the introduction of a new syndrome called "COVID stress syndrome" (Taylor et al., 2020), which has been consistently found to be linked to feelings of depression and anxiety in the general population (Barzilay et al., 2020; Salari et al., 2020). That elevated levels of (sudden) stress activate feelings or symptoms of depression is a well-documented process in the psychological literature. In order alleviate the feelings of stress and to regain a sense of control of the situation in which people find themselves today, one could experience the need to cognitively project personal feelings of threat and stress to a social out-group or power (Poon et al., 2020). This is where narratives and the sense-making function of conspiracy theories come into play. Although sense-making mechanisms (e.g., obtaining information from different types of sources to make sense of the COVID-situation) are intended to reduce anxious or depressive feelings, they often actually result in a higher susceptibility to conspiracy beliefs (van Prooijen and Douglas, 2017; van Prooijen, 2017; Šrol et al., 2021). Conspiracy beliefs are then a "*feature of the mind*" that help shaping certainty and control in times of uncertainty and stress (Kossowska and Bukowski, 2015; Moulding et al., 2016), which makes people with depressogenic schemata extra susceptible for this "feature." Furthermore, cognitive theoretical models have suggested that negative schemata also catalyze a need for more information about the stressful situation in order to make the threat more predictable or controllable. Yet, recent studies have found that seeking for information actually backfires and could even exacerbate levels of stress because of the fact that one encounters new, stress-evoking information such as graphic imagery in mainstream news media, but also misinformation and conspiracy theories (Taylor et al., 2020). Based on this literature, we expect that feelings of anxiety (H4) and depression (H5) mediate the positive association between exposure to information sources and conspiracy and misinformation beliefs.

The Present Study

The overarching goal of this international study was to better understand how information is delivered and communicated by authorities and media in the context of the COVID-19 pandemic, and how it is received, understood, and used by the public in eight countries/regions: Belgium, Canada, England, Hong Kong, New Zealand, the Philippines, Switzerland, and the United States. The selection of these countries/regions was informed by Humprecht et al.'s (2020) framework for cross-national comparative research on disinformation. Based on

several indicators (e.g., populism, polarization, media trust, social media use, strength of public broadcaster), they develop clusters of countries to inform cross-national research on disinformation. They find that most Western and Central European countries (including Belgium and Switzerland) belong to a single cluster, with a media-supportive and consensual political system. Despite some differences in media systems, their analysis finds that the United Kingdom and Canada also belong to this cluster. These countries "seem to be well equipped to face the challenges of the digital information age because they have stable, trusted institutions that enable citizens to obtain independent information and uncover manipulation attempts" (Humprecht et al., 2020, p. 507). In their study, the United States is a unique case. It does not belong to any cluster, given its polarized political and media environment, which has created a fertile ground for the spread of disinformation today. Political communication in the United States is characterized by populist rhetoric, while media coverage has become more partisan and, as a consequence, trust in the media has decreased (Humprecht et al., 2020). Although not included in the current framework, we expect that the Philippines [with the election of president Rodrigo Duterte (Webb and Curato, 2019)] and Hong Kong [with its highly partisan media landscape and the on-going polarization around the question of independence (Wu and Shen, 2020)] share several characteristics with the U.S., warranting their selection. New Zealand is the only country which does not clearly fit into this disinformation framework, but this country was mainly selected for its approach to the COVID-19-pandemic. At the time of the study, nearly all countries worldwide were still combating the pandemic, while New Zealand—thanks to a highly restrictive approach early on—had effectively eliminated COVID-19 within its borders (Cousins, 2020). While we cannot make predictors for all countries, based on this literature we expect that conspiracy and misinformation beliefs are low in countries with a media-supportive and consensual political system (H6a), but high in countries with a polarized political and media environment (H6b).

DATA AND MEASURES

Design

We collected data through online surveys among a sample of the adult population in eight countries/regions: Belgium, Canada, England, Hong Kong, New Zealand, the Philippines, Switzerland, and the United States ($N = 8,806$). The construction of the online survey was based on the Knowledge–Attitude–Practice model (Bettinghaus, 1986) and, therefore, explored a wide range of aspects, going from risk perceptions and beliefs to positive/negative attitudes and adaptive/maladaptive behaviors. Sociodemographic characteristics were also assessed. The survey contained closed-ended questions only and lasted an average of 18 min per participant. It was pretested among 600 Canadian adults from April 8, 2020 to April 11, 2020, and validated in five different languages (i.e., English, Dutch, Filipino, French, German, Italian, and Chinese). The final surveys were fielded from May 29, 2020 to June 12, 2020 in all countries/regions. This

study was approved by the Research Ethics Board of the CIUSSS de l'Estrie—CHUS (HEC ref: 2020-3674).

Selection of Participants

Recruitment and data collection were carried out by only two polling firms, with the collaboration of international partners, to ensure the standardization of the whole process. Any adults ($\geq$ 18 years) living in each of the eight countries/regions listed above and able to answer an online questionnaire were eligible to participate in the online survey. Participants were randomly recruited from online panels. Several sources were used for the recruitment of panel members, including (a) random recruitment using traditional and mobile telephone methodologies, i.e., recruitment through the firm's call center, and (b) recruitment by invitation, through social media (Facebook and Instagram), through offline recruitment, and through partner programs and campaigns such as the friend recommendation program. Significant efforts were made to maximize the representativeness of the sample by using software generating representative samples of the population and by including hard-to-reach groups through targeted recruitment. The final sample was composed of approximately 1,000 adults per country/region (Généreux et al., 2020). See **Supplementary Appendix A** for a comparison of our study sample to the population in the different countries under study in terms of age and household composition.

Measures

Belief in Conspiracy Theories and Misinformation

We developed two indices regarding *belief in conspiracy theories* (e.g., the pharmaceutical industry is involved in the spread of the coronavirus), one with three items (presented in all regions) and another one with six items (presented in all regions except Hong Kong), each presenting possible conspiracy theories regarding the coronavirus disease. The items originated from a Pew Research Center and Fondation Jean-Jaurès/Conspiracy Watch survey, which was one of the only sources available about COVID-19 and conspiracy beliefs when this study was developed (Fondation Jean Jaurès, 2020). Answer options ranged from 1 (do not agree at all) to 10 (fully agree). Principal component analysis indicated a single component with high internal consistency for both scales (three-item $\alpha = 0.77$; six-item $\alpha = 0.86$). For the exact wording of items and more information regarding the scales, see **Supplementary Appendix B**.

Belief in misinformation was measured through five items, each presenting a news item regarding the coronavirus which was untrue (but not linked to conspiracies) (e.g., the coronavirus cannot be transmitted in warm countries). These items originated from the WHO Mythbusters, a digital platform developed by the WHO to combat misinformation and fake news regarding a number of topics (WHO, 2020b). Answer options ranged from 1 (do not agree at all) to 10 (fully agree). Principal component analysis on these five items indicated a single component with high internal consistency ($\alpha = 0.86$). These factor scores were saved and used in subsequent analyses. For the exact wording of each item and more information regarding the scale, see **Supplementary Appendix C**.

COVID-19 Information Sources

Twelve items were used to assess which channels were used by respondents to gather information about the new coronavirus: federal government, local government, politicians, WHO, health professionals in the media, public health authorities (via press conferences), television, radio, newspapers (on- and offline), social media, the internet, and friends/family. For each mode of information, answer options ranged from 1 (never) to 4 (mainly/always). Principal component analysis on these items indicated four components with an Eigenvalue > 1 and with moderate to high internal consistency. These components were: information through public health experts ($\alpha = 0.70$), political actors ($\alpha = 0.67$), traditional media ($\alpha = 0.71$), digital media and personal contacts ($\alpha = 0.73$). In the descriptive analyses, mean scores of these components were used for ease of interpretation, while factor scores were used in the SEM to increase model parsimony.

Trust in COVID-19 Information Sources

Seven items were used to assess trust in different actors and information sources within society: scientists, doctors and health experts, national health organizations, global health organizations, news organizations, government, politicians, people you know. In order to remain in line with the sources of information, we calculated the mean score of the three items regarding health actors (scientists, doctors and health experts, national health organizations, global health organizations) and the mean score of the two items regarding political actors (government, politicians). Answer options ranged from 1 (do not trust at all) to 10 (fully trust). In the descriptive analyses, mean scores of these components were used for ease of interpretation, while factor scores were used in the SEM to increase model parsimony.

Anxiety and Depression

Two psychological states were assessed: generalized anxiety disorder (GAD) and major depression episode (MDE), using the GAD-7 (Swinson, 2006) and the Patient Health Questionnaire-9 (PHQ-9) scales (Levis et al., 2019), respectively. These two scales are based on the diagnostic criteria for GAD and MDE described in DSM-IV. These seven and nine item scales, respectively, are primarily designed for use by health professionals but are also regularly used in population-based studies. Answer options ranged from 0 to 3, with the high end indicating greater anxiety or depression. We calculated the aggregate score of the items in each scale to use in subsequent analyses.

Socio-Demographic Characteristics

Respondents were asked to indicate age, which was categorized for the purpose of the ANOVA (**Table 4**). Categories were 18–34, 35–54, 55+. Gender was measured by four options (1 = male, 2 = female, 3 = other, 4 = prefer not to answer). Due to the small group size, those identifying as other ($n = 18$) and those who preferred not to answer ($n = 6$) were indicated as missing. Information regarding educational attainment was adapted for each country and harmonized following the data collection (1 = secondary education or lower, 2 = tertiary education or

higher) (**Table 1**). An overview of the Pearson correlations can be found in **Table 2**.

Analytic Plan

As mentioned above, we developed two measures regarding belief in conspiracy theories; one with three items and another with six items. In this analysis, we present the results of the analyses per country using the three-item conspiracy scale because the additional items were not presented in Hong Kong. We conducted robustness analyses with all countries combined (**Supplementary Appendix E**) and with the six-item scale (see **Supplementary Appendix F**) and found no notable differences with the results based on the three-item scale.

In order to investigate country and sociodemographic differences in conspiracy theory and misinformation beliefs, we used independent samples t-tests and one-way ANOVA tests. We then estimated a structural equation model (SEM) for each country or region to investigate associations of exposure to information sources with anxiety and depression, and associations of exposure to and trust in information sources with conspiracy and misinformation beliefs. We also investigated if and how trust in information moderated the effect of exposure. In this model, we controlled for socio-demographic characteristics. We estimated a SEM because of its advantages over OLS regression in three ways in the current study. First, SEM allows for the incorporation of measurement error and offers greater power to detect effects, which is even more important for interaction terms (which we will include in our model) (Sardeshmukh and Vandenberg, 2017). Second, it can test all mediated effects simultaneously if there are multiple mediators—as is the case here. In this study, the relationship between

exposure to information sources and conspiracy/misinformation beliefs may be mediated by both anxiety and depression. The SEM analysis allows the specification of these relationships when testing the joint mediating effects of anxiety and depression. SEM can also compare different mediated effects to determine which one is the largest or test if a specific mediated effect is larger than the direct effect (Li, 2011). Third, SEM remains the preferred method for a confirmatory rather than exploratory approach, i.e., for hypothesis testing and multivariate analyses of structural theory (Lei and Wu, 2007; Frissen, 2021). In that sense, a SEM is desired if we wish to determine to what extent collected data are consistent with specific hypotheses (as is the case here). Hence, in the current study, we chose for SEM as it proves to be a robust way to test whether the expectations as discussed above are confirmed by the data from large-scale samples of eight COVID-affected countries from multiple regions in the world.

RESULTS

In terms of belief in conspiracy theories, one-way ANOVA results signaled significant differences between countries (**Table 3**). Mean scores indicated that respondents from the Philippines ($M = 5.83$), the United States ($M = 5.19$), and Hong Kong ($M = 5.03$) reported the highest scores with regards to conspiracy beliefs. Respondents from Switzerland ($M = 4.31$), but especially Canada ($M = 3.95$) and New Zealand ($M = 3.86$) reported the lowest scores. As for misinformation beliefs, results again pointed to significant country differences. Respondents from same three countries [Philippines ($M = 4.91$), Hong Kong ($M = 4.06$), United States ($M = 3.73$)] reported the highest

TABLE 1 | Descriptive results of individual-level variables (in% or mean scores).

	Belgium	Canada	England	Hong Kong	New Zealand	Philippines	United States	Switzerland	Total
Age (mean)	48.9	48.0	47.5	46.3	46.6	38.2	47.8	49.3	46.6
Gender (%)									
Male	49	48	49	45	48	49	49	48	48
Female	51	51	51	55	51	50	51	52	52
Educational attainment (%)									
Secondary education or lower	65	32	60	38	34	41	24	44	49
Tertiary education or higher	35	68	39	61	64	57	76	55	51
Information sources (mean)									
Health experts	2.4	2.5	2.5	2.5	2.5	3.1	2.5	2.4	2.6
Political actors	2.1	2.4	2.3	2.1	2.3	2.6	2.2	2.4	2.3
Traditional media	2.5	2.1	2.2	2.5	2.4	2.9	2.2	2.4	2.4
Digital media and personal contacts	1.7	1.9	2.0	2.4	2.0	2.8	2.1	2.0	2.1
Trust in information sources (mean)									
Health experts	6.9	7.6	7.5	6.7	7.6	7.8	7.1	7.1	7.3
Political actors	4.7	6.2	5.5	5.0	6.8	6.5	4.9	6.4	5.8
Traditional media	5.8	6.3	6.0	6.5	6.3	7.1	6.0	6.1	6.3
Personal contacts	7.6	7.7	7.7	7.2	8.1	7.6	7.6	7.7	7.6
GAD (mean)	4.9	5.6	6.2	6.4	5.0	6.4	6.8	4.0	5.7
PHQ (mean)	5.0	6.4	7.4	7.0	6.3	6.9	7.6	5.1	6.4
N	1,015	1,501	1,041	1,140	1,000	1,041	1,065	1,003	8,806

1% of respondents are missing for gender, and 1.5% for educational attainment.

TABLE 2 | Pearson correlations, mean scores, and standard deviations of the study variables.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Misinformation beliefs	3.44	2.04	1											
2. Conspiracy beliefs	4.66	2.27	0.60**	1										
3. Exposure: Health experts	2.55	0.74	0.08**	−0.03*	1									
4. Exposure: Political actors	2.31	0.75	0.18**	0.01	0.54**	1								
5. Exposure: Traditional media	2.39	0.78	0.14**	0.05*	0.44**	0.40**	1							
6. Exposure: Digital media and personal contacts	2.12	0.75	0.37**	0.33**	0.29**	0.26**	0.41**	1						
7. Trust: Health experts	7.29	1.87	0.01	−0.19**	0.47**	0.36**	0.26**	0.05**	1					
8. Trust: Political actors	5.77	2.45	0.22**	−0.08**	0.30**	0.50**	0.26**	0.12**	0.61**	1				
9. Trust: Traditional media	6.26	2.24	0.16**	−0.01	0.34**	0.29**	0.38**	0.18**	0.56**	0.52**	1			
10. Trust: Personal contacts	7.64	1.66	0.09**	−0.16**	0.38**	0.42**	0.25**	0.06**	0.81**	0.80**	0.54**	1		
11. GAD	5.67	5.48	0.20**	0.23**	0.05**	0.03**	0.03**	0.20**	−0.06**	−0.07**	−0.01	−0.07**	1	
12. PHQ	6.43	6.41	0.24**	0.26**	0.02	0.04**	0.01	0.19**	−0.06**	−0.05**	0.00	−0.06**	0.82**	1

*p < 0.05; **p < 0.01.

belief in misinformation, while respondents from New Zealand ($M = 3.05$), Canada ($M = 2.75$), and Belgium ($M = 2.62$) reported the lowest beliefs in misinformation. These results support the assumption in H6a: respondents from countries with a media-supportive and consensual political system in this study (Belgium, Switzerland, Canada, England) report some of the lowest conspiracy/misinformation beliefs, although scores for English respondents are markedly higher than for those from other countries in this cluster. Conversely, we also confirm that conspiracy beliefs are higher among respondents in countries with a polarized political and media environment (H6b).

With regards to sociodemographic differences, the results in **Table 4** indicated that there were statistically significant differences in conspiracy beliefs by age and education, with mean scores indicating that younger age categories (18–34: $M = 5.22$; 35–54: $M = 4.81$) and lower educated individuals ($M = 4.83$) held higher conspiracy beliefs than older age categories (55 + : $M = 3.99$) and highly educated individuals ($M = 4.53$). As for misinformation beliefs, we again found that younger age categories ($M = 4.03$ for 18–34), lower educated individuals ($M = 3.52$), and women ($M = 3.33$) were more inclined to believe in misinformation than older age categories ($M = 2.85$ for 55 +), higher educated individuals ($M = 3.36$), and men ($M = 3.56$).

Subsequently, we present the (standardized) direct effects from the structural equation model (SEM). The model was estimated in SAS Version 9.4 using proc calis. Goodness-of-fit indices indicated that all eight models yielded a good fit to the data (RMSEA < 0.08, GFI > 0.90, CFI > 0.95, SRMR < 0.05). We included sociodemographic indicators in all models, but only present them in the full model in **Supplementary Appendixes E,F**. The associations of these indicators with conspiracy and misinformation beliefs were consistent in all regions.

TABLE 3 | One-way ANOVA for country of residence on conspiracy beliefs and misinformation beliefs.

Dependent variables	df	F	Sig.	Country	Mean score
Conspiracy beliefs	7	107.82	0.00	Philippines	5.83
				United States	5.19
				Hong Kong	5.03
				England	4.97
				Belgium	4.35
				Switzerland	4.31
				Canada	3.95
				New Zealand	3.86
Misinformation beliefs	7	172.63	0.00	Philippines	4.91
				Hong Kong	4.06
				United States	3.73
				England	3.51
				Switzerland	3.11
				New Zealand	3.05
				Canada	2.75
				Belgium	2.62

Answer options for both misinformation and conspiracy beliefs ranged from 1 to 10, with the high end of the scale denoting high misinformation/conspiracy beliefs.

Table 5 (see also **Figures 1**, **2**) shows that conspiracy theory and misinformation beliefs were associated with exposure to several information sources about COVID-19—and the interactions with trust in these sources. In all countries except Switzerland, exposure to health experts was associated with lower conspiracy and misinformation beliefs. At the same time, exposure to political actors was associated with greater conspiracy beliefs in the U.S., Hong Kong, and the Philippines, and greater and misinformation beliefs in all countries/regions except Belgium and Canada. In terms of information from traditional media (television, radio, print news), analyses showed greater exposure was negatively associated with conspiracy beliefs and misinformation beliefs in Belgium and Switzerland only. In Canada, exposure to traditional media was associated with lower conspiracy beliefs, and in Hong Kong with lower misinformation beliefs only. Based on these results, we can partially confirm hypotheses 2a and 2b. Conversely, exposure to digital media and personal contacts was associated with greater conspiracy theory beliefs and misinformation beliefs in all countries/regions, confirming Hypotheses 1a and 1b.

The association of exposure to information sources with conspiracy and misinformation beliefs was significantly moderated by trust in these sources in several instances, confirming hypothesis 3. Although results differed between countries, two main trends could be discerned. In several

countries, we found that the effect of exposure to health actors differed by levels of trust: as trust in information from health actors increased, the negative association between exposure to health actors and conspiracy and/or misinformation beliefs became stronger. Furthermore, we also found that the effect of exposure to digital media was moderated by trust in these media: as trust in digital media increased, the (positive) association between exposure to digital media and conspiracy and/or misinformation beliefs increased as well. In short, information from health actors was more likely to be associated with lower conspiracy or misinformation beliefs for those who report high trust in these actors, while information from digital media was more likely to be associated with higher conspiracy or misinformation beliefs among those who report high trust in these media. While there are some additional significant effects of the interaction between exposure to and trust in information sources, there was no clear pattern among these across countries.

Anxiety was not associated with conspiracy or misinformation in most countries, although Hong Kong presents a clear exception. There, a higher score on the GAD was associated with lower conspiracy and misinformation beliefs. We also find similar associations in Belgium and the United States. However, feelings of depression were more strongly associated with conspiracy or misinformation beliefs across countries. In all countries/regions, except Canada and the Philippines, a higher score on the PHQ was associated with greater conspiracy and misinformation beliefs. The results of a robustness analysis of all countries combined (**Supplementary Tables A6**, **A7**) showed that these indicators also mediated the effect of exposure, confirming hypothesis 4 and hypothesis 5. Direct effects indicated that exposure to traditional media was strongly and negatively associated with both anxiety and depression, and that exposure to digital media and personal contacts was positively associated with anxiety and depression. Exposure to health experts was also positively associated with anxiety, while exposure to politicians was negatively associated with these feelings.

Finally, we considered the results of the control variables—which were included in all models. In terms of age, we found that older respondents held greater conspiracy beliefs, but lower misinformation beliefs than younger respondents, and that women held lower conspiracy and misinformation beliefs than men. No clear effects emerge in terms of educational attainment. These results were mostly in line with our earlier findings (see **Table 4**).

TABLE 4 | One-way ANOVA for age, and independent samples *t*-test for gender and educational attainment, on conspiracy beliefs and misinformation beliefs.

Dependent variables	Independent variables	df	F	Sig.	Mean score
Conspiracy beliefs	**Age**	8,781	76.35	0.00	
	18–34				5.22
	35–54				4.81
	55 +				3.99
	Gender	8,781	13.82	0.24	
	Male				4.63
	Female				4.69
	Education	8,710	15.70	0.00	
	Secondary education or lower				4.83
	Tertiary education or higher				4.53
Misinformation beliefs	**Age**	8,781	91.62	0.00	
	18–34				4.03
	35–54				3.54
	55 +				2.85
	Gender	8,781	49.04	0.00	
	Male				3.56
	Female				3.33
	Education	8,710	4.23	0.00	
	Secondary education or lower				3.52
	Tertiary education or higher				3.36

Answer options for both misinformation and conspiracy beliefs ranged from 1 to 10, with the high end of the scale denoting high misinformation/conspiracy beliefs.

DISCUSSION

While the SARS-CoV-2 virus spread rapidly across the globe, many societies were also confronted with an inescapable spread of "viral" phenomena like misinformation and conspiracy theories. Conspiracy ideas and misinformation narratives are considered to be viral because the population dynamics underlying their spread hold many characteristic parallels to those involved in the spread of infections and communicable diseases: (1) they tend to spread at a higher pace through an ecosystem than other ideas, and (2) they might have

serious consequences in terms of public health behavior and public safety (e.g., lower vaccination intentions Jolley and Douglas, 2014) and for political and macro-economic outcomes (decreased trust in governmental and health institutions Lutkenhaus et al., 2019).

The current study set out to investigate who believes in these "contagious" narratives and who does not. More specifically, we aimed to examine how exposure to communication channels is associated with beliefs in conspiracy theories and misinformation. Additionally, we tested the moderating role of

TABLE 5 | Direct standardized effects of predictors on conspiracy beliefs and misinformation beliefs per country.

	Belgium		Canada		England		Hong Kong	
	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs
Exposure to information								
Health experts	−0.16**	−0.03	−0.18***	−0.08*	−0.07*	−0.17***	−0.12**	−0.09**
Political actors	−0.02	0.07	−0.03	0.05	0.00	0.14***	0.10**	0.43***
Traditional media	−0.20***	−0.12**	−0.11**	−0.01	−0.03	0.01	0.03	−0.11**
Digital media and personal contacts	0.25***	0.19***	0.28***	0.21***	0.26***	0.26***	0.27***	0.15***
Interaction trust/exposure								
Health experts	0.15***	0.04	0.09*	−0.03	0.12***	−0.01	−0.08*	0.00
Political actors	0.02	−0.12**	0.04	0.09**	−0.01	0.06	0.10**	−0.06
Traditional media	−0.04	−0.06	0.06*	−0.04	0.04	−0.01	−0.02	0.01
Digital media and personal contacts	−0.05	−0.01	0.02	0.04	0.03	−0.04	0.12***	0.15***
GAD	0.04	−0.12*	0.05	−0.01	0.09	0.04	−0.15**	−0.23***
PHQ	0.12*	0.16**	0.07	0.08	0.16**	0.13*	0.37***	0.41***

	New Zealand		Philippines		Switzerland		United States	
	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs	Conspiracy beliefs	Mis information beliefs
Exposure to information								
Health experts	−0.21***	−0.10**	−0.06	−0.10*	−0.05	−0.07	−0.18***	−0.20***
Political actors	0.03	0.09*	0.05*	0.16***	−0.06	0.08*	0.07*	0.25***
Traditional media	−0.02	0.00	0.02	0.04	−0.16**	−0.08*	−0.03	0.03
Digital media and personal contacts	0.31***	0.28***	0.09*	0.09*	0.33***	0.26***	0.32***	0.26***
Interaction trust/exposure								
Health experts	0.10*	0.06	−0.01	−0.03	0.11**	0.02	0.09*	−0.02
Political actors	0.13**	0.02	−0.06	−0.08	0.08*	−0.04	0.08*	0.03
Traditional media	−0.09*	−0.07*	0.03	0.13**	−0.00	0.00	0.01	0.02
Digital media and personal contacts	0.09**	0.07*	−0.03	0.09*	0.03	0.04	0.08*	0.16***
GAD	−0.04	−0.05	0.11*	0.07	0.08	0.04	−0.08	−0.13*
PHQ	0.24***	0.26***	−0.01	0.00	0.13*	0.11*	0.21***	0.26***

*$p < 0.05$; **$p < 0.01$, ***$p < 0.001$. This analysis also includes sociodemographic indicators.*

one's trust in these information and communication channels as well as the mediating role of depression and anxiety. Given the unprecedented global nature of the deeply mediatized COVID-19 pandemic, a cross-country comparison seemed to be the most appropriate method. Data collected in eight different countries across the globe at the height of the COVID-19 pandemic in late May 2020 provided interesting new insights.

The extent to which people believe in COVID-19 conspiracy theories and misinformation varies significantly across the various geographical regions as well as by socio-demographic characteristics. The Philippines, United States, and Hong Kong ranked as the top three for beliefs in conspiracy theories and misinformation. Significantly lower scores for both beliefs were found for Switzerland, Canada and New Zealand and Belgium. This finding suggests that citizens of specific countries in our dataset (Philippines, Hong Kong, and the U.S.) are more susceptible to these narratives while others (Canada, New Zealand, Switzerland, and Belgium) are more resilient. A potential explanation is the different political, media, and economic climates of the countries under scrutiny. Indeed, as recently theorized by Humprecht et al. (2020), a country's resilience to misinformation and conspiracy theories depends on several political, media-systems related, and economic indicators such as the level of societal polarization in the nation and the amount of populist and partisan communication; the strength of public service media, and the overlap or fragmentation of news media audiences; and the adoption of social media. While a systematic, comparative analysis of these indicators on a global scale is lacking, it seems safe to claim that the Philippines (with the election of president Rodrigo Duterte Webb and Curato, 2019), Hong Kong [with its highly partisan media landscape and the on-going polarization around the question of independence (Wu and Shen, 2020)], and the United States [with the polarizing presidency of Donald Trump, the large advertising and social media markets, and the fragmented news media landscape (Mudde and Kaltwasser, 2018; Humprecht et al., 2020)] are indeed confronted with higher levels of populism and societal polarization and with weaker public service media systems compared to countries like Switzerland, Canada, and Belgium (e.g., Frissen et al., 2020).

In terms of socio-demographics, some interesting findings came to light. First, age was significantly associated with misinformation beliefs and conspiracy beliefs: younger respondents believed more strongly in these narratives than the older generations. This suggests that with age, one develops some type of resilience to misinformation. Second, gender was a significant factor for believing in misinformation but was not significant for conspiracies. Third, believing in conspiracies (but not misinformation) differed significantly across educational attainment: the higher the educational attainment, the weaker the belief in the COVID-19 conspiracy theories. While not significant, the opposite trend was found for misinformation beliefs. Although this corroborates previous findings (van Prooijen, 2017), our results indicate that misinformation and conspiracy theories are indeed similar, but substantially different, misinformation phenomena, particularly in terms of

an individual's susceptibility to these beliefs. It suggests that, in contrast to believing in conspiracy theories, misinformation beliefs are to a lesser extent a question of an individual's level of education or news media literacy. In fact, highly educated people do not believe substantially less in misinformation narratives than lower educated people. Yet, the question of why this is the case remains still unanswered.

Beliefs in conspiracy theories and misinformation tend to be negatively associated with exposure to traditional media and positively associated with digital media and personal contacts. More specifically, exposure to COVID-19 related information through traditional news media sources such as newspapers, radio, and television, is associated with lower beliefs in conspiracy theories and misinformation narratives in Belgium and Switzerland. At the same time, exposure to digital media to acquire COVID-19 information is associated with greater conspiracy beliefs and misinformation in all countries/regions. With these results, we build on the findings of earlier studies that suggested that conspiracy thinking was rather associated with an avoidance of established and traditional media (Boberg et al., 2020), and that the digital media ecosystem rather than the traditional news media, is a hotbed for the development of mis- and disinformation beliefs (Shu et al., 2016; Vosoughi et al., 2018). In line with previous literature, we also found that exposure to health experts is associated with lower conspiracy beliefs (Humprecht et al., 2020). One would expect that more exposure to information from political actors would also decrease beliefs in conspiracies and misinformation, but surprisingly, results showed that this exposure is associated with greater conspiracy and misinformation beliefs in Hong Kong, the United States, and the Philippines, and not associated with these beliefs in most other countries/regions. This relationship may seem somewhat puzzling and provokes additional questions. Does this suggest that trust in politics functions in fact as a catalyst for beliefs in misinformation, which contrasts previous studies (e.g., Humprecht et al., 2020)? We do not think so. During these uncertain times, audiences depend on and trust politicians to convey accurate and up-to-date information so that they can make informed decisions regarding their personal health. However, insights about COVID-19 shift at a rapid pace, and information that is widely disseminated by media and politicians, is sometimes contradicted by the same actors a few days or weeks later due to new scientific insights into the virus (see worldwide discussions regarding the effectiveness of facemasks to decrease the odds of transmitting COVID-19) (Apuke and Omar, 2020; Pennycook et al., 2020). This ambiguity will result in higher appraisals of threat, stress or anxiety among audiences (Garfin et al., 2020). Such situations "may lead to the rapid generation of hypotheses, conjecture, and potentially CTs [conspiracy theories], particularly when the person is exposed to large volumes of information" (Georgiou et al., 2020, p. 2). This immediately explains some interaction effects we found as well—it is precisely those individuals who trust politicians most and are most exposed to them, that will feel the greatest need to believe in sometimes far-fetched theories to make sense of the ambiguous or contradictory information

FIGURE 1 | Direct standardized effects of predictors on conspiracy beliefs per country.
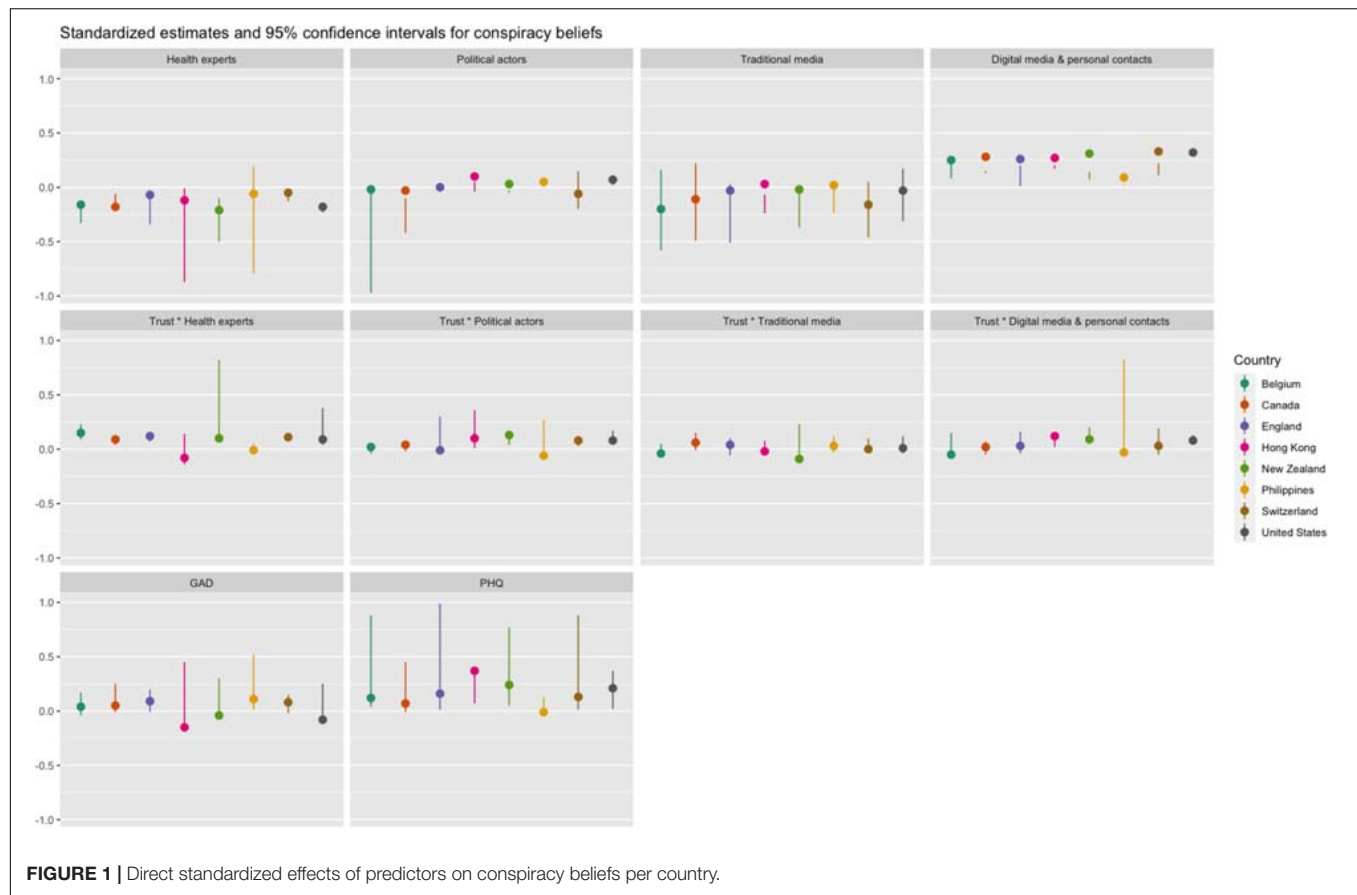
they regularly receive during the current crisis. The same goes for individuals with high exposure to and trust in digital media and personal contacts; they report greater misinformation beliefs. They consume a lot of (conflicting) information from information sources that they trust, which stimulates anxiety, stress, and fear. In order to make sense of this situation—and thus reduce anxiety—they generate or believe alternative explanations for this informational ambiguity. Important to note in this regard is that these cross-country results are likely driven by dynamics within a few countries in our study (e.g., the United States, Hong Kong, the Philippines—the same countries from which respondents reported the greatest conspiracy and misinformation beliefs).

Our data show that anxiety was not strongly associated with conspiracy beliefs or misinformation beliefs in most regions, while depression was associated with higher beliefs in both misinformation and conspiracy theories. Both indicators mediate the relationship between exposure to information sources and conspiracy/misinformation beliefs. This seems to be best interpreted by looking at the intersection between (coping with) stress, uncertainties, and threats on the one hand, and Beck's cognitive theory of depression (Beck, 1967), on the other hand.

Even though we did not include stress as a measurement in the current study, previous studies have shown that stressful life events are a significant predictor for beliefs in conspiracy theories above and beyond other psychological distress factors

such as anxiety (Swami et al., 2016). Nevertheless, we encourage future studies to look into the cognitive-theoretical approach more in detail in order to come to a better understanding of the association between depression and beliefs in misinformation and conspiracy theories.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The findings of the present study are subject to some limitations. First and foremost, while we use data from eight different countries, all our data were cross-sectional. This means that none of the findings in the current study should be interpreted as causal but rather as correlational. Because there is no temporal ordering between data points, all arrows in the model follow merely theory-driven hypothesized paths. Recent examples of internationally comparative studies on the COVID-19 pandemic where the relationship between misinformation beliefs and anxiety and depression was reversed also exist (Généreux et al., 2020). We can only test causality and/or reciprocity if we use a multi-wave research design consisting of at least three time points (Ployhart and MacKenzie, 2015). That being said, we encourage future studies to investigate whether these associations follow the hypothesized directions by means of a longitudinal research design.
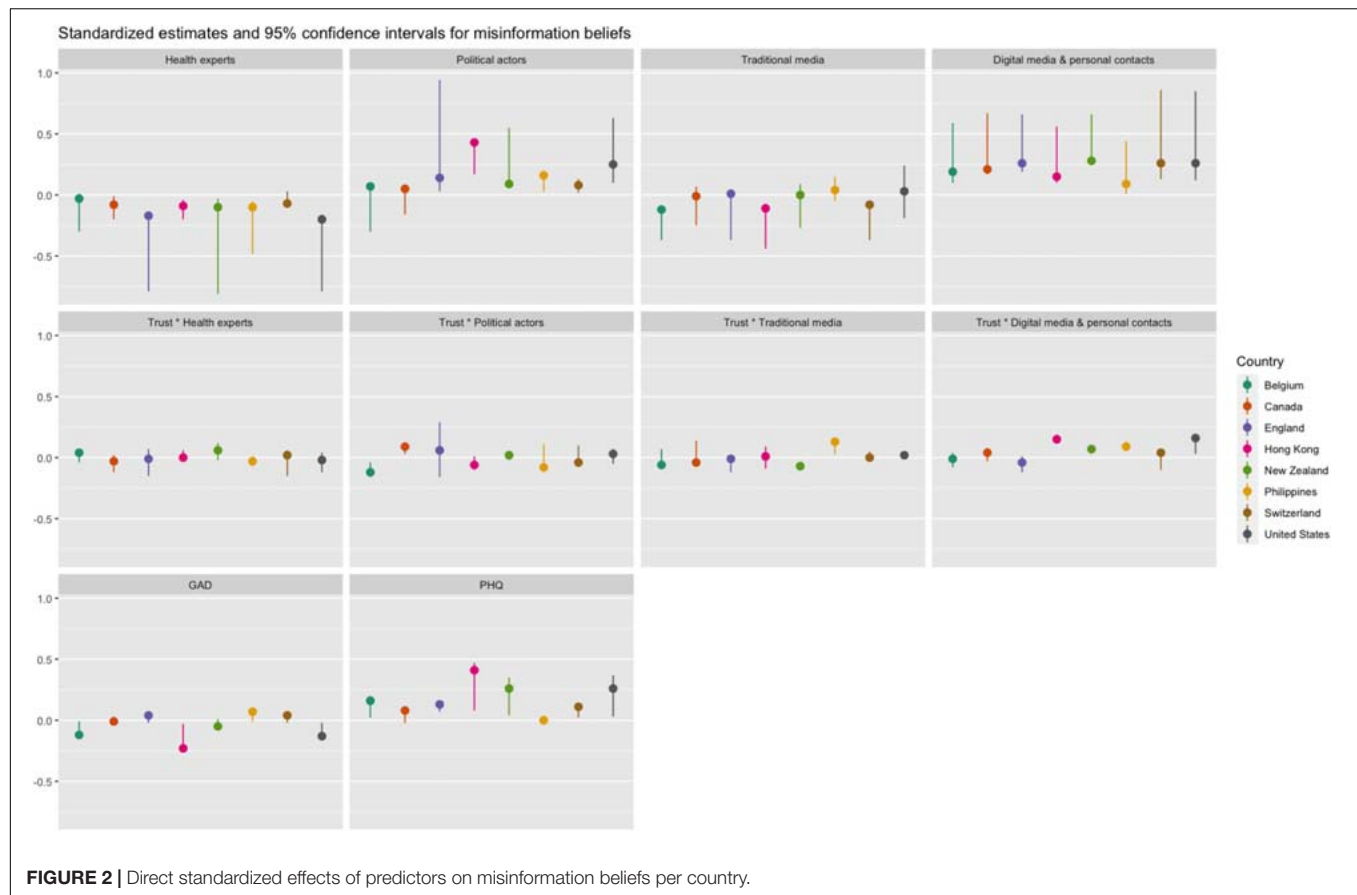
FIGURE 2 | Direct standardized effects of predictors on misinformation beliefs per country.

Second, while we collected data in eight different countries, it should be noted here that our cross-country comparison has also some limitations. At the moment of collecting the data (May 29, 2020–June 12, 2020 in all countries) several countries were in different stages of the pandemic. For example, whereas Hong Kong and several European countries already passed a first peak in terms of COVID-related deaths, cases in the United States were still surging. This means that our results should be interpreted with this in mind and may also provide potential explanations for (the lack of) some effects. Particularly in regions where the peak of the first COVID-19-wave had passed at the time of the study, media effects were smaller or absent, while they were more pronounced in regions in which the infection rate was still growing.

CONCLUSION

While the world is fighting a pandemic, it is also fighting an infodemic (WHO, 2020b) in which falsehoods tend to spread faster, further, and more easily than truths. In reaction to this, people everywhere in the world have retrogressed back to their trusted, traditional news media channels as their main providers of pandemic-related information, but they have also become more inclined to believe conspiracy theories and misinformation. The latter is specifically the case when exposure to digital

media and politicians is high, but less so when exposure to traditional media and health experts is high. Our comparative analysis of eight regions around the world suggests that this might be a result of the increasing occurrence of mis- and disinformation about the COVID-19 pandemic on digital media and the conflicting information that originates from politicians, while mainstream news media commonly attempt to "debunk" misinformation and conspiracy theories. Additionally, schemata and other cognitive processes that are associated with a sense of uncertainty and stress might set in motion a never-ending chain reaction in which people seek for more information to reduce uncertainty and stress, but in contrast stumble upon stress-evoking discourses.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Board of the CIUSSS de l'Estrie—CHUS. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FUNDING

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.646394/full#supplementary-material

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The Effect of Frames on COVID-19 Vaccine Resistance

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In order to control the spread of infectious diseases such as COVID-19, it will be important to develop a communication strategy to counteract "vaccine resistance", that is, the refusal to take the COVID-19 vaccine even when available. This paper reports the results of a survey experiment testing the impacts of several types of message content: the safety and efficacy of the vaccine itself, the likelihood that others will take the vaccine, and the possible role of politics in driving resistance to the vaccine. In an original survey of 1,123 American M-Turk respondents conducted in the summer of 2020, we provided six different information conditions suggesting the safety and efficacy of the vaccine, the lack of safety/efficacy of the vaccine, the suggestion that most others would take the vaccine, the suggestion that most others would not take the vaccine, the suggestion that the vaccine is being promoted by liberals to gain greater control over individual freedom, and the suggestion that its approval is being by President Trump rushed for political motivations. We compared the responses for those in the treatment groups with a control group who received no additional information. In comparison to the control group, those who received information about the safety/efficacy of the vaccine were more likely to report that they would take the vaccine, those who received information that others were reluctant to take the vaccine were more likely to report that they themselves would not take it, and those who received information about political influences on vaccine development expressed resistance to taking it. Communication of effective messages about the vaccine will be essential for public health agencies that seek to promote vaccine uptake.

Keywords: COVID-19 vaccination, public opinion, framing, survey-experiment, vaccine resistance

INTRODUCTION

Vaccination programs have reduced the toll of infectious diseases by preventing infection or reducing the severity of symptoms, contributing to higher standards of public health by lowering morbidity and mortality rates (Andre et al., 2008). But vaccination programs are effective in providing herd immunity only when they are accepted by large segments of the population. Response to a vaccine can be understood as a continuum ranging from outright refusal to active demand for immediate uptake (Dubé et al., 2013; Larson et al., 2014). *Vaccine resistance*, defined as the unwillingness to get vaccinated when one is available (Lazer et al., 2021), has been identified by the World Health Organization as one of the top ten threats to global health (World Health Organization 2019; Puri et al., 2020). According to the COVID States Project, 21% of adults in the United States in February 2021 were considered "vaccine resistant", while 31% were classified as "vaccine hesitant", indicating

that they preferred to wait until others have been vaccinated before making a personal decision on the matter (Simonson et al., 2021). In the COVID-19 pandemic of 2020–2, as in future outbreaks of vaccine-preventable illness, it will be important to combat this resistance/hesitancy and to promote vaccine uptake through effective communication strategies (Nyhan et al., 2014; French et al., 2020).

An understanding of how different types of information may influence the public's beliefs and vaccination intentions is required in order to develop an effective communication strategy. The contribution of this paper is the examination of the causal effect of exposure to pro- and anti-vaccination message frames on individuals' reported likelihood of getting vaccinated for COVID-19. The case study we examine here is the situation in the summer of 2020 surrounding beliefs about a vaccine for COVID-19 that had not yet been approved, but the implications are transferrable to the acceptance of vaccines developed in the future as well.

FRAMING EFFECTS AND VACCINATION RESISTANCE VS. UPTAKE

Communication about the development and testing of any vaccine is transmitted through "frames" used in the message. For example, a *media frame, or frame in communication*, refers to "words, images, phrases, and presentation styles that a speaker (e.g., a politician, a media outlet) uses when relaying information about an issue or event to an audience" (Chong and Druckman 2007, 100). An *emphasis framing effect* occurs when exposure to a media frame causes an audience to privilege the specific consideration(s) made salient when forming an overall opinion on any issue (Druckman 2001). For example, the *New York Times* published an article on November 19, 2020 that announced the results from a successful COVID-19 vaccine trial with the headline, "Pfizer Says New Results Show Vaccine is Safe and 95% Effective" (Thomas 2020). Similarly, NBC News ran a story on December 9, 2020 that was headlined, "FDA: Pfizer's COVID-19 Vaccine Safe and Effective After One Dose" (Edwards 2020). This emphasis in the news on the safety and efficacy of the vaccine and its potential to prevent mild and severe forms of COVID-19 highlights an important positive "frame", or "subset of potentially relevant considerations", that may influence attitudes about whether or not to get vaccinated, an important antecedent of the actual behavior (Ajzen 1991). We focus exclusively on *emphasis framing effects* and not *equivalency framing effects* that occur when positive or negative information unconsciously influences preferences (Tversky and Kahneman 1981; Druckman 2004).

The empirical study described here contributes to the understanding of the impact of message framing on vaccine resistance/uptake. We tested the impacts of several types of emphasis frames: two emphasizing the safety and efficacy (or their absence) of the vaccine, two emphasizing the likelihood that taking the vaccine would be in accord (or not) with general social norms, one suggesting that the entire discussion of vaccines is being shaped by "radical liberals" and media elites who want to

exert more government control over individual behavior, and one suggesting that President Trump is pressuring the FDA to rush the approval of a COVID-19 vaccine in order to provide an "October Surprise" that might boost his chances of re-election. Given the polarizing nature of media coverage surrounding the vaccine's development and approval process in the months leading up to August 2020 when our study was fielded, we anticipated that the effectiveness of the "political frames" might depend on whether the respondents' political in-group was cast in a positive or a negative light.

Because of its significance to public health, there have been numerous studies of the factors that cause vaccine hesitancy and resistance (Hornsey et al., 2018; Puri et al., 2020; Thunstrom et al., 2020). Most of the studies have focused on decision-making in the context of parents vaccinating their children, the acceptance of the HPV vaccine, or decision-making with respect to uptake of the flu vaccine (Brewer et al., 2007; Dubé et al., 2013; Smith et al., 2017; Kim et al., 2019; Callaghan et al., 2020). In a review of 316 articles on framing in health communication, Guenther et al. (2020) noted that most experimental studies to date have focused on the relative persuasiveness of "gain" as opposed to "loss" frames. In other words, these studies look at the relative persuasiveness of frames that emphasize the "gains" of taking an action or compliance as opposed to the "losses" of not engaging in a particular behavior or noncompliance (e.g., applying sunscreen, scheduling a cancer screening exam, getting vaccinated). Issue frames that are applicable to a single issue or emphasis frames that emphasize different dimensions of an issue are the dominant form of political communication (Druckman 2001; Brugman and Burgers 2018). As Penta and Baban (2018) noted, there has been insufficient scholarly attention to effective messages that appear in the context of realistic news settings, and additional work is needed to better understand how to craft effective interventions that promote vaccine uptake.

Vaccine Safety and Efficacy

The influence of perceived safety on vaccine resistance has been a finding of several meta-analyses of the scientific literature. In a review of 2,791 studies published between 1990–2019, Sweileh (2020) found that although the reasons for vaccine refusal varied depending on the disease and on the cultural and national context, the overwhelming reason was fears about the safety of the vaccines. Yaqub et al. (2014) reviewed 1,187 articles published between 2009 and 2012, primarily about HPV and flu vaccines, and found that "fear of adverse side effects and vaccine safety" were the leading reasons for hesitancy or refusals, both in the general population and among healthcare professionals. Similarly, a review of 2,895 articles in English, French and Spanish from 2004–2014 (Karafillakis and Larson 2017, 4,846) found that although different concerns were expressed about vaccine safety for different types of vaccines, the "largest area of concern was vaccine safety." In a study of childhood vaccine safety, van der Linden et al. (2015) found that agreement with a statement that "90% of medical scientists agree that vaccines are safe" was the most important predictor of public support for vaccines. Similarly, an analysis of 25 national samples from 12

different countries showed that "trust in experts" was the most consistent predictor of vaccine acceptance (Kerr et al., 2020). Finally, a more recent study found that presenting individuals with information specifically about a COVID-19 vaccine's safety increased Americans' plans to get vaccinated (Motta 2021).

Along with safety, the efficacy of a vaccine is also important in the decision-process (Motta 2021). In a study manipulating an H1N1 vaccination message along with perceived safety, efficacy, susceptibility to the disease and severity, Nan et al. (2012), Nan et al. (2016) found that the most important factor in the acceptance of the vaccine among older adults was perceived efficacy. Similarly, Chapman and Coups (1999) found that perceived efficacy of the flu vaccine was the most important factor in its acceptance by healthy adults, followed closely by the likelihood that it would not have side effects. News stories focused on considerations about the safety and efficacy of any COVID-19 vaccine has been persistent from the fall of 2020 to the present.

In the case of the COVID-19 vaccine, based on the large body of empirical literature emphasizing the importance of both safety and efficacy in the decision to accept a vaccine, we propose the following: *Individuals presented with a message that emphasizes the safety and effectiveness of a vaccination for COVID-19 will increase their intentions to get vaccinated* (**Hypothesis 1a**). *Individuals who are presented with a message that emphasizes the lack of safety and potential ineffectiveness of any approved vaccine for COVID-19 will decrease their intentions to get vaccinated* (**Hypothesis 1b**).

Normative Social Influence

A long scholarly tradition has demonstrated the impact of "social norms" on behavior changes. Social norms are the "tacit rules that members of a group implicitly recognize and that affect their decisions and behavior" (Brewer et al., 2017, 170). Cialdini et al. (1991) distinguished two distinct types of social norms: those that are "injunctive", informing people about what is approved or disapproved, and those that are "descriptive" of typical or common behavior. Examples of experimental manipulations of social norms to change behavior include studies of college binge drinking (Perkins and Craig 2002), smoking (Linkenbach et al., 2003), hotel towel reuse (Goldstein et al., 2008), and energy conservation (Schultz et al., 2007; Bolsen 2013).

The underlying principle for the operation of descriptive social norms is that most people want to bring their behavior in line with what they perceive to be the behavior of others (Brewer et al., 2017). A descriptive social norms marketing campaign will therefore outline what a majority of people are doing in order to get the target audience to conform. Research has shown that "strategic messaging" that highlights a social norm can have an influence on behavioral decisions ranging from voting (Gerber et al., 2008) to using weight-loss products (Lim et al., 2020) or charitable giving (Croson et al., 2009). Indeed, the application of the scholarly findings about social norms into popular marketing has been familiar in the multitude of advertisements that suggest that "everyone else" is buying or participating in what is being sold (Melnyk et al., 2019).

Social norms may also have a negative effect on behavior because the perception that "everyone is *not* doing it" will decrease the intention to act (Kahan 2014, 4). In such instances, even when the intention is to increase the acceptance of a behavior, communicating that people are not adopting this behavior may have the unintended effect of decreasing engagement in the pro-social behavior being promoted (Murray and Matland 2014; Palm et al., 2020; Rimal and Real 2005; but see; Hassell and Wyler 2019).

Several studies have examined the impact of social norms on the adoption of various vaccines (Xiao and Borah 2020). Allen et al. (2009) found that social norms, that is, the perceived behavior of friends who either had already been vaccinated or were considering the vaccine, were the strongest predictors of the intent to be vaccinated against human papillomavirus (HPV). Brunson (2013) identified the role of descriptive social norms in parental decisions about their children's vaccinations. De Bruin et al. (2019) documented the impact of perceived vaccine coverage in the social circle (defined as people with whom the respondent had regular contact) on vaccination behavior for influenza. Similarly, Parker et al. (2013) found that social influence, that is, the likelihood that people around the respondent were being vaccinated, was the most common reason for choosing to get a flu vaccine.

Because of the consensus in the literature concerning the likelihood that people will try to make their behavior conform with their perceptions of the behavior of others, we hypothesize that: *Exposure to a message that emphasizes other Americans' willingness to get vaccinated for COVID-19 will increase individuals' intentions to get vaccinated* (**Hypothesis 2a**). Conversely, *exposure to a message that emphasizes other Americans' unwillingness to get vaccinated for COVID-19 will decrease individuals' intentions to get vaccinated* (**Hypothesis 2b**).

Politicization and Vaccine Resistance/ Uptake

Vaccine resistance not only has a long history, but it also reflects "historical events and individual belief systems reflective of different societal periods" (McAteer et al., 2020, 703). Not surprisingly, then, the issues around the development of a COVID-19 vaccine too have become an issue intertwined with politics in the United States. The public has become sharply divided about all aspects of the science surrounding COVID-19 from the viruses' origin (Bolsen et al., 2020) to perceptions about the effectiveness of various government policies seeking to mitigate its impacts (Rutjens et al., 2021). A content analysis of newspaper and television coverage surrounding the issue from March to May 2020 showed that politicians were featured as often or more often than scientists (Hart et al., 2020). A recent survey in the US found that an increase in conservatism also increased the odds of vaccine resistance; moreover, those who intended to vote for President Trump in 2020 were 35% more likely to report that they would refuse a COVID-19 vaccination (Callaghan et al., 2020). Another study reported that when Republicans were exposed to an anti-vaccination argument posted on Twitter by President Trump, they became more concerned about getting vaccinated (Hornsey et al., 2020).

While conservatives have expressed higher levels of hesitancy toward a COVID-19 vaccine, President Trump stated publicly that approval of a vaccine before November would help his chances for re-election (Irfan 2020). If this rhetoric creates a perception that political interference occurred on the part of the Trump administration to pressure the FDA for rapid approval, this politicization of the vaccine may have contributed further to vaccine resistance, especially on the part of Democrats who may be motivated to view the President's decisions about the vaccine as being driven by political goals (Taber and Lodge 2006; Bolsen and Palm 2019). The *New York Times* published an article voicing concerns about an October Surprise before Election Day and fear that the FDA might approve a vaccine too hastily in order to please the President (Emanuel and Offit 2020). Given this context, we hypothesize that *individuals who are exposed to a "political message" stating that the COVID-19 vaccine is being rushed by President Trump for approval prior to Election Day will increase vaccine resistance* (**Hypothesis 3a**). We anticipate that this effect is likely to be most pronounced among Democrats given their distrust toward President Trump as members of a political out-group during a divisive election.

Another political argument that surfaced in United States media was that the government should require "compulsory vaccinations" for COVID-19 "to win the war against the novel coronavirus" (Lederman et al., 2020). This rhetoric sometimes appeared alongside claims that "Operation Warp Speed" was a way to further regulate the lives of Americans and enrich drug companies. This sort of rhetoric feeds into concerns about "big government" regulating the lives of individuals and usurping personal choices about private health matters (Kavalski and Smith 2020; Dougherty 2021). We hypothesize that *a message that emphasizes that the liberal media is pushing for "mandatory vaccinations" and "immunization cards" will increase vaccine resistance* (**Hypothesis 3b**). We anticipate that this effect is likely to be most pronounced among Republicans given the information is associated as coming from the "liberal media" and being used to advance an agenda that includes greater government regulation and restrictions on personal freedom (Taber and Lodge 2006; Palm et al., 2020).

METHODS AND MATERIALS

We implemented a survey-experiment in August 2020 in which we randomly assigned 1,123 respondents, recruited from Amazon's Mechanical Turk (MTurk), to one of six experimental conditions that varied emphasis frames about a COVID-19 vaccine or to a control condition. MTurk is an online crowdsourcing platform commonly used in the social sciences to estimate causal relationships; the results are comparable to identical studies fielded on general population samples (Mullinix et al., 2015; Levay et al., 2016). We restricted the sample to United States respondents who had successfully completed at least 100 tasks and had at least a 95% approval rating on MTurk. The sample was large and diverse with respect to demographic and political characteristics: for instance, 41% of respondents identified as Republicans, 22% identified as

Independents, and 37% identified as Democrats. Further, our sample is 55% female and 45% male. Other descriptive statistics for the sample are available in the **Supplementary Appendix Table A1**.

Experimental Treatments and Conditions

Participants in all conditions completed an IRB-approved consent form and were informed that they would be asked some questions about their opinions related to a COVID-19 vaccine. To complete the survey, respondents had to check a box to indicate they had read the following debriefing statement: "At present there is no FDA-licensed vaccine to prevent COVID-19. Vaccines have been highly effective in preventing a range of serious infectious diseases. The FDA has the scientific expertize to evaluate any potential COVID-19 vaccine candidate regardless of the technology used to produce or to administer the vaccine. This includes the different technologies such as DNA, RNA, protein and viral vectored vaccines being developed by commercial vaccine manufacturers and other entities. For factual information about the regulation of COVID-19 vaccine development, please consult this website from the Food and Drug Administration." We also provided a link to the FDA website from which this language was drawn.

Respondents randomly assigned to the *control* condition ($N = 157$) were not exposed to any information prior to answering our key outcome measures (described below). Respondents randomly assigned to one of six other conditions were exposed to a message that was about 220 words long. The message varied the emphasis frame in the story's headline and content of a short "article" formatted to mimic a news story about a COVID-19 vaccine. **Table 1** reports the headline and full wording we incorporated into each experimental treatment. We used information from published news articles as the basis for our messages, although we edited them for length and reading level (e.g., Bump 2020; Cornwall 2020; Lederman et al., 2020; National Institutes of Health, 2020; Weixel 2020). Because we were attempting to simulate actual news articles, the "descriptive-norm" and "political" versions of our treatments also made reference to the vaccine's safety and effectiveness to situate these frames in a realistic news-story context. In the real world, frames are often encountered in a context where a mixture of distinct or even competing frames may be present (Chong and Druckman 2007). The treatments were reflective of real-world news stories, but we acknowledge that this design makes it more difficult to isolate aspects of the stimuli that may be driving any observed impact on respondents' vaccination intentions.

Respondents randomly assigned to the ***safe and effective*** condition ($N = 172$) were presented with the headline, "Scientists Are Working on a Safe and Effective COVID-19 Vaccine", followed by information that a vaccine would be "safe, have few side effects, and most of all, will be effective in preventing the illness" and that it will have been "carefully tested and evaluated by scientists and medical professionals" (NIH 2020). Respondents assigned to the ***unsafe and ineffective*** condition ($N = 159$) were presented with the headline, "A COVID-19 Vaccine is Neither Effective nor Safe", followed

TABLE 1 | Experimental treatments.

Scientists are working on a safe and effective COVID-19 vaccine [*N = 172/Safe and effective*]

Scientists around the world are working on a vaccine in order to end the COVID-19 pandemic. The vaccine would prevent infection from the virus, or at least reduce its symptoms. At present, we have been asked to wash our hands frequently, avoid close contact in public places and wear a face-mask or cloth covering. These measures help reduce the rate of spread of the disease. However, it is clear that the only way to end the pandemic will be an inexpensive, widely available, safe and effective vaccine. A new vaccine will either prevent the disease or at least reduce its severity. In the United States, the FDA (food and drug administration) has set high standards so that when an approved vaccine is released, it will be safe, have few side-effects, and most of all, will be effective in preventing the illness. The vaccine safety system overseen by the FDA ensures that the vaccine has been carefully tested and evaluated by scientists and medical professionals. The FDA monitors the *manufacture* of the vaccine to ensure its safety, purity, potency and effectiveness. The vaccine will make everyone safer by stopping the spread and severity of the disease.

A COVID-19 vaccine is neither effective nor safe [*N = 159/Unsafe and ineffective*]

Throughout time, various viruses and bacterial diseases have emerged and humanity has survived all of them without vaccines. In fact, scientists tell us that in the case of the novel coronavirus (COVID-19), we can go back to living a normal life again once we develop a kind of "herd immunity". Sweden developed that kind of herd immunity not by closing businesses or taking vaccines, but instead simply by social distancing. There are other issues with any COVID-19 vaccine. First, the vaccine will not be very effective. The FDA (food and drug administration) will approve a vaccine that shows only 50% efficacy. This means that all those who are vaccinated are not immune, but instead will be only 50% less likely to get the disease. Second, the vaccine may have serious side-effects, such as diarrhea, headaches, narcolepsy or even worse. And these side-effects may develop long after this new vaccine is administered, so they won't be anticipated in the first roll-out of the vaccine. Third, any immunity from a new vaccine is likely to last only a few months, and then another round of vaccinations would be necessary. Recent flu vaccines, with effectiveness ranging from only 19–60% in the past 10 years, last only one season, and the immunity can disappear before the end of the winter.

Most americans say they will get vaccinated against COVID-19 [*N = 171/Willing*]

The COVID-19 pandemic has disrupted everyday life in the United States in many ways. A safe and effective vaccine will reduce the spread of this disease. Most americans are looking forward to the approval of such a vaccine so that they can become immunized against COVID-19. The results from a recent tracking survey indicated widespread willingness in the United States to take a COVID-19 vaccination. Vaccination is one of the most successful public health advancements in human history. Vaccines have reduced the spread of disease and prevented millions of unnecessary deaths. In the past, scientists have developed vaccines that have cured diseases like measles, small pox, and polio. Vaccines work with the body's natural defenses to safely develop immunity to the disease. Public health experts say that the only way to end the COVID-19 pandemic will be the development of an inexpensive, widely available, safe and effective vaccine. Most americans report that they plan to become vaccinated against COVID-19 when the vaccine becomes available. More than two-thirds of all americans, and more than three-fourths of those over the age of 55 would take the vaccine. This high level of vaccine acceptance by each and every american is important for our nation to wipe out this pandemic.

Many americans say they will not get vaccinated against COVID-19 [*N = 157/Unwilling*]

Even if a vaccine were FDA-approved and available to them at no cost, many americans say they will not get vaccinated for COVID-19. The results from a recent gallup tracking survey indicated widespread reluctance in the U.S. to take any COVID-19 vaccination. When asked why they were reluctant to be vaccinated, most responded that they do not trust vaccines or that it is not actually necessary. All medications and vaccines have potential risks that must be carefully weighed against any benefits. Response to any vaccine depends on factors such as a person's immune system, age, and physical condition. Vaccines such as those developed to protect against the flu virus have only been effective 20–60% over the past 10 years. The FDA will approve a COVID-19 vaccine if it is at least 50% effective, which many think is too low a threshold. Part of americans' hesitation to take the vaccine may stem from the belief that private companies and governments are "rushing through" clinical trials for a COVID-19 vaccine. This rush to produce a vaccine could lead to shortcuts that result in harmful side effects. The basic history lesson when it comes to vaccines and immunization is that there has always been a risk and there will always be a risk.

Liberal media pushing agenda for "mandatory vaccinations" and "immunization cards" [*N = 149/Agenda*]

Vaccines are notoriously difficult to make; the vaccine for mumps, the fastest ever developed, took 4 years. Through "operation warp speed" the government is paying billions of dollars to the pharmaceutical companies to develop and manufacture a vaccine to fight COVID-19. The United States *Today* published an editorial recently stating that the "only answer" to "win the war against the novel coronavirus" in America is "compulsory vaccination–for all of us." people would be required to get an immunization card for the government to monitor compliance. Those who refuse to be vaccinated "could lose tax credits" and "private businesses could refuse to employ or serve" them. Radical liberals clearly are using the debate over COVID-19 vaccinations to advance an agenda of more government control over people's personal lives. Amnesty international says it is a basic human right that people should be able to "make our own decisions about our health and body" without fear of being discriminated against. The basic history lesson when it comes to vaccines and immunization is that there has always been a risk and there will always be a risk. Individuals should decide whether they want to take that risk–not government!

President trump pushing for rapid approval of a COVID-19 vaccine [*N= 158/Trump*]

President trump launched "operation warp speed" earlier this year. It is a groundbreaking partnership between the federal government, scientific community, and private sector to develop a vaccine for COVID-19. The project's goal is to have 300 million vaccine doses available in record time. "That means big and it means fast," trump said when he announced the initiative. "A massive scientific, industrial and logistical endeavor unlike anything our country has seen since the manhattan project." some have worried that president trump might pressure the United States food and drug administration (FDA) to approve a COVID-19 vaccine before election day (an "October surprise"). The fear is that the FDA might approve the vaccine based on flimsy safety and efficacy data to please the president, according to an editorial published in the *New York Times*. Public health experts say the United States government is making a risky bet by focusing so much of its pandemic response on the hope that a shot will end the coronavirus' devastating march. "There's no guarantee that a vaccine is going to work," said luciana borio, who served as the FDA's acting top scientist. "And even if it does, there's no guarantee that it'll be the right product for most people, or that the virus won't mutate."

Note: The treatments were formatted to look like a real press release and used paragraphs and larger font that displayed here. The baseline condition is the "control condition" (N= 157) that did not receive any information.

by an information calling into question the efficacy of any FDA-approved vaccine by noting that it will be approved by the FDA if it shows "only 50% efficacy" (FDA, 2020), suggesting that it could have serious side-effects, and that immunity could last only for a few months. Respondents in the *willing* condition (*N* = 171) were presented with the headline, "Most American

Say They Will Get Vaccinated against COVID-19", followed by information that included the results from "a recent tracking survey" that "indicated widespread willingness in the U.S." to take the vaccine. The treatment included additional details explaining why most Americans are willing to get vaccinated (Bump 2020). Conversely, respondents in the *unwilling*

TABLE 2 | Will take vaccine - *Main Effects with Demographic Covariates.*

	(1) Main effects		(2) Demographics	
	Coefficient	p-value	Coefficient	p-value
Safe and effective	0.36** (0.22)	0.050	0.39** (0.22)	0.036
Unsafe and ineffective	−0.18 (0.23)	0.211	−0.24 (0.22)	0.142
Willing	0.43** (0.22)	0.028	0.37** (0.22)	0.045
Unwilling	−0.40** (0.23)	0.038	−0.37** (0.22)	0.047
Agenda	0.07 (0.23)	0.378	0.01 (0.22)	0.484
Trump	−0.34* (0.23)	0.066	−0.38** (0.22)	0.044
Republican			0.30** (0.17)	0.037
Democrat			0.59*** (0.17)	0.000
Liberal			0.14*** (0.04)	0.001
Female			−0.35*** (0.12)	0.002
Education			0.27*** (0.05)	0.000
Age			0.04 (0.05)	0.165
Income			−0.01 (0.02)	0.235
Minority			−0.18* (0.13)	0.073
Constant	4.95*** (0.16)	0.000	3.01*** (0.40)	0.000
N	1,123		1,118	
Adjusted R^2	0.017		0.078	
AIC	4,758.4		4,672.9	
BIC	4,793.6		4,748.2	

Note: *Cell entries are OLS coefficients with standard errors in parentheses below. Significant coefficients estimates are denoted with stars based on one-tail* p-values *presented. The* Control *condition is used as the reference group and is omitted from the model.* *p < 0.10, **p < 0.05, ***p < 0.01.

condition (N = 157) saw the headline, "Many Americans Say They Will Not Get Vaccinated against COVID-19", followed by information from a "recent tracking survey" that "indicated widespread reluctance in the United States to take any COVID-19 vaccination" (Cornwall 2020). It included additional details explaining why many Americans may be hesitant to take the vaccine. Two additional conditions invoked "politics" in an anti-vaccination message. In the ***agenda*** condition (N = 149), respondents were presented with the headline, "Liberal Media Pushing Agenda for 'Mandatory Vaccinations' and 'Immunization Cards'", followed by information suggesting that the rush to develop a COVID-19 vaccine is a way to enrich pharmaceutical companies and for the government to assert greater control over the lives of individuals (Lederman et al., 2020). In the ***Trump*** condition (N = 158), respondents read the headline, "President Trump Pushing for Rapid Approval of a COVID-19 Vaccine", followed by information raising concern that the FDA might approve a vaccine due to

political pressure prior to Election Day, as an "October surprise" (Cohen 2020; Weixel 2020).

The dependent variable that immediately followed exposure to one of the randomized conditions was our measure of vaccine resistance. Participants in all conditions responded to this question: "If an FDA-approved vaccine against the coronavirus becomes widely available, how likely is it that **you** will get vaccinated?" (1 = extremely unlikely; 7 = extremely likely)[1].

RESULTS

To test our hypotheses, we estimate OLS regression models with robust standard errors. We regress the dependent variable (i.e., the measure for vaccine resistance/uptake) on our condition indicators, omitting the *Control* condition as the reference group (**Table 2**). We present the results with and without the inclusion of basic demographic covariates–party identification, ideology, gender, age, education, income and minority status–to improve the precision of our estimates of treatment effects and any imbalances across conditions following randomization (Angrist and Pischke 2009; Kam and Trussler 2017). In all models, cell entries contain OLS coefficients representing the difference in means between the treatment condition and the *control* condition. We also included a manipulation check at the end of the survey where respondents in the treatment conditions were asked if the "news article" they read earlier was opposed to or supportive of getting vaccinated for COVID-19. The treatments were accurately perceived in the directions we intended across all conditions (**Supplementary Appendix Table A2**).

Our first set of hypotheses tested the degree to which exposure to frames highlighting considerations related to the safety and effectiveness of a COVID-19 vaccine would shift intentions to take the vaccine in the direction of the message. As we predicted (Hypothesis 1a), respondents who read the *safe and effective* treatment were more likely to express an intention to get vaccinated (*b = 0.36, p = 0.05*, column 1, **Table 2**). Counter to our prediction (Hypothesis 1b), reading the *not safe* treatment had no statistically significant impact on respondents' willingness to get vaccinated; however, the coefficient in the model for *not safe* is negative and there is some movement in the expected direction from the control condition.

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[1]After responding to our main dependent variable (vaccine resistance), we also asked respondents, "In general, how **important** do you believe it is that all Americans get vaccinated for the coronavirus once an FDA-approved vaccine is widely available?" (1 = not at all important; 7 = extremely important) and "How likely is it that **other Americans** will get vaccinated if an FDA-approved vaccine against the coronavirus becomes widely available?" (1 = extremely unlikely; 7 = extremely likely). These additional measures are conceptually distinct from "vaccine resistance". Thus, although the three items are highly correlated and may be appropriately combined into a composite index measuring a single construct (Cronbach's alpha = 0.74), we focus exclusively on our item tapping vaccine resistance. The treatment effects we report have nearly identical effects on these additional post-treatment measures and are available from the authors upon request.

Our second set of hypotheses was that frames highlighting a descriptive social norm would have an impact on respondents' intentions regarding vaccine resistance/uptake. As we predicted (Hypothesis 2a and Hypothesis 2b), the *unwilling* treatment decreased reported intentions to take a COVID-19 vaccine (*b = -0.40, p = 0.04*, column 1, **Table 2**), whereas the *willing* treatment increased reported intentions to get vaccinated (*b = 0.43, p = 0.03*).

Our third set of hypotheses focused on how exposure to distinct frames that "politicize" the COVID-19 vaccine will increase vaccine resistance and decrease vaccine uptake. As we predicted (Hypothesis 3a), respondents exposed to a framed message emphasizing that President Trump is pressuring the FDA for rapid approval of a vaccine for political purposes were less likely to say that they would take the vaccine (*b = −0.34, p = 0.06,* column 1, **Table 2**). However, counter to our prediction (Hypothesis 3b), we find no evidence that the reading an article that politicizes the COVID-19 vaccine by claiming that it is being promoted by a radical liberal agenda seeking to regulate personal health decisions had any effect on respondents' attitude regarding vaccine resistance/uptake.

We also report, in **Table 2**, the results from a second OLS regression model that includes the dichotomous variables for condition indicators and additional demographic and political variables that have been associated with vaccine resistance/uptake (Lazer et al., 2021; Simonson et al., 2021). First, as expected given that random assignment was successful, the substantive impact of the treatment effects is unchanged with the inclusion of these additional demographic and political measures; however, the model fit is slightly improved (and the standard errors for each condition's estimated effect are slightly smaller) with the inclusion of these additional covariates. Second, although we must be cautious about making generalizations given the nature of our sample, we observe that both Democrats and Republicans stated that they are more likely to get vaccinated than Independents in the sample. In addition, similar to findings from surveys of nationally representative samples in the United States, minorities and females are less likely to say they will get vaccinated, while those with higher levels of education and a liberal political ideology are more likely to report a willingness to get vaccinated.

We anticipated, given the general polarization surrounding all aspects of the science of COVID-19 and the nature of our "political frames", that party identification might moderate the impact of our treatments on respondents' attitudes about vaccine resistance/uptake. Specifically, we anticipated the framed message highlighting President Trump pressuring for rapid approval for political purposes might have a particularly pronounced influence on Democrats, whereas we anticipated that the framed message emphasizing the role of a liberal media promoting mandatory vaccinations might be especially impactful at generating vaccine resistance among Republicans. We tested for interaction effects between the experimental condition assignment and party identification with an OLS regression (**Table 3**). Overall, we find almost no evidence that party identification is a moderator of any

TABLE 3 | Will take vaccine - treatment effects - *Party Identification Interaction*.

	Coefficient	p-value
Safe and effective	0.84** (0.46)	0.034
Unsafe and ineffective	0.17 (0.47)	0.358
Willing	0.22 (0.47)	0.318
Unwilling	−0.90** (0.47)	0.029
Agenda	−0.11 (0.47)	0.408
Trump	−0.32 (0.46)	0.240
Republican	0.30 (0.41)	0.234
Democrat	0.66* (0.42)	0.059
Republican X safe and effective	−1.18** (0.57)	0.020
Republican X unsafe and ineffective	−0.53 (0.58)	0.182
Republican X willing	0.05 (0.58)	0.468
Republican X unwilling	0.65 (0.59)	0.134
Republican X agenda	−0.01 (0.58)	0.492
Republican X trump	0.16 (0.58)	0.391
Democrat X safe and effective	−0.06 (0.58)	0.460
Democrat X unsafe and ineffective	−0.35 (0.60)	0.283
Democrat X willing	0.37 (0.59)	0.266
Democrat X unwilling	0.58 (0.60)	0.169
Democrat X agenda	0.52 (0.60)	0.194
Democrat X trump	−0.23 (0.59)	0.348
Constant	4.59*** (0.32)	0.000
N	1,123	
Adjusted R^2	0.048	

Note: *Cell entries are OLS coefficients with standard errors in parentheses below. Significant coefficients estimates are denoted with stars based on one-tail p-values presented. The* Control *condition is used as the reference group and is omitted from the model.* *p < 0.10, **p < 0.05, ***p < 0.01.

treatment effect reported in **Table 2**. The only statistically significant interaction term is for Republicans in the *safe and effective* condition: Republican respondents in this condition were less likely to say they would get the vaccine relative to other subgroups[2]. In sum, there was almost no evidence that the "political frames" we employed had a larger effect on specific partisan subgroups in our sample,

[2]We calculated the average marginal effects of the experimental treatments by party. The results are available in **Supplementary Appendix Table A4**.

nor did most of the other messages. This may reflect the fact that with respect to COVID-19 vaccine resistance factors other than partisanship appear to play a more dominant role in resistance to the science (e.g., see Rutjens et al., 2021).

DISCUSSION

It is crucial to know how messages the public receives about a novel vaccine ultimately shape decisions regarding whether or not to get vaccinated (Mheidly and Fares 2020). In this study, information that highlighted the safety and efficacy of an approved vaccine against COVID-19 increased individuals' willingness to take the vaccine. As noted earlier, this study was done in the summer of 2020 before the FDA issued an emergency use authorization for any vaccine. The finding of a clear causal effect of a single exposure to a message emphasizing the vaccine's safety and efficacy in the context of a survey suggests that as these messages are encountered in actual media stories, they may have a powerful and lasting effect on vaccine uptake.

The results also demonstrate the powerful impact that communicating descriptive social norms can exert on decisions about whether or not to get vaccinated. The experimental treatments we developed highlighted the degree to which other Americans are willing to get vaccinated for COVID-19. Responses indicating intentions to get the approved vaccine increased when respondents were informed that most Americans plan to get vaccinated in the context of a short article that included additional frames regarding the safety and efficacy of the vaccine. Learning that most Americans are hesitant about getting vaccinated, on the other hand, increased vaccine resistance. Further, we find these effects are not driven by responses among a particular partisan subgroup in our sample, but rather due to the impact of descriptive-norm-based messages across respondents. These findings suggest that messages highlighting the willingness of other Americans to get vaccinated may be an effective way to promote positive vaccination attitudes, intentions and even uptake. Future research might employ more refined treatments that parse out the role that norm-based information exerts on subgroups in the population with relatively higher levels of vaccine resistance/ hesitancy, such as parents, younger and female Republican voters, ethnic minorities, and those with strong religious convictions (Lazer et al., 2021; Lin et al., 2021; Rutjens et al., 2021; Simonson et al., 2021).

We also found evidence that frames that invoked political motives of President Trump to rush the approval of the COVID-19 vaccine to help win re-election increased vaccine resistance. Although we expected that respondents who identified themselves as Democrats would be most responsive to this message, we found no difference among the partisan subgroups in the sample. With respect to the second political message, and also counter to our expectation, we found no overall or subgroup effect of the message emphasizing the vaccine being promoted to advance a liberal policy agenda and mandatory vaccinations.

We note two limitations of this study. First, the relatively small size of our partisan subgroups and nature of our convenience sample may limit the ability to reliably detect how a more representative sample of partisans might have reacted to the messages. Second, although the descriptive norm-based frames appeared in the headlines of our treatments and were also emphasized in the body of the text, the messages also mentioned the vaccine's safety and effectiveness in order to make them seem more realistic. As such, our ability to isolate any specific word(s) or sentence(s) in the stimuli that may have been most impactful in producing the observed treatment effects is limited. Future work should also assess how people respond to simultaneous exposure to framed messages that include competing arguments, since this is more representative of the information environment in which most people live. Further, it will be important to evaluate the duration or persistence of the emphasis framing effects we uncovered.

In order to combat vaccine hesitancy, it is urgent that messaging be carefully and thoughtfully crafted, taking into account what social scientists have learned about the factors that influence message acceptance. Scientific misinformation poses a significant threat to vaccine uptake and can lead to catastrophic public health consequences (Rutjens et al., 2021). Emphasis framing is one important antidote for combatting the effects of scientific misinformation (Levy et al., 2020). We extend this research on framing and vaccine resistance/ uptake by evaluating the impact of distinct theoretically motivated messages on attitudes toward getting vaccinated for COVID-19. The results demonstrate the powerful impact of perceptions regarding the safety and efficacy of any vaccine for promoting its uptake. They also suggest that conveying descriptive social norms may be a particularly fruitful avenue for targeted communication campaigns promoting vaccine uptake, for instance, among traditionally skeptical populations. It will be important for future research to identify ways to overcome the deleterious impact of messages that politicize the science surrounding any given vaccine as well, especially given the powerful role political rhetoric can play in stimulating vaccine resistance and scientific misperceptions.

DATA AVAILABILITY STATEMENT

The data for this manuscript are publically available at: "Replication Data for The Effect of Frames on COVID-19 Vaccine Resistance", https://doi.org/10.7910/DVN/KI2JQR, Harvard Dataverse.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Georgia State University's IRB.

AUTHOR CONTRIBUTIONS

RP and TB co-designed the study, co-wrote the manuscript, and are equal first authors. JK was primarily responsible for data collection and analysis.

ACKNOWLEDGMENTS

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.661257/full#supplementary-material

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Political Preferences, Knowledge, and Misinformation About COVID-19: The Case of Brazil

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The COVID-19 pandemic has led to a vast research agenda focusing on how citizens acquire knowledge about the virus and the health expert guidelines to protect themselves and their close ones against it. While many countries and regions have been accounted for, there still remains a substantial gap with respect to public opinion about the virus in Latin America, most notably in Brazil, which currently has the second highest in number of fatalities in the world. In this article, we employ a national survey of Brazilians ($n = 2,771$) to measure and explain knowledge and misinformation about the coronavirus and its illness, COVID-19. Our focus concerns the role of political preferences in a context of high elite polarization with a sitting government that has systematically downplayed the risks associated with the coronavirus and its illness. Our findings are clear: political preferences play a substantial role in explaining differences in knowledge about the coronavirus and COVID-19, more than conventional determinants of learning like motivation, ability, and opportunities. Specifically, we find that supporters of President Jair Bolsonaro—an avid science and COVID-19 denier—know significantly less about the coronavirus and its illness and are more likely to believe in a conspiracy theory that claims that the coronavirus was purposefully created in a Chinese laboratory to promote China's economic power, when compared to Brazilians who are less supportive of him and his government. Our findings carry important implications for how Brazilians take informational cues from political elites in that—even in a major event like a global pandemic—supporters of the president are as likely as ever to "follow their leader" and deny expert-backed scientific evidence.

Keywords: coronavirus, COVID-19, public health, knowledge, partisanship, political preferences, misinformation, Brazil

INTRODUCTION

Fighting a pandemic like the coronavirus SARS-Cov-2 and its illness COVID-19 requires an adequate public response to guidelines issued by public health professionals. For these guidelines to be effective, however, they need to be relayed by the media and elected officials to the public so that its members can learn about the virus and its illness and protect themselves and people around them (World Health Organization, 2018). What happens, however, when guidelines are downplayed by political elites that believe the virus is inoffensive and that its illness is no worse

than a "small flu"? The US and Brazil are two emblematic cases that illustrate this situation, despite other notable differences in their capacity to handle such crisis. In both countries, political elites, including their respective presidents Donald Trump and Jair Bolsonaro, minimized the seriousness of the coronavirus and its illness since its outbreak and failed to be informative agents to curb the spread of the virus (Barberia and Gómez, 2020; Ortega and Orsini, 2020; Rutledge, 2020; Yamey and Gonsalves, 2020; Calvo and Ventura, 2021)[1]. This has resulted in lower compliance with health recommendations along partisan lines (Clinton et al., 2020) and many lives lost[2].

In this article, our focus is on Brazil, one of the countries most severely hit by the coronavirus and COVID-19[3]. According to the *Coronavirus Resource Center* from Johns Hopkins University, Brazil, as of late February 2021, had more than 10.2 million confirmed cases—third in the world, after the U.S. and India— and more than 250 thousand deaths—in this case only overcome by the U.S. Brazilians also have seen the collapse of their public health services in many important cities. In Manaus, for example, dozens of COVID-19 patients died because hospitals did not have oxygen to treat them. In Rio de Janeiro, I.C.U.s reached an occupancy rate of 99.8% in public hospitals. Furthermore, a new COVID variant was detected in Manaus and spread rapidly to other cities and parts of the world, leading governments in the U.K., Italy, and Portugal to suspend flights from Brazil.

More specifically, we seek to measure how much Brazilians know about COVID-19 and what explains variations in their knowledge about this subject. We argue that Brazil's political elites have been unable to provide its citizens with clear health guidelines to protect themselves against the virus, explaining, in part, why the country has fared so poorly at fighting the coronavirus pandemic. Specifically, President Jair Bolsonaro has systematically rejected the recommendations of health authorities, including those from his own health ministers, resulting in two consecutive substitutions in the Ministry of Health in less than a month at the beginning of the pandemic (between April 16 and May 15, 2020) when the number of infections and deaths grew rapidly[4]. Since then, the Health Ministry has been under the command of an army general with no previous experience in public health.

Despite the criticism it has received for its (lack of) actions against COVID-19, the popularity of the Bolsonaro government has remained relatively high since the beginning of the pandemic (Jota, 2020). This is cause for concern given the role of elites in influencing public opinion along partisan lines (Zaller, 1992; Druckman et al., 2013) and, in particular, on complex and novel

("hard") issues like a pandemic (Carmines and Stimson, 1980). In this paper, we rely on survey data collected in September and October of 2020, several months after the outbreak of the coronavirus pandemic, to examine the influence of political preferences on knowledge about COVID-19. We look at two measures. The first is a measure of knowledge about the virus and its illness, including how the virus is transmitted, ways to protect oneself from the virus and the symptoms related to COVID-19. The second concerns support for a conspiracy theory about the origin of the coronavirus. Our findings show a substantial role for political preferences, with Brazilians supportive of President Bolsonaro significantly showing less knowledge about COVID-19 and more likely to believe that the virus was created purposely in a Chinese laboratory to increase China's economic power.

In what follows, we discuss the importance of information acquisition by citizens for a successful collective response to combat pandemics. We next address the individual-level determinants of knowledge acquisition followed by the presentation of our data and measures of interest. The subsequent sections present our results and a brief discussion of what we found, as well as some limitations of this study. We conclude by summarizing our main findings and proposing avenues for future research.

THE ROLE OF (MIS)INFORMATION IN A PANDEMIC

An individual is said to be health literate when they are capable of acquiring, understanding and applying health knowledge in ways which promote and maintain good health (Nutbeam, 2009). Not surprisingly, health literacy is desirable to combat the COVID-19 pandemic (Paakkari and Okan, 2020). The knowledge acquisition process, however, must not only be quick but also homogeneous to prevent uninformed (or worse, misinformed) minorities from adopting behaviors that put a large number of people at risk in a pandemic (Vaughan and Tinker, 2009; Lin et al., 2014).

Recent work on the COVID-19 pandemic reveals that those more knowledgeable about the disease are more likely to adhere to preventive practices like the use of masks (Bates et al., 2020; Li et al., 2020; Zhong et al., 2020), social distancing (Clements, 2020; Li et al., 2020; Zhong et al., 2020), and frequent hand hygiene (Bates et al., 2020; Li et al., 2020). In addition, people who consider themselves knowledgeable about the virus and its illness report lower levels of stress and claim that the pandemic has low psychological impact on them (Wang et al., 2020). In sum, knowledge acquisition is central in the preparedness to fight a pandemic.

Paradoxically, acquiring knowledge about COVID-19 is challenging because of the scarcity of the information or the abundance of competing false information, depending on the context. In poor countries (Lau et al., 2020) or in more vulnerable population segments (Vaughan and Tinker, 2009), for example, many do not have access to means of communications like radio, TV or the Internet to access information about the coronavirus and its disease. Many of these members of vulnerable populations are not even properly exposed to government communication

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[1] In the Philippines, President Rodrigo Duterte played a similar, dysfunctional role, downplaying the pandemic and telling the public that he wanted to "slap the virus" (Lasco, 2020).

[2] As of March 3, 2021, the US and Brazil count 529,515 and 257,562- deaths, respectively (worldmeters.info).

[3] We recognize that COVID-19 is the disease caused by the coronavirus (SARS-CoV-2). For the sake of simplicity, however, we will hereafter only use COVID-19 to refer to both the virus and its illness.

[4] Luiz Henrique Mandetta was fired by President Bolsonaro on April 16, 2020, after several public disagreements about the sanitary measures that should be taken by the federal government; and Nelson Teich resigned on May 15, 2020 expressing his frustration with the lack of support he received from the President.

campaigns. Moreover, they also generally possess very low levels of health literacy, which reduces their ability to understand and apply the health recommendations and judge their importance for their own health and that of others (Paakkari and Okan, 2020; Van den Broucke, 2020).

Acquiring knowledge in a context characterized by the profusion and diffusion of incorrect information about the coronavirus and its illness can also be challenging (Vaezi and Javanmard, 2020; Zarocostas, 2020). In an infodemic, countless misinformation is disseminated (purposefully or not), including fake news and conspiracy theories (Van Bavel et al., 2021). Such environment, like one characterized by a scarcity of information, creates important hurdles to combat the pandemic because it prevents or slows down the adherence of preventive behaviors. Worst, it can even encourage behaviors that contribute to the greater spread of the virus and its disease.

LEARNING ABOUT COVID-19

Numerous studies have already explored the determinants of knowledge about different aspects of COVID-19, including the most common symptoms of the disease, how the virus is transmitted and what are the recommended treatments to fight the illness. Multiple knowledge questions were applied to population samples in surveys from several countries, including China (Lin et al., 2020; Zhong et al., 2020), where the pandemic originated, the United States (Clements, 2020), where the highest number of cases and deaths have been reported so far, and in developing countries from the Middle East (Saudi Arabia, Al-Hanawi et al., 2020; Jordan, Khasawneh et al., 2020), Africa (Nigeria, Olapegba et al., 2020), and Asia (Malaysia, Azlan et al., 2020; Philippines, Lau et al., 2020). Interestingly, little is known about how much Latin Americans know about the virus and its illness (with the exception of Bates et al., 2020) and, most notably, the current situation in Brazil. Moreover, most of the existing work on the determinants of knowledge about COVID-19 focuses on demographic variables like income, education, gender, and age. The bulk of these studies overlook the importance of the political context on people's ability to learn, like the degree of elite polarization around the pandemic and the measures to fight it (for an exception, see Clements, 2020). In particular, we wish to contribute to the extant literature by showing that people's political preferences can explain variations in knowledge about COVID-19 in a context where political elites have diverged about the importance of the pandemic and on how to address it.

We use Luskin's (1990) model for explaining political sophistication as our starting point to identify the factors related to knowledge about the coronavirus and COVID-19. According to Luskin, knowledge is associated with three factors: the opportunity to access information, the ability to understand and store it and the motivation to be aware of it.

First, the opportunity to learn speaks to an individual's ability to overcome financial and logistical barriers of access to sources of information. Not surprisingly, higher levels of knowledge about COVID-19 are observed among individuals with higher income (Al-Hanawi et al., 2020; Azlan et al., 2020; Clements, 2020; Krägeloh et al., 2020) and among those with greater access to means of communication (Olapegba et al., 2020). In poor countries, financial, and communications infrastructure barriers reduce access to the Internet and other technological equipment like cell phones and computers, especially among the most vulnerable (Coetzee and Kagee, 2020).

Second, the ability to understand and store information is related to the cognitive capacity of individuals and, more generally, their level of education. This is consistent with recent work that shows that higher levels of education are usually associated with greater knowledge about COVID-19 (Al-Hanawi et al., 2020; Lau et al., 2020; Zhong et al., 2020).

Third, the motivation to seek information is the result of the complex and heterogeneous sets of interests individuals have to direct their attention to some objects and not others. As for the coronavirus and COVID-19, greater proximity to the illness has been associated with higher levels of knowledge. Zhong et al. (2020), for example, find that people who live in Hubei province, whose capital is Wuhan (Ground Zero for the coronavirus pandemic), know more about COVID-19 than people in other Chinese provinces. Little is known, however, about the association between knowledge of the virus and its illness and proximity with the disease, in either having caught the disease or through interpersonal networks like infection or death among members of the same household, family members or close friends. Surprisingly, not much is known about the relationship between knowledge and an individual's level of preoccupation or worriedness about the virus and its disease.

Beyond the opportunities, ability and motivation to learn about COVID-19, we argue that political preferences can affect knowledge in contexts where political elites have *not* responded uniformly to the pandemic, that is, in places where the issue has been "politicized" along partisan lines. Although in some countries political elites have united and uniformly supported health authorities (e.g., see Merkley et al., 2020 for Canada; and Harris, 2020 for U.K.), followed technical guidelines (Hindustan Times, 2020 for India), and tried to compromise to better respond to the crisis (The Conversation, 2020 for South Africa), in others, however, the pandemic has led to important political divisions about how to tackle the issue. The US and Brazil stand as two emblematic examples that come to mind where political elites have diverged in substantial ways, with one camp taking the issue of the pandemic seriously and encouraging the adoption of guidelines issued by public health professionals with the other, frequently in position of power, downplaying the virus and its illness and ignoring such guidelines. In both cases, the political divide over COVID-19 has led to disastrous consequences in terms of infections and fatalities.

In the US, independent voters and Democrats know more than Republicans about the disease (Clements, 2020). Specifically, independents and Democrats know 7.5 and 10.2% more about COVID-19 than Republicans, respectively. This is consistent with the divide observed at the elite level where Democrats have championed the adoption health guidelines to combat the pandemic while Republicans have downplayed them (Clinton et al., 2020; Green et al., 2020; Gadarian et al., 2021). In Brazil,

TABLE 1 | Knowledge items presented to respondents and distribution of responses (in %).

	True	False	Don't know
1. Coronavirus spreads via respiratory droplets from infected individuals.	96.0	0.9	3.1
2. The use of a mask helps to protect against the coronavirus.	95.3	2.7	2.1
3. Being isolated at home is an effective way to reduce the spread of the virus.	91.7	5.7	2.6
4. You can contract COVID-19 if you touch your eyes with contaminated hands.	91.0	3.2	5.8
5. The most common symptoms of COVID-19 are fever, tiredness and a dry cough.	87.9	4.3	7.8
6. Diarrhea and loss of taste can also be symptoms of COVID-19.	86.8	4.0	9.2
7. People with COVID-19 but without a fever do not transmit the coronavirus to other people.	6.8	82.6	10.6
8. COVID-19 symptoms can take up to 14 days to appear.	81.8	7.4	10.8
9. The coronavirus can stay in your hands if you don't scrub them with soap for at least 20 s.	73.3	11.9	14.8
10. There are specific drugs for the prevention of COVID-19.	11.1	70.0	18.9
11. If a person with COVID-19 coughs or breathes near you, there is a risk of getting the disease, even if you and the other person are wearing masks.	66.9	22.4	10.6
12. Taking chloroquine prevents COVID-19.	12.6	60.8	26.7
13. Taking chloroquine cures COVID-19.	15.8	56.8	27.3
14. Unlike the common cold, stuffy nose, runny nose and sneezing are less common in people infected with COVID-19.	29.8	39.6	30.6
15. You can get COVID-19 if you eat contaminated food.	55.2	20.8	24.0

Correct answers are gray-shaded. Items were randomly presented to respondents each time.

where President Jair Bolsonaro has systematically minimized the seriousness of the virus and its illness (Barberia and Gómez, 2020; Ortega and Orsini, 2020), Calvo and Ventura (2021) show that Bolsonaro voters are more optimistic about the health risks and job insecurity associated with the COVID-19 pandemic when compared to those who voted for Fernando Haddad (PT) in the second round of the 2018 presidential election. Furthermore, a study looking at vaccination acceptance finds that Bolsonaro supporters are less likely to vaccinate than those who do not support him (Gramacho and Turgeon, 2021), in line with Bolsonaro's expressed skepticism about vaccination as a means to combat the pandemic. Consequently, we expect Brazilians supportive of the president to also be less knowledge about COVID-19 when compared to those who disapprove of him.

The above discussion suggests that individuals with greater opportunity and motivation to learn and equipped with greater skills to integrate the information acquired are likely to have more knowledge about COVID-19 when compared to those with less opportunity, motivation, and ability. But, more importantly for present purposes, we also argue that the political context matters. Specifically, we expect that supporters of political elites that have downplayed the importance of the pandemic are likely to know *less* about the virus and its illness, as compared to those who do not support these elites.

DATA AND MEASURES

We collected survey data from a national online sample of 2,771 Brazilians[5]. The survey was conducted from September 23 to

October 2, 2020 and asked many questions about the COVID-19 pandemic and politics, in general. The sample follows quotas for age, gender, region and social class (including joint distributions of these population characteristics) based on the recent data from the Brazilian National Household Sample Survey (PNAD)— a large survey conducted periodically by the Brazilian census agency (*Instituto Brasileiro de Geografia e Estatística*, IBGE).

Measures

Our study affords one measure of knowledge and another of misinformation about COVID-19 as dependent variables of interest. First, respondents in our survey were asked 17 true or false questions about how the coronavirus is transmitted, ways they can protect themselves from the virus and the symptoms related to the illness. Correct answers are scored "1" while incorrect and don't know answers are coded as "0," following the recommendation from Luskin and Bullock (2011) about don't know responses. We create a score of knowledge about COVID-19 using 15 of the 17 items. Two items were left out. One of them, about the use of masks in children, because the science here is more ambiguous. The other, about the transmission of COVID-19 from sexual activities, because the wording we used could lead to ambiguous interpretation. **Table 1** provides the details about the 15 true or false questions asked by our survey respondents about COVID-19. For the regression analysis presented below, we transformed this score on a scale that runs from 0 to 100 for ease of interpretation of the ordinary least squares coefficient estimates. Consequently, one correct answer is worth 6.67 percentage points on that new scale.

All 15 items come from *frequently asked questions* mentioned and answered by World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) in their respective official websites. Besides that, eight out of the 15 items

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[5]Respondents were recruited from Netquest among their nearly half a million Brazilian panelists. Netquest is the only survey firm in Brazil that has the ISO 26362 certification for online panels.

in our questionnaire were also used in previous studies on the same subject. More specifically, similar versions of items 1, 5, 7, 8, and 14 were used by Azlan et al. (2020), Clements (2020), and Zhong et al. (2020); items 2 and 3 were used by Azlan et al. (2020); and item 15 appeared in Lin et al. (2020). Details are provided in the **Supplementary Material**.

Our measure of misinformation concerns support for a conspiracy theory about the origin of the coronavirus (SARS-CoV-2). The question asks respondents if they believe that the novel coronavirus originated in a live-animal market in Wuhan, China, that ended up accidentally getting spread throughout the world or if it is a virus that was created purposely in a Chinese laboratory to increase China's economic power, a conspiracy theory circulated heavily on social media. The best scientific evidence to date excludes the idea that the novel coronavirus originated in a lab or was purposeful manipulated (Andersen et al., 2020). The most plausible theory about the origin of the virus links it to a live-animal market in Wuhan, China, where several of the initial cases were identified (Wu et al., 2020; Zhou et al., 2020). Our interest lies with those who believe in the conspiracy theory that the virus was created purposefully in a laboratory in China and, for that reason, our measure codes support for such claim as "1" and "0" otherwise (including those that don't know which of the two explanations is true).

RESULTS

In what follows, we present how much Brazilians know about COVID-19 and what determinants help explain why some people know more and other less. We next look at misinformation about the origin of the novel coronavirus and identify those Brazilians that are most susceptible to fall prey for such misleading information.

Knowledge About COVID-19

Table 1 shows the distribution of respondents that identified the statement to be true or false or that they did not know whether the statement is true or false. The correct answer to each statement is gray-shaded and the statements are ordered from the most to the least successfully answered. The table indicates that nearly all Brazilians (96.0%) know that the coronavirus spreads via respiratory droplets from infected individuals and that the use of a mask helps to protect against the virus (95.3%). Significantly less Brazilians, however, are aware that chloroquine does not prevent or cure COVID-19 (60.8 and 56.8%, respectively).

Overall, knowledge about COVID-19 is moderately high in Brazil with 8 out of 15 items being correctly answered by more than 80% of the respondents. **Figure 1** below shows the distribution of correct answers to the 15 items. The distribution is left-skewed, indicating that most Brazilians possess accurate knowledge about the virus and its illness. Precisely, respondents answered, on average, 10.9 items correctly with a low standard deviation of 2.3, suggesting that most Brazilians scored around that mean.
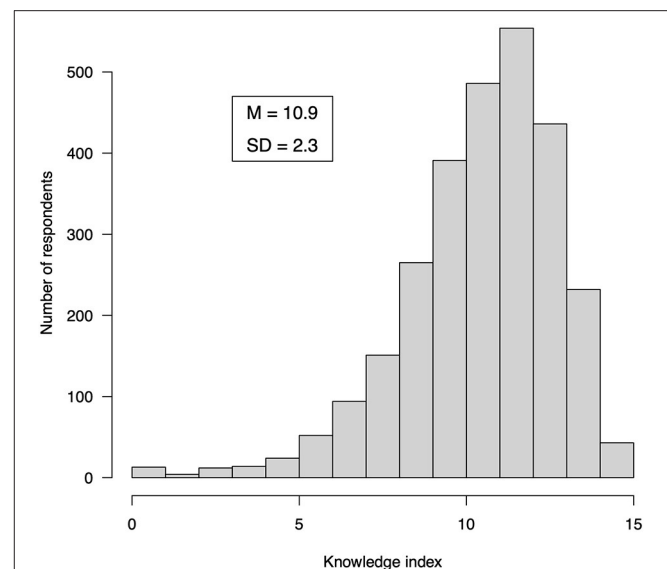
FIGURE 1 | Distribution of knowledge index about the coronavirus (SARS-CoV-2) and COVID-19.

Explaining Knowledge About COVID-19

Despite the relatively high knowledge about COVID-19 in Brazil, some differences exist. What explains these differences? In other words, what are the determinants of knowledge about the disease? Our earlier discussion suggests that people are capable of learning when they are motivated and have the ability and opportunity to do it. But, because the COVID-19 pandemic has been extensively "politicized" in Brazil—not only along partisan lines but also involving other branches of government like the Supreme Court (Barberia and Gómez, 2020), we also argue that political preferences affect how much people know about the virus and its illness. In particular, we believe that supporters of President Jair Bolsonaro—an avid denier of the coronavirus and COVID-19—are likely to know less about the virus and its illness when compared with those who are less supportive of the president and his government.

We propose a multivariate regression model where we account for respondents' motivation, ability and opportunity to learn about COVID-19. More importantly, we examine how the respondents' political preferences affect knowledge about the illness.

Our model has five variables to capture the role of motivation. All five measures, we argue, provide respondents with incentives to learn about COVID-19 and should, therefore, be positively correlated with knowledge. The first measure captures the respondent's level of worriedness about COVID-19 on a 4-point scale from "not worried at all" to "very worried," rescaled to range from 0 to 1. In our sample, 72.4% of respondents claim to be quite or very worried about the illness. The second measure is a dichotomous variable that indicates whether the respondent had (1) or did not have (0) COVID-19, independently of the strength of the symptoms. 11.2% of our respondents indicated they had contracted COVID-19 at some point. The third measure

of motivation is also a dichotomous variable and that takes the value of "1" for respondents who live with someone or have a close friend or relative that had or died from COVID-19 and "0" otherwise. Some 46.0% of our respondents find themselves in either of these conditions. The fourth measure speaks to the respondents' own health condition. It indicates respondents who suffer from a health condition that increases their risk of becoming severely ill from COVID-19. Specifically, it identifies all respondents who have or had (1) cancer; (2) chronic kidney or heart diseases; (3) diabetes; (4) asthma or other respiratory disease; (5) heart problems related to obesity; or, (6) organ transplant. Those who answered positively to any of these health conditions are scored "1" or "0" otherwise. 26.1% of our respondents indicated suffering from at least one of these health conditions. The fifth, and last measure of motivation, identifies respondents that live with an elder (60+) in their household (1) and 0 otherwise. In our sample, 25.7% of respondents indicated living with an elder.

Our measure of ability is proxied by the respondent's level of education. Specifically, we include in our regression equation a dichotomous variable that identifies respondents with a college degree or more (1) and 0 otherwise. In our sample, 21.9% of respondents possess such level of education. We expect respondents with a college education to be more knowledgeable about COVID-19.

Our model affords three measures of opportunity to learn about the virus and its illness. The first measure identifies respondents that are from the upper strata of the Brazilian society. Precisely, we include in our model a dichotomous variable that takes the value of 1 for respondents who pertain to the top three social class categories (out of seven) and 0 otherwise. The social class measure is based mainly on the respondent's household patrimony and income and is commonly used in survey research in Brazil. We expect upper class Brazilians to know more about COVID-19 because their social status provides for conditions that are more propitious to learning. In our sample, 22.9% of respondents are considered upper class. The second and third measures refer to media consumption about COVID-19. Both measures are dichotomous variables. The first identifies respondents who say they very frequently get their information about the virus and its illness from Brazil's traditional and well-establish media outlets (1) and "0" otherwise. Some 44.0% of our respondents fall into that category. The second, on the other hand, identifies respondents who claim they very frequently get their information about the virus and its illness from social media (1) (Facebook, Instagram, YouTube, Twitter, or WhatsApp) and "0" otherwise. 26.1% of our respondents claim they get most of their information about the virus and its illness from social media. We expect those who get most of their information about COVID-19 from traditional media outlet to know more about the virus and its illness and those that get that information from social media to know less because the content shared on those platforms are more prone to misinformation (Silverman, 2016; Allcott and Gentzkow, 2017) and low-quality health information (Xuewei et al., 2018).

The next two variables serve to evaluate the hypothesis that political preferences can affect learning about COVID-19 in

contexts where the pandemic has been extensively "politicized" like it has in Brazil (Barberia and Gómez, 2020). In particular, President Jair Bolsonaro and his government has constantly downplayed the importance of the virus and its illness. We believe that such stance by government officials has negatively affected the capacity of Brazilians to learn fact-based knowledge about the virus and its illness, especially among those who are supportive of the president and his government. To capture the role of political preferences, we include a measure of the Bolsonaro government's approval. Respondents were asked to indicate their approval of the Bolsonaro government on a 5-point scale, from "great" (1), "good" (2), "fair" (3), "bad" (4) to "terrible" (5). The measure was rescaled from 0 to 1, with higher values indicating positive evaluations and lower values negative ones. In our sample, 34.3% of the respondents judged the Bolsonaro government to be "good" or "great" while 43.9% thought his government to be "bad" or "terrible." We expect respondents with higher evaluations of the president and his government to be less knowledgeable about COVID-19. The second measure indicates the respondent's preferred political party and is coded "1" for those whose select "Bolsonaro's party" and "0" otherwise. It is important to note that President Bolsonaro has not been affiliated to a political party since November 19, 2019 and, for that reason, respondents were given that option of merely indicating "Bolsonaro's party." We recognize that this operationalization is not ideal, but we see this variable as a measure that allows us to identify those voters that feel particularly strongly for President Bolsonaro, as such voters are willing to adopt any party that President Bolsonaro would eventually become affiliated with. In our sample, 7.8% of the respondents indicated "Bolsonaro's party" as their preferred party. Again, we expect respondents to identify with Bolsonaro's party to know less about the virus and its illness.

Finally, we include additional controls in our regression model. The first is age of the respondent. The second is a dichotomous variable that identifies female respondents (1) and 0 otherwise. The third is also a dichotomous variable and identifies white (1) from non-white (0) respondents. Finally, we include dummies for the respondent's state of residency (including the Federal District) and use the state of Rondônia as the reference category. Women, on average, are more health literate than men (Manierre, 2015) and whites are generally more privileged than non-whites in Brazil beyond mere wealth (Theodoro et al., 2008). We expect both women and whites to know more about COVID-19. We have no clear expectation for age and state of residency.

Table 2 (left column) presents the regression coefficients and standard errors for our knowledge of the COVID-19 model, as estimated by ordinary least squares (OLS). **Table 2** shows that many of our independent variables exert statistically significant effects on knowledge of the virus and its illness despite the model's adjusted-R^2 being relatively low at 0.181. Recall that the measure of knowledge has been transformed to range from 0 to 100 to ease interpretation of the regression coefficients. Effects can thus be presented in percentage points on the knowledge scale.

Results from **Table 2** suggest that three of the five motivation variables exert statistically significant effects on knowledge and

TABLE 2 | Explaining knowledge about COVID-19 and support for conspiracy theory about the origin of the coronavirus.

	OLS estimated coefficients (s.e.)	
	Knowledge	Conspiracy theory
Motivation		
Worried about COVID-19	6.992** (1.035)	−0.152** (0.031)
Had COVID-19	1.856* (0.903)	0.027 (0.027)
Relative or close friend had or died from COVID-19	2.244** (0.571)	−0.002 (0.017)
R's health condition increases risk of severe illness from COVID-19	−0.372 (0.635)	0.025 (0.019)
Elder living in household	−0.028 (0.642)	0.014 (0.019)
Ability		
College education	2.624** (0.726)	−0.013 (0.021)
Opportunity		
Upper social class	3.300** (0.744)	−0.039 (0.022)
Most information on COVID-19 from traditional media sources	2.751** (0.604)	0.012 (0.018)
Most information on COVID-19 from social media	−0.479 (0.666)	0.023 (0.020)
Political preferences		
Bolsonaro's government approval	−10.972** (0.859)	0.325** (0.032)
Preferred party is Bolsonaro's party	−3.169** (1.096)	0.173** (0.032)
Additional control[†]		
Age	−0.033 (0.020)	−0.002* (0.001)
Female	0.717 (0.563)	−0.010 (0.017)
White	1.872** (0.615)	−0.017 (0.018)
Constant	69.753** (3.688)	0.362** (0.109)
Number of observations	2,652	2,643
Adjusted-R^2	0.181	0.131

*$p < 0.05$ and **$p < 0.01$ (two-tailed).

[†] The regression equations also include dummies for all Brazilian states and the Federal District except for Rondônia that serves as the reference category.

in expected ways. First, respondents that are more worried with the illness show greater knowledge ($p < 0.01$, two-tailed). Specifically, the difference in knowledge is seven percentage points from an individual that is not worried at all to one that is very worried holding the other variables fixed. Second, those that had COVID-19 also know slightly more than those who did not have it—a difference of nearly two percentage points ($p < 0.05$, two-tailed). Third, respondents who have a relative or close friend that had COVID-19 or died from the disease also know slightly more, an increase of a little over two percentage points ($p < 0.01$, two-tailed). Lastly, the respondent's health condition and whether he or she lives with an elder has no effect on how much the respondent knows. Overall, these results suggest that respondents with greater motivation or incentives to learn about the novel coronavirus and its illness generally do so.

The literature on health behavior offers a potential reason why two of our five motivation variables have failed to show any effect on knowledge about COVID-19. Previous studies suggest that self-efficacy can be a decisive factor in obtaining

information about a serious health threat and in adjusting behavior accordingly (Witte, 1994; Sheeran et al., 2016). When individuals have a low sense of self-efficacy in the face of a health threat, it is common for them to control their fear of the disease instead of changing their behavior to avoid it. Unfortunately, we do not have a variable that measures the respondents' sense of self-efficacy, but this finding from the literature may explain why those with serious illnesses or who lived with elderly people at home have not seek out more information about COVID-19.

Next, we look at the role of ability. The estimated coefficient for education suggests, as expected, that respondents with a college education are slightly better informed about the virus and its illness than those less educated by close to three percentage points. The effect is not particularly large although it is statistically significant at 0.01 (two-tailed). Our sample characteristics may account for at least part of this result, as low educated Brazilians are underrepresented among our respondents. We believe that the effect of education is presumably larger in the Brazilian population than the one obtained from our data.

The third group of variables examine the role of opportunity. Here, two of our three variables of opportunity exert a statistically significant effect on knowledge of COVID-19. First, upper class respondents, as expected, know more about the virus and its illness. On average, respondents from the upper class are more knowledgeable by a little more than three percentage points, as compared to those from lower social classes ($p < 0.01$, two-tailed). Also as expected, respondents who very frequently look for information about the coronavirus and its illness from traditional media outlets know slightly more about the virus and COVID-19, when compared with those who do not, by a difference of close to three percentage points ($p < 0.01$, two-tailed). Finally, those that very frequently use social media platforms to inform themselves about the virus and its illness do not know less than those who do not. This finding is somewhat surprising, but, because we also control for traditional media consumption, the group of comparison are all those respondents who do not use any type of media to inform themselves and this group may also not be very informed about COVID-19.

Together, motivation, ability and opportunity explain differences in knowledge but nearly all effects—with the exception of how worried one is with COVID-19—are relatively small. We now turn to the role of political preferences.

Our first measure of political preferences is the approval of the Bolsonaro government. As expected, those that have more positive evaluations of President Jair Bolsonaro tend to know substantially less about COVID-19. Specifically, those who believe that the Bolsonaro government is "great" score <11 percentage points on the knowledge scale, as compared to those that believe that it is "terrible" ($p < 0.01$, two-tailed). This is, by far, the largest difference detected by our regression model. The second measure, for its part, indicates that those that chose the party of Bolsonaro as their preferred party are some three percentage points *less* knowledgeable about the coronavirus and its illness than those who indicated another party or none ($p < 0.01$, two-tailed). Put together, individuals who, at the same time, consider the Bolsonaro government to be "great" and also

TABLE 3 | Support for conspiracy theory about the origin of the coronavirus (SARS-CoV-2).

Every country in the world is currently confronted with the coronavirus, also known as COVID-19. In your opinion, the coronavirus is:	
a) A virus that originated in a live-animal market in Wuhan, China, that ended up accidentally getting spread throughout the world	35.9
b) A virus that was created on purpose in a Chinese laboratory to increase China's economic power	26.4
c) I don't know which of the options is true	37.7
Number of observations	2,759

Options a and b were randomly presented to respondents each time.

indicated a preference for his political party score 14 percentage points less than those who see his administration as "terrible" and prefer another party or no party.

The effects of both political measures suggest important differences in knowledge about COVID-19 between Brazilians who support President Bolsonaro and his government or indicate a preference for his party and those who do not. The effects are larger than those uncovered for the traditional determinants of learning (motivation, ability, and opportunity) and highlight the importance of the political context and the role of elites on knowledge about public health issues.

This last finding is quite impressive and deserves closer attention. How robust are our findings about the role of politics on knowledge of COVID-19? We performed a robustness check by estimating the same regression equation as presented in **Table 2** but by dropping one item, each time, from our knowledge score to evaluate if our results were not driven by any specific knowledge item. We found that in each of these 15 additional regression estimations, our two political variables of interest (evaluation of President Bolsonaro and the respondent's preferred party) remain statistically significant and their effects are of similar size, indicating that our findings are not unduly influenced by any specific knowledge item. Specifically, the average estimated coefficients are −11.0 and −3.2 for the evaluation of President Bolsonaro and the respondent's preferred party, respectively. The minimum and maximum coefficient estimates are (−11.8; −7.5) and (−3.9; −2.4), again, for the evaluation of President Bolsonaro and the respondent's preferred party, respectively.

Finally, among our control variables, only race shows a statistically significant effect and a rather small. Precisely, white respondents, as compared to non-whites score about two percentage points more on our knowledge scale. None of the dummies used to control for the respondent's state of residency (including the Federal District) showed statistical significance.

Support for Conspiracy Theory About the Origin of the Coronavirus (SARS-CoV-2) and Its Determinants

The other side of being informed or knowledgeable is being *misinformed*, that is, "firmly holding beliefs that happen to be wrong" (Kuklinski et al., 2000, p. 793). We tapped our

respondents about one such form of misinformation—the belief that the coronavirus was created on purpose in a Chinese laboratory to increase China's economic power. This conspiracy theory, like many others, has been circulated on social media platforms (Aos Fatos, 2020). **Table 3** below presents support for this conspiracy theory. We find that a little over a quarter of Brazilians believe that the coronavirus was purposefully created in a Chinese laboratory to increase China's economic power. About 36% of Brazilians believe in what accounts to be the best evidence-based explanation for the origin of the virus, that is, that the virus originated in a live-animal market in Wuhan, China, and spread accidentally to other parts of the world. Interestingly, there is close to 38% of our respondents that do not know which of these two explanations about the origin of the coronavirus is true. Although we do not have, as of yet, a definitive answer about the origin of the virus, there is a scientific consensus that it did not originate in a laboratory (Andersen et al., 2020).

The question now is: what explains support for such misinformation? **Table 2** (right column) presents the coefficients and standard errors for support of the conspiracy theory about the origin of the coronavirus where support is coded 1 and 0 otherwise, also estimated by OLS for ease of interpretation as recommended by Angrist and Pischke (2008)[6]. The expectation about the effect of our independent variables is, this time, reversed. Admittedly, the determinants of misinformation are not necessarily the same as knowledge, but we believe that our model of knowledge is a good place to start if we consider misinformation to be the flip side of knowledge. The Adjusted -R^2 (at 0.131) suggests that this model performs only slightly worse at explaining support for the conspiracy theory about the origin of the coronavirus than it does for knowledge of the virus and its illness. In the Discussion section below, we address some of the other known determinants of misinformation and, in particular, conspiracy theory beliefs. Unfortunately, our data do not allow to account for them.

If more motivated individuals are likely to know more about the coronavirus and its illness, then those that are less motivated should be more prone to misinformation. Of our five independent variables measuring motivation, only one exerts a statistically significant effect on support of the conspiracy theory about the origin of the virus. Precisely, we find that respondents who are more worried about COVID-19 tend to show less support for the conspiracy theory ($p < 0.01$, two-tailed). The probability to support the conspiracy theory that the coronavirus was purposefully created in a Chinese laboratory to increase China's economic power decreases by 15 percentage points when comparing individuals who claim to be "not worried at all" with those who are "very worried" about COVID-19, holding the other variables fixed. This drop in support for the conspiracy theory about the origin of the virus is substantially large and suggests that motivation also plays an important in explaining misinformation, although the other variables proxying motivation do not exert any effect.

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[6]In **Supplementary Table 1**, we also present the estimated coefficients obtained from maximum likelihood, adopting a logit model. The substance of the findings is the same as the ones presented in **Table 2**.

Contrary to what we found earlier about the role of ability on knowledge of the coronavirus and its illness, it appears that education does not explain support for the conspiracy theory about the origin of the virus in Brazil. In other words, college educated Brazilians appear to be no less supportive of the conspiracy theory about the origin of the coronavirus.

Social status and media consumption, be it from traditional or social media platforms, do not affect support for the conspiracy theory about the origin of the virus. Thus, there is no apparent role for the opportunity to learn in explaining support for the conspiracy theory about the origin of the coronavirus.

Results in **Table 2** indicate that both variables measuring political preferences have statistically significant effects on support for the conspiracy theory ($p < 0.01$, two-tailed). The effects are also as expected with Brazilians with positive evaluations of the Bolsonaro government and those preferring Bolsonaro's party being all more likely to support the conspiracy theory that the coronavirus was created in a Chinese laboratory to increase China's economic power. The effects are also substantively large. In particular, we find that the probability to support the conspiracy theory among Brazilians who see the Bolsonaro government as "great" is 33 percentage points higher than those who think his government is "terrible." This effect is more than twice the size of the effect uncovered for motivation (as proxied by worriedness about COVID-19). The effect for the respondent's preferred party is also substantively large. Specifically, the probability to support the conspiracy theory among those who indicated Bolsonaro's party as their preferred party is 17 percentage points higher than that among those who indicated another party or no party. This effect is substantial and slightly larger than the effect for motivation (again, as proxied by worriedness about COVID-19).

Finally, among our control variables, only age shows a statistically significant effect. Our results suggest that older people are less likely to believe in the conspiracy theory about the origin of the coronavirus. For example, a 60-year-old respondent, as compared to an 18-year-old, is about 8 percentage points less likely to support the conspiracy theory about the origin of the coronavirus.

The analysis above indicates, once again, an important role for political preferences in contexts where the COVID-19 pandemic has been extensively politicized like in Brazil. Specifically, supporters of elites that downplayed the importance of the pandemic tend to be less knowledgeable about the coronavirus and COVID-19 and also to be more likely to believe in falsehoods about the origin of the virus. Our findings show support for the idea that people "follow the leader" (Lenz, 2012), even in dire circumstances like a pandemic.

DISCUSSION

Our findings add to the growing literature that shows that elite discourse affects the masses along partisan lines, including on a priori non-political issues like public health. For example, Baum (2011) has shown that Democrats and Republicans in the US differed in their concerns about the 2009 swine flu (H1N1 virus) and vaccination uptake, with Republicans who consume less traditional media sources being less worried about the pandemic and to vaccinate. Similarly, Clinton et al. (2020) show that Republicans are less likely to follow guidelines to limit mobility and social contact as compared to Democrats in curbing the novel coronavirus pandemic. Even when it comes to health policy or benefit uptake, Democrats and Republicans differ, with Republicans being less likely to adhere to the Affordable Care Act (Lerman et al., 2017; Sances and Clinton, 2019).

Our contribution moves beyond the US to another political context that is also increasingly polarized. Over the past three decades, Brazilian politics has been increasingly divided along voters supportive of the Worker's Party (PT) and those opposed to it (Samuels and Zucco, 2018). Today, the Anti-PT figure is populist right-wing President Jair Bolsonaro. Since he took office in early 2019, President Bolsonaro has been a fervent denier of science and climate change. When the coronavirus pandemic reached Brazil in 2020, President Bolsonaro maintained course, downplaying the importance of the virus and its illness (Barberia and Gómez, 2020). He referred to COVID-19 as a "small flu" and did not adopt behaviors recommended by public health experts. He did not practice social distancing and refused, most of the time, to publicly wear a mask. He gathered with hundreds if not thousands of supporters at various rallies, putting many of Brazilian lives at risk. In July 2020, President Bolsonaro tested positive for COVID-19 (UOL, 2020) but that did not change his behavior. Worst, in early December 2020, President Bolsonaro said on public TV that he would not receive the vaccine against COVID-19 (Reuters, 2020).

The Brazilian government has done poorly to promote the health of its citizens since the outbreak of COVID-19, with millions infected and more than 250,000 deaths by early March 2021 and many more to come. These infections and deaths are, in part, the result of lower health literacy about the virus and its illness among Brazilians and, in particular, among supporters of President Bolsonaro. This is presumably because of his failure, as a leader, to promote good behavior and communicate adequate health guidelines to combat the pandemic. Our findings in that respect could not be clearer: the strongest determinant of knowledge about COVID-19 and belief in the conspiracy about the origin of the virus is support for President Bolsonaro. Specifically, those that support him are significantly less knowledgeable about the virus and are more likely to believe in a conspiracy theory that stipulates that the virus was created in a laboratory to promote China's economic power, despite there being scientific consensus that the virus did *not* originate in a lab.

Although our model looks at the direct effect of political preferences on knowledge, we believe that the causal mechanism is more complex than what our observational design can reveal. Specifically, political preferences affect knowledge because it might affect the opportunities and motivations to learn. For example, Brazilians who support Bolsonaro—like him—are less concerned about COVID-19. Specifically, 43% of those who consider the Bolsonaro government to be "bad" or "terrible" claim that they are "very concerned" about the disease. That portion is only 23% among those who believe his government

to be "good" or "great." Moreover, today's fragmented media environment allows partisans to feed on media diets that are congruent with their beliefs (Iyengar and Hahn, 2009). Bolsonaro supporters are more likely to reject traditional media. Precisely, only 36% of those who consider the Bolsonaro government to be "good" or "great" say that they very frequently get their information about the virus and its illness from Brazil's traditional and well-establish media outlets. On the other hand, more than 53% of those who believe his government to be "bad" or "terrible" do so.

Our study is not without limitations. First, most work in the area and, more specifically in the US, has looked at partisanship as the dividing force. In Brazil, partisanship is not nearly as meaningful and even less so since the election of President Bolsonaro who has now spent most of his tenure without a party affiliation. Samuels and Zucco (2018) demonstrate rather clearly that the only party with a solid partisan base in Brazil is the Worker's Party (PT) and that politics in Brazil is largely divided among three groups: Worker's Party supporters (*petistas*), those that oppose the Worker's Party (*antipetistas*) and non-partisans. Consequently, partisanship is not the cornerstone of Brazilian politics and, for that reason, we relied instead on support for President Bolsonaro—a prominent *antipetista* figure in Brazil politics (Hunter and Power, 2019; Rennó, 2020). The conclusions, however, remain the same: when political elites show discordance, the masses respond accordingly, even on non-political issues of high importance like a pandemic where elite consensus is most desirable.

A second limitation concerns the representativeness of our online sample. Sampling representative national samples over the Internet, in Brazil or anywhere else in the world, is no easy feat (Smith et al., 2016). Although we are confident that our sample is as close as one can get to a representative sample of Brazilians in times of social distancing, we also know that our respondents are slightly more educated and wealthier than members of the Brazilian population because we use a sample of online respondents. It should be noted that around 25% of Brazilians do not have access to the Internet (NIC.br., 2020) and are, therefore, not represented in our data. This implies that knowledge about COVID-19 is presumably lower in Brazil than what we find in our survey. That does not mean, however, that the knowledge gap attributed to political preferences would be lower have we had a more representative sample. To the contrary, less educated and poorer Brazilians that approve of President Bolsonaro are also likely to know less than similarly poor and low educated Brazilians who disapprove of his administration.

A third limitation is our inability to account for other known determinants of support for conspiracy theories. There is a large literature about conspiracy theory beliefs and the individual-level determinants of such beliefs (for a general discussion on the topic, see Douglas et al., 2019). For example, support for conspiracy theories is also related to beliefs in unseen, intentional forces and attraction to Manichean narratives (Oliver and Wood, 2014), particular cognitive style (Dagnall et al., 2015), political extremism (Van Prooijen et al., 2015), and many others. Unfortunately, our survey does not afford measures for these other known individual-level determinants.

We do not believe, however, that our inability to account for these other determinants has biased in any substantial way the effect we uncovered for the role of political preferences, another well-known determinant of belief in conspiracy theories (Uscinski et al., 2016).

Finally, a fourth limitation of our study concerns the fact that knowledge about COVID-19 is fluid and constantly changing as the pandemic evolves. For example, we still know little about the proportion of asymptomatic cases of COVID-19. Some studies have suggested that this proportion can be as high as 82% of the cases (He et al., 2021a), others have it at about 48% (Syangtan et al., 2021), and still others estimate that proportion to be only 16% of the cases (He et al., 2021b). Therefore, it is possible that what we believe to be true or correct knowledge today—in the light of the best scientific evidence we have at hand—might be invalidated in the future as we learn more about COVID-19.

CONCLUSION

This study examined the determinants of knowledge about COVID-19 in Brazil, paying particular attention to the role of political preferences. The COVID-19 pandemic has been extensively politicized in Brazil with its president, Jair Bolsonaro, at center stage. From the beginning of the outbreak, President Bolsonaro has systematically minimized the lethality of the coronavirus and the severity of the pandemic. Our survey results from a national sample of Brazilians reveal that political preferences explain most of the differences observed in levels of knowledge about the virus and its illness and support for the incorrect belief that the coronavirus was purposely created in a Chinese laboratory to increase China's economic power. The effects of motivation, ability and opportunity—known determinants of learning—pale in comparison to the role of political preferences. Specifically, Brazilians who believe that the Bolsonaro government is "great" know around 10% less about the virus and its disease when compared to those who believe his government is "terrible." Similarly, the probability to support the conspiracy about the origin of the coronavirus is 32 percentage points higher among those who believe the Bolsonaro government to be "great," as compared with those who believe it is "terrible."

The results from our study also prompt other important questions for future research. In particular, further work is needed to better understand the relationship between political preferences and knowledge. For example, are the effects of political preferences on knowledge conditioned by other factors like political sophistication or particular cognitive style? Similarly, does proximity with the disease moderate the effect of political preferences on knowledge? In other words, how are supporters of a government that denies the severity of the COVID-19 pandemic affected when they themselves get infected or when a close friend or family member gets infected and/or dies from the disease? Do they seek out more information or do they keep following their leader in denying the science? The answers to these questions are important to better understand the relationship between political elites and citizens. On one hand,

it allows us to understand the limits of the influence of political elites on the opinions and behaviors of citizens in the midst of a major crisis like a pandemic. On the other hand, it allows us to identify the conditions that are more propitious for people to form opinions and adopt behaviors autonomously, even when contrary to those of their preferred political leader.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

We have submitted documentation to the Brazilian research ethics committee (Comitê de Ética em Pesquisa) prior to data collection but, unfortunately, we had to start collecting our data before obtaining the approval of said committee. We recognize the importance of obtaining ethical assessment prior to data collection but the funds used for this research project were released a few weeks only before the first round of the 2020 municipal elections in Brazil and part of the project was to collect data about the electoral campaign leading up to the first-round election. Thus, we decided to move forward with the data collection without ethics approval. We were later informed (early January 2021) that the committee will not emit a decision about our protocol because the data have already been collected. That said, we strongly believe that our research protocol would have been approved by any ethics committee because: (1) respondents were informed about the purpose of the study and were asked

to give their consent prior to participating; (2) no identifying information was collected about the respondents; (3) respondents could skip questions and/or terminate the questionnaire at any time; (4) we did not deceive respondents in any way or provided them with misinformation about COVID-19; and, (5) our survey represents less than minimal risks.

AUTHOR CONTRIBUTIONS

WG and MT wrote the article and conducted all empirical analyses. JK wrote the first version of the abstract. MS has been responsible for data collection and communications with the online sample provider Netquest. All authors commented, copyedited, and approved the submitted version of the article. All authors contributed to the creation of the survey instrument.

FUNDING

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.646430/full#supplementary-material

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Platform Effects on Alternative Influencer Content: Understanding How Audiences and Channels Shape Misinformation Online

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People are increasingly exposed to science and political information from social media. One consequence is that these sites play host to "alternative influencers," who spread misinformation. However, content posted by alternative influencers on different social media platforms is unlikely to be homogenous. Our study uses computational methods to investigate how dimensions we refer to as audience and channel of social media platforms influence emotion and topics in content posted by "alternative influencers" on different platforms. Using COVID-19 as an example, we find that alternative influencers' content contained more anger and fear words on Facebook and Twitter compared to YouTube. We also found that these actors discussed substantively different topics in their COVID-19 content on YouTube compared to Twitter and Facebook. With these findings, we discuss how the audience and channel of different social media platforms affect alternative influencers' ability to spread misinformation online.

Keywords: misinformation, social media, alternative influencers, platforms, computational social science

INTRODUCTION

People are increasingly exposed to science and political information from social media (Brossard and Scheufele, 2013), while traditional sources of information, such as television and newspapers, are increasingly ceding their share of the information marketplace. As a result, online platforms provide new opportunities to educate the public (Sugimoto and Thelwall, 2013) but have also become playgrounds for misinformation (Syed-Abdul et al., 2013) and manipulation (Lewis, 2018). Individuals who post political and science information on social media vary widely in their expertise and intentions. While social media empower non-expert actors to make contributions to debates with traditionally undervalued expertize in local knowledge and community preferences (Wynne, 1992), they also increase the ability of ill-intentioned actors (i.e., alternative influencers) to the circulation of empirically false claims, such as the vaccine-autism link (Kata, 2012).

Research into political and scientific misinformation is an active research area which has explored patterns of misinformation use and effects on individuals. However, one major gap in that literature is a theoretically-informed accounting of how communication platforms, such as Facebook, YouTube, or Twitter, fundamentally differ from one another and how those differences affect the information available there. The content of social media platforms, we argue, is in part a function of differences in audience makeup and user interactions. Together, these two factors affect the structure of the information that actors choose to post with respect to *what* content they post and

how they present the content (Hiaeshutter-Rice, 2020). This study uses this framework to begin building theoretically-informed expectations of informational differences across platforms, drawing on COVID-19 content posted by actors known to spread misinformation.

Though we know that alternative influencers (Lewis, 2018) spread science and political misinformation on social media, and that social media platforms shape information in different ways, we have very little understanding, both in theory and in practice, of how platforms and actors intersect to influence what information the public is exposed to on social media. That is, content posted by alternative influencers on different social media platforms is unlikely to be homogenous. Instead, platform differences are likely to alter the emotion and associated topics discussed by alternative influencers, features known to affect public attitudes and trust in science and politics (Cobb, 2005; Brader, 2006; Nisbet et al., 2013; Hiaeshutter-Rice, 2020). Given increasing concern during the COVID-19 pandemic about the deleterious effects that social media content is having on democratic society and public health, understanding how different social media platforms shape and circulate content produced by actors known to spread misinformation is vital for unpacking how some segments of the public become misinformed about controversial issues including COVID-19 (Pew Research Center, 2015), as well as shed light on how to slow the spread of misinformation online.

CONTENT DIFFERENCES ACROSS COMMUNICATION PLATFORMS

Communication Platforms

There is more information available to individuals now than at any point in history, a fact that will likely remain true for all future points in time. Yet *where* people can access information is also vitally important because communication platforms shape the structure of information. For example, Wikipedia may be very similar to a physical encyclopedia, but the capacity for editing and hyperlinking means that information on Wikipedia is structured differently than a physical book can be. Communication platforms differ fundamentally from one to another, and those differences have consequences for the content and structure of information communicated *via* that platform. Importantly, these informational differences can shape public knowledge and beliefs.

Despite this, most scholarship into misinformation has relied on investigations of single communication platforms. These studies are not invaluable, far from it, and we have learned a great deal about how individual platforms operate. However, this limitation has consequently masked the realities of the entire information ecosystem. In part, this has been a function of limitations of data collection. We have an abundance of information about platforms from which data is easier to collect, such as Twitter. Yet overreliance on these platforms limits our understanding and ability to make claims about media ecosystems more broadly, and in particular about how information moves across platforms (Thorson et al., 2013). While some authors have looked at communication across platforms

(e.g., Bossetta, 2018; Golovchenko et al., 2020; Lukito, 2020), we argue that there are still gaps in the literature for a systematic analysis of the underlying structures of the communication ecosystem and the corresponding consequences on content (Bode and Vraga, 2018). Here, we outline how different dimensions of platforms structure content (Hiaeshutter-Rice, 2020), followed by a discussion of how this content affects belief in misinformation online.

Platform Audiences and Channels

Although platforms do not exist independently of one another, they are distinct in how they are constructed and used (Segerberg and Bennett, 2011; Hiaeshutter-Rice, 2020). Platform differences are, we argue, vital to understanding differences in information across platforms. In this paper, we propose two relevant dimensions to consider: audience and channel. This is a new framework which we propose as a way to think about how information on platforms is shaped by the ways content creators view a platform's technical features and their intended use. Much like a political campaign, content creators develop their messages and information with a platform's audience and channel in mind, which necessarily has consequences on content. By defining the audience and channel of platforms, we can move toward building expectations about content differences between platforms. As we move into our explanation, we also want to note that these are wide categorizations rather than discrete components of a platforms.

A platform's audience can range from *narrow* to *broad*, referring to the homogeneity of the recipients. Broader audiences may be characterized by diversity with respect to political partisanship, age, racial demographics, location, or other interests, while narrow audiences are more similar in their demographic makeup or beliefs. We should note that broad does not mean large but instead refers to degree of diversity. Further, a platform's audience is defined by the content creator's perceptions, not necessarily how the platform functions as a whole. We provide specific examples below.

Platforms we categorize as *narrow* audiences are ones where the audience of users are largely made-up of a constrained set of beliefs, ideologies, or partisanship. For instance, the audience of the Twitter account of a sports team is likely to be made up of fans of that team. This broadly applies to users on platforms as a whole. A *broad* audience is one that has a larger and, potentially at times, conflictual set of beliefs and preferences. Thus, platforms like Facebook and Twitter have *narrow* audiences. While these social media platforms have wide and diverse user bases, regular *direct* exposure to an account on Facebook or Twitter is predicated on following that account.[1] Actors on Facebook and Twitter can be reasonably assured that their content is

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[1]Of course, the other way that individuals see content is to be algorithmically exposed to it through interactions by their connections. For instance, if User A follows User B and User B follows User C, who is not followed by User A, sometimes User A will see User C's content even though they do not follow them. As we are primarily interested in how the initial user creates content, this type of indirect exposure is of less interest for our project.

largely being viewed by the interested users and that they are incentivized to tailor that content to the narrower range of interests that their audiences want (Wang and Kraut, 2012). In comparison to Facebook or Twitter, we characterize YouTube as a *broad* audience platform (Iqbal, 2020). Though users have the option to follow content on YouTube, they are exposed to a much wider range of content creators as they use the site. This is in part because YouTube provides access to content through at least three distinct modes. The first is direct connection with users, such as subscribing to an account. The second is goal-oriented exposure, such as searching for specific content without necessarily a specific content creator in mind. Finally, users are also exposed to content through recommendations, such as popular content on the main page and along the side of a playing video as well as videos playing automatically after the one being watched ends. It is notably the second and third mechanisms which we theorize encourages content that resonates with a broader audience. For content creators on broad audience platforms, their videos are being shown to a much wider and more diverse audience than they might otherwise encounter on a different social media platform. We argue that content creators on YouTube are thus incentivized, indeed financially so, to tailor their content to a wide range of audiences. Differences in the perceived audience of a platform may affect the content and presentation of information. For example, content on platforms with narrower audiences may focus on emotions and topics that are more motivating to one's loyal base, while content on platforms with broader audiences may use emotions and content with wider appeal.

The other important dimension of a platform is the degree to which actors must share the attention of the audience. Here, we refer to the channel of the platform, which may be *independent* (free of interaction from other, possibly opposing, actors) or *shared* (in which creators must anticipate and respond to others). Importantly, this is not a binary classification, but rather represents a range perceived by users of the platform. For example, Facebook and Twitter are shared channel platforms because other users can quickly respond to what creators post in both their own spaces and on the creator' page directly. Yet Twitter is likely more shared than Facebook; for instance, opposing political candidates have regularly and directly engaged with each other on Twitter but have not connected to a similar degree on Facebook (such as Hillary Clinton telling Donald Trump on Twitter to "delete your account" during the 2016 United States Presidential Election). YouTube is a more independent channel than Facebook and Twitter because the content of the video cannot be interrupted by other actors, but it is less independent than traditional broadcast television because of the ability to post comments under a video. Whether the platform has a more shared channel, in which content creators compete for attention, or a more independent channel, in which their messages are largely uncontested, is likely to affect the content of their messages. For example, content in shared channels may include more emotional cues that attract audience attention or respond about topics raised by others, compared to content in more independent channels.

We note that there are myriad other influences that may drive differences in content across communication platforms, including business practices, curation methods, and economic incentives (Thorson and Wells, 2016; Caplan and Gillespie, 2020). Further, we are not prescribing hard and fast rules as to how platforms operate. Instead, we offer a theoretically-informed framework for thinking about platform differences and which dimensions may influence the content and information that is produced. These are based on our read of the vast extant literatures on how platforms are used instead of, rather than one study or source of descriptive data specific data source or study. Moreover, we are attempting to be specific what components of a platform fit into which category. For instance, we consider Facebook to be a *narrow* and *shared* platform when it comes to users posting content to their pages, whereas paying for an advertisement through the Facebook interface would likely be *narrow* and *independent* as the structure of that communication is different. Classifying platforms by their audience and channel offers an initial framework for building theoretically informed expectations about content differences across platforms. We therefore apply this structure to our investigation of alternative influencers' COVID-19 content to build understanding of what platform audiences and channels may have enabled or minimized the spread of misinformation during a global pandemic.

Content Differences Across Platforms and Misinformation

Actors' awareness of platforms differences with respect to audience and channel are likely to affect the content of the information they post on different platforms. That is, the content that actors share on two platforms is likely to be different even if it is about the same issue. Two differences that are particularly relevant to the spread of misinformation on social media are 1) the emotional cues in messages, particularly anger and anxiety or fear, and 2) content differences, referring to the surrounding topics prevalent to content about a specific issue.

Emotion

Emotions can be broadly defined as brief, intense mental states that reflect an evaluative response to some external stimulus (Lerner and Keltner, 2000; Nabi, 2003). Content that contains emotional cues or language is more attention grabbing, leading to greater online viewing, than non-emotional content (Most et al., 2007; Maratos, 2011; Bail, 2016). This is particularly the case for high-arousal emotions, such as awe, anger, or anxiety (Berger and Milkman, 2012). In the context of misinformation research, investigating the appraisal tendencies and motivations associated with discrete emotions has been particularly fruitful with respect to anger and anxiety or fear (Nabi, 2010; Weeks, 2015). Anger is experienced as a negative emotion in response to an injustice, offense, or impediment to one's goals, and is characterized by an "approach" tendency or motivation to act (Nabi, 2003; Carver and Harmon-Jones, 2009). Similar to anger in their negative valence, the related emotions of anxiety and fear are aroused in response to a threat of harm, encounter with an

unknown, or anticipation of something negative (Carver and Harmon-Jones, 2009; Nabi, 2010; Weeks, 2015). In contrast to anger, though, anxiety and fear are characterized by "avoidance" tendencies or a lack of motivation to engage, confront, or act (Carver and Harmon-Jones, 2009; Weeks, 2015). Both anger and fear are known to be associated with misinformation sharing and belief, so investigating their prevalence in content posted by alternative influencers on different platforms offers insight into the role that audience and channel may play in distributing misinformation online.

Emotion and Misinformation Spread on Social Media

Both anger and anxiety or fear have been tied to information behaviors that spread misinformation on social media. Angry individuals are more likely to selectively expose themselves to content that reinforces prior beliefs or identities (MacKuen et al., 2010), a behavior that increases the likelihood of being exposed to false information online (Garrett et al., 2016). In addition, anger-inducing content online is more likely to be clicked (Vargo and Hopp, 2020) and circulated (Berger and Milkman, 2012; Hasell and Weeks, 2016) than less emotional content. Like anger, fear or anxiety cues increase attention to content (Ali et al., 2019; Zhang and Zhou, 2020) and can promote the circulation of misinformation. For example, in the absence of consistent, credible information about extreme events like natural disasters, anxiety and fear can facilitate the spread of rumors and misinformation on social media as individuals seek information to alleviate uncertainties (Oh et al., 2010). But fear and anxiety have also been deployed strategically to bring attention to and spread false information; by intentionally provoking fear, doubt, and uncertainty in their online content, anti-vaccine activists sow confusion and misperceptions about vaccines (Kata, 2012). Similarly, conspiracy theories, characterized by paranoia, distrust, and fear supposedly powerful groups posing some threat, are spread widely on social media because users are encouraged to engage with conspiratorial content (Aupers, 2012; Prooijen, 2018; Katz and Mays, 2019).

The emotions of anger and anxiety or fear can promote information behaviors that spread misinformation because they increase attention to and engagement with the content. Consequently, this can lead to increased visibility of an influencers content (e.g., clicks on content or sharing on one's own account). These information behaviors may be particularly desirable for actors posting content on *shared* channel platforms, where actors compete with many others to convey their messages. That said, such strategies may also be used on *independent* channel platforms. In sum, the use of anger and fear language increases engagement with content, and such language might be unevenly distributed across platforms with different audiences and channels.

Emotion and (Mis) Information Processing

Importantly, these emotions not only affect attention and sharing behaviors but also affect how individuals evaluate information. Attaching emotions to information facilitates that information's retrieval from memory (Nabi et al., 2018)

and affects cognitive processing (Kühne and Schemer, 2015; Lee and Chen, 2020; Chen et al., 2021). Angry individuals are more likely to rely on heuristic or biased information processing that support their prior beliefs, leading to greater belief in identity-supporting misinformation (Weeks, 2015). In addition, angry individuals are more likely to perceive content as hostile to their political beliefs or positions (Weeks et al., 2019), which may motivate them to dismiss or counter argue accurate information. In contrast to anger, anxious individuals engage in less biased information processing (Weeks, 2015) and are instead inclined to seek additional information (MacKuen et al., 2010). However, it has been noted in some health contexts that fear-inducing content without efficacy information may lead to reactance or information avoidance (Maloney et al., 2011). Thus, while there may be some boundary conditions regarding the intensity of fear or anxiety, in general individuals are more likely to reach accurate conclusions about information when they are anxious or fearful, as compared to when they are angry, due to the different ways these emotions motivate information processing (Nabi, 2010; Weeks, 2015).

In the context of alternative influencers' COVID-19 content, investigating platform differences in emotional language may offer insight into where individuals are exposed to misinformation and why they may be inclined to believe it. The differences in information processing tendencies associated with these emotions (anger vs. fear as we discussed above) could influence content differences across platforms. On platforms with *narrow* audiences comprised of users who actively choose to follow content, anger-inducing language may mobilize a loyal base. In contrast, content with fear and anxiety cues may be more engaging on platforms with *wider* audiences, as it could draw users, who are not yet persuaded of a position, to an actor's content as a means of seeking further information. However, actors could use similar emotional strategies across different platforms to maximize engagement and reach. Given little prior literature to support these predictions, we ask the following research questions whose answers will aid us in building theoretically-informed expectations regarding how emotional language may be shaped by the channel and audience of platforms.

RQ1: How does the proportion of anger language in alternative influencers' COVID-19 content differ between platforms with different audience and channel (YouTube vs. Facebook vs. Twitter)?

RQ2: How does the proportion of fear language in alternative influencers' COVID-19 content differ between platforms with different audience and channel (YouTube vs. Facebook vs. Twitter)?

Content Differences

Differences in platform audience and channel may additionally drive differences in the topics within content about the same issue across platforms. That is, the substance of actors' content is expected to differ by platform, even when that content is ostensibly on a single issue.

The topics an actor discusses on a platform may vary based on their perceived audience (narrow or broad) and the channel of the platform on which they are posting (independent or shared). Even when discussing the same issue, actors may emphasize shared identities or concerns on platforms with wide audience (e.g., Americans, infection rates) and narrower identities or interests on platforms with narrower audiences (e.g., opposition to local lawmakers). Topics in content may also differ between platforms with shared and independent channels; an actor must respond to others' arguments, concerns, or questions on a shared channel platform, but is less motivated to do so on a more independent platform. Thus, not only the emotionality, but the topics in content an actor posts are likely to differ across platforms with different audiences and channels.

Importantly, these content differences may alter how audiences react to issues, which could have effects on attitudes and accuracy (Chong and Druckman, 2010). For example, work on climate change news coverage has shown that content which features skeptical positions alongside consensus positions leads to less accurate beliefs about climate change than content which emphasizes scientists' views (Dunwoody and Kohl, 2017). Politicizing cues can shift attitudes about scientific topics because evoking partisan identities and values leads individuals to follow partisan elites over other experts, even if those positions are incorrect (Bolsen and Druckman, 2018). Alternatively, emphasizing narratives about "naturalness" can reduce support for vaccination and GM foods (Blancke et al., 2015; Bradshaw et al., 2020; Hasell and Stroud, 2020). In sum, the language and topics that are discussed alongside an issue may influence peoples' conceptualization or interpretation of that issue.

For these reasons, differences in the topics in alternative influencers' COVID-19 content across platforms are important to understand. The presence of content differences means that individuals exposed to content posted by these actors across different platforms may come away with systematically different information and attitudes. Identifying the extent to which topic differences in content are driven a platforms' audience and channel may help us uncover the roles that different platforms play in spreading misinformation. However, while we expect that the prevalence of different topics will vary by platform in COVID-19 content posted by alternative influencers, we are unsure what those differences may be. We therefore ask the following research question:

> **RQ3:** How does alternative influencers' COVID-19 content, as observed *via* the prevalence of associated topics, differ between platforms with different audience and channel (YouTube vs. Facebook vs. Twitter)?

The Present Study

In this study, we address gaps in extant literature concerning how platforms affect the structure of information by investigating how alternative influencers' content about COVID-19 differs with respect to emotion and topics across different social media platforms. Here we collect and analyze a novel dataset of content posted by actors who are infamous for spreading

misinformation (Lewis, 2018) from Facebook, Twitter, and YouTube. We investigate platform differences using dictionary methods and structural topic modeling. In doing so, we advance the field's theoretical understanding about misinformation online and explicate the roles that platform audience and channel play in shaping information online.

MATERIALS AND METHODS

Data Collection

We collected data from Lewis's (2018, Appendix B) list of "alternative influencers," actors who are known to share misinformation online. There are total of 66 alternative influencers which represent numerous ideologies from "classical liberal" to "conservative white nationalist" (see Figure 1 in Lewis, 2018). The people on this list are not media elites. In fact, as Lewis described, the list focuses on political influencers from both the extreme left and the right wing. Some are professors, while majority are individual content creators who founded their own talk shows or vlogs on YouTube (see Appendix A in Lewis, 2018 paper for biographical information on these influencers). We searched for the alternative influencers' accounts on three platforms: Twitter, YouTube, and Facebook. We could not collect data from all influencers on all platforms; some did not have accounts with all platforms, others had been banned or de-platformed, while others had "private" settings on their accounts. Among these 66 influencers, 77% had YouTube accounts, 38% had Facebook accounts, and 56% had Twitter accounts from which we were able to collect data. Though starting dates varied by platform (we had Twitter data from 2008, Facebook from 2012, and YouTube from 2008), we were able to collect all publicly available data posted by these users on all platforms through mid-November 2020. **Supplementary Table S1** in the supplemental materials lists all accounts from which we collected data.

To collect all Facebook posts made by these influencers we used CrowdTangle, a third-party platform that provides researchers with historical data for public content on Facebook pages (content that has been removed either by the user or by Facebook are not included in the dataset). The CrowdTangle API, owned by Facebook, is marketed as containing all posts for public facing Facebook pages. Though we are relying on their API to produce results, we feel reasonably confident that the data collected is as close to, if not actually, population level data for these pages. The data we collected includes the text of the post, the engagement metrics, date the post was made, unique ID for the post, as well as various other metrics that we do not use here.

Twitter data was collected using a two-step process. The first was to use the Python package "snscraper" to collect a list of URLs for up to 50,000 tweets by each account. We then used the Python package "tweepy" to crawl through the list of URLs and download the relevant components of the tweet. This includes the screen name of the account, the text of the tweet (which includes any links), the date the tweet was sent, Twitter's unique ID for the tweet, and the number of retweets.

TABLE 1 | # of influencers and posts/videos.

Platform	# of influencers that have account	# of posts/videos collected	Data range
Facebook	28	299,995 posts	2012–2020
Twitter	39	609,042 posts	2008–2020
YouTube	51	42,684 videos	2008–2020

To collect all the YouTube videos that were posted by these influencers, we used a YouTube Application Programming Interface (API) wrapper from GitHub developed by Yin and Brown (2018).[2] This wrapper allows researchers to collect all the videos that were posted by a channel and all the video-level information such as video description, the number of views, likes, and shares. We then used the Python open-source package, *youtube-transcript-api*, to collect all the transcripts of each video. Around 10% of the video does not have transcripts available either because the videos were censored or due to content creators' privacy settings.

Both the Twitter and Facebook APIs as well as the YouTube transcript script produce .csv files with each post/video being represented by a row. The text of the post is contained in its own cell with the corresponding metadata (date published, author, etc.) in separate cells. This allows us to cleanly analyze the textual content of the posts without having to remove superfluous information.

Table 1 describes the number of posts/videos we collected from each platform, and how many influencers we were able to find for each platform. In our analyses, we only included the alternative influencers who were active on the platforms we were comparing (discussed further below), so that our results reflected platform differences, not user differences.

In this paper, we focus on the textual features of these posts and videos and thus we did not collect the visual content of the YouTube videos, Twitter, and Facebook posts. The audio information in YouTube videos is partially captured by the transcript. This means that we do not have information on the visual components of the videos. We acknowledge that it will be fruitful for future research to expand our current analysis to examine the differences in image use across platforms.

Analytical Approach

As this paper is interested at comparing the emotion and topics in COVID-19 content posted by these alternative influencers across platforms, we first used a dictionary keyword search to identify COVID-19-related content. Drawing from Hart et al. (2020), our search included the keywords "corona," "coronavirus," "covid," and "covid-19," as well as, "pandemic," "china virus," "wuhan flu," and "china flu." Facebook or Twitter posts that contained one of these keywords were included in our dataset. However, YouTube video transcripts are longer, and it is likely that

COVID-19 could be mentioned briefly in a video that about another topic. Therefore, we only included YouTube video transcripts in our dataset that mentioned a COVID-19 keyword two or more times to ensure that some portion of the video was substantively about COVID-19.

Our analytic approach uses two methods to understand emotion and topic differences across platforms. We use dictionary methods to look at the prevalence of fear and anger language in COVID-19 content on each platform. We used the NRC Word-Emotion Association Lexicon that was developed by Mohammad and Turney (2013). The NRC has eight basic emotion (anger, fear, anticipation, trust, surprise, sadness, joy and disgust) and two sentiments (negative and positive). We used the anger dictionary and fear dictionary (which contained anxiety-related words as well) in these analyses. However, we excluded the word "pandemic" from the fear dictionary, as it overlapped with the keywords used to select COVID-19 content. There are several reasons we chose the NRC emotion dictionary over others. First, this dictionary, was built through a crowdsourcing method by asking participants to indicate which word is closest to an emotion (for around 85% of the words, at least four of five workers reached agreement). Thus, these emotion dictionaries are built from the user's perspective, rather than constructed prescriptively by researchers. Second, in terms of validation and suitability of NRC to analyzing social media posts, scholars have conducted extensive validity checks on different emotion dictionaries for studying emotion on social media. For instance, Kusen et al. (2017) applied three widely used emotion dictionaries to code social media posts and then validated the performance of these dictionaries with online human coders. They found that NRC is more accurate at identifying emotion compared to other emotion dictionaries such as EmosenticNet and DepecheMood. Following the formal validation of dictionary approach suggested in González-Bailón and Paltoglou (2015) and van Atteveldt et al. (2021), we selected a random sample of messages covering different accounts from the three platforms (102 Facebook messages, 113 Twitter messages, and 101 YouTube segments). Three researchers coded each message for fear or anger (i.e., binary variable). Then we calculated the precision and recall for the anger and fear for each platform comparing hand annotation result and the dictionary result. The precision for anger ranged from 53 to 83% for the three platforms; the recall for anger ranged from 64 to 95%. For fear, the precision ranged from 60 to 80% and the recall ranged from 88 to 98% (see **Supplementary Table S4** for details).

We then used the R software and its quanteda.dictionaries package to apply this dictionary to our text data. The main function *liwcalike*() gives the percentage of emotion words relative to the total number of words, which we computed for all platforms. For example, this method first counts the number of fear or anger words in each YouTube video transcript and calculated the percentage of emotion words relative to the total number of words in the transcript. The fear or anger score assigned to the YouTube dataset represents the average fear or anger score across all videos' transcripts. After computing the fear and anger scores for Facebook and Twitter in a similar

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[2]For details about this GitHub wrapper, please check: https://github.com/SMAPPNYU/youtube-data-api and the tutorial is in: http://bit.ly/YouTubeDataAPI.

way, we then conducted a linear regression to examine whether influencers used emotions differently on different platforms (results from which are discussed below). Specifically, we conducted three linear regressions, with each one comparing the posts of the overlapping accounts for two platforms. In each linear regression, our dependent variable is the percentage of emotion language for a post/video, predicted by a categorical variable that captures which platform a post comes from, such as whether a post comes from Twitter or from Facebook. We controlled for the account-level information in the linear regression to address non-independence among these posts, which come from an overlapping group of influencers. Thus, we were able to control for the impact of account on emotion. We reported the marginal effect of platform influence on emotion using the R ggeffects package in the result section.

Second, to analyze topic differences in COVID-19 content across their platforms, we used structural topic modeling (STM; Roberts et al., 2019). STM has been notably used across political subfields of research and is a useful tool for text analysis (e.g., Farrell, 2016; Kim, 2017; Rothschild et al., 2019). Functionally speaking, STM utilizes the co-occurrence of all words in given corpus (for example, all COVID-19 Facebook posts) to identify topics reflected in groups of words that regularly co-occur. We chose STM over other frequently used models (LDA or CTM) because STM uses document metadata which allows us to classify which platform the text comes from. Given our research questions, this is an extremely useful component of the model. Here, we were not focused on investigating the content of the topics, per se, but were instead interested in the degree to which topics vary by platform.

Running the STM on our corpus required a fair amount of pre-processing of the text to yield understandable topics. We eliminated emoticons, dates, numbers, URLs, Bitcoin wallets, and other topically meaningless text using base R gsub functions. We then removed stopwords, common words such as "the" and "its," using the STM stopwords removal function.[3] Finally, we stemmed the remaining text (e.g., "essential" and "essentials" stemmed to "essenti"). This leaves us with 34,450 words spread across our corpus. We should note that, unlike the entire corpus, the COVID-19 subset that we use here contains, on average, longer texts. Median word count for COVID-19 texts is 52 whereas the overall corpus is 15. Longer text makes for easier topic modeling and a further reason to use the STM package.

However, there are reasons to consider not stemming, notably those raised by Schofield and Mimno (2016). We chose to stem the corpus for a few reasons, the more pressing of which is that sheer quantity of words prohibited us from make evaluations of each word in context. However, the concerns raised by Schofield and Mimno may be addressed by their recommendation of using a Porter stemmer, which is employed here.

From there, we used the spectral initialization function to produce our topics (see Mimno and Lee, 2014; Roberts et al., 2019). This algorithm provides a good baseline number of topics

and is a recommendation for a corpus that requires long processing times.[4] While we use spectral initialization, we also show some optimization results in **Supplementary Tables S5–S10 and Figure S1**. For these, we used a sample of 800 randomly drawn observations from our COVID dataset. We started by using the default fixed beta of 1/K and varied, first, the K values surrounding the K produced by the spectral initialization (80, 90, and 100). We then used k = 92 and varied the alpha (0.01, 0.05, and 0.1). These six models (K = 80, alpha = 0.01; K = 90, alpha = 0.01; K = 100, alpha = 0.01; K = 92, alpha = 0.01; K = 92, alpha = 0.05; K = 92, alpha = 0.1) are all shown in the Appendix. This background work provides a useful test of our hyperparameter optimization. We do use the results of the spectral initialization throughout the remainder of this piece as we find that the topics selected are reasonable for clarity and coherence. The result is 92 topics (see **Supplementary Table S2** for a full list of topics and the top-7 words that distinguish them). The extent to which different topics were associated with different platforms are discussed in the results below.

RESULTS

Emotion

We compared how anger and fear, two of the most important emotions in misinformation and conspiratorial content, were used by alternative influencers across the three platforms in their COVID-19 content, controlling for account. **Figure 1** presents the marginal effects of platform on fear and anger, with 95% confidence interval. Regression tables are in **Supplementary Table S3**. We conducted three linear regressions, each comparing two platforms (e.g., Facebook vs. Twitter). For each linear regression model, the platform variable only utilizes data from influencers that are active on both platforms being compared, and in addition we controlled for what account the post came from. In this way, we ensure that differences in content are attributable to differences in the audience and channel of the platforms, rather than reflecting different content creators. There is data from 32 influencers included in the Twitter and the YouTube linear regression model, 24 in the YouTube and Facebook, and from 20 in the Twitter and Facebook.

Examining the marginal effects from the linear regression models, we found that there was a greater proportion of fear and anger language on Facebook and Twitter compared to YouTube. In their COVID-19 content, alternative influencers used a much higher percentage of fear on Facebook (2.43%) than on YouTube (1.71%) ($p < 0.01$). They also used a higher percentage of anger on Facebook (1.51%) compared to YouTube (1.29%) ($p < 0.01$). This pattern held when comparing Twitter and YouTube: alternative influencer used more fear words on Twitter (2.72%) than on YouTube (1.77%) ($p < 0.01$) and a higher percentage of anger words on Twitter (1.57%) than on YouTube (1.29%) ($p < 0.01$). Comparing Facebook and Twitter, whose audience and channel

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[3]The list of stopwords can be found here: http://www.ai.mit.edu/projects/jmlr/papers/volume5/lewis04a/a11-smart-stop-list/english.stop.

[4]The default hyperparameters for the model (alpha = 0.01 and beta = 1/K) produced convergence around iteration 116.
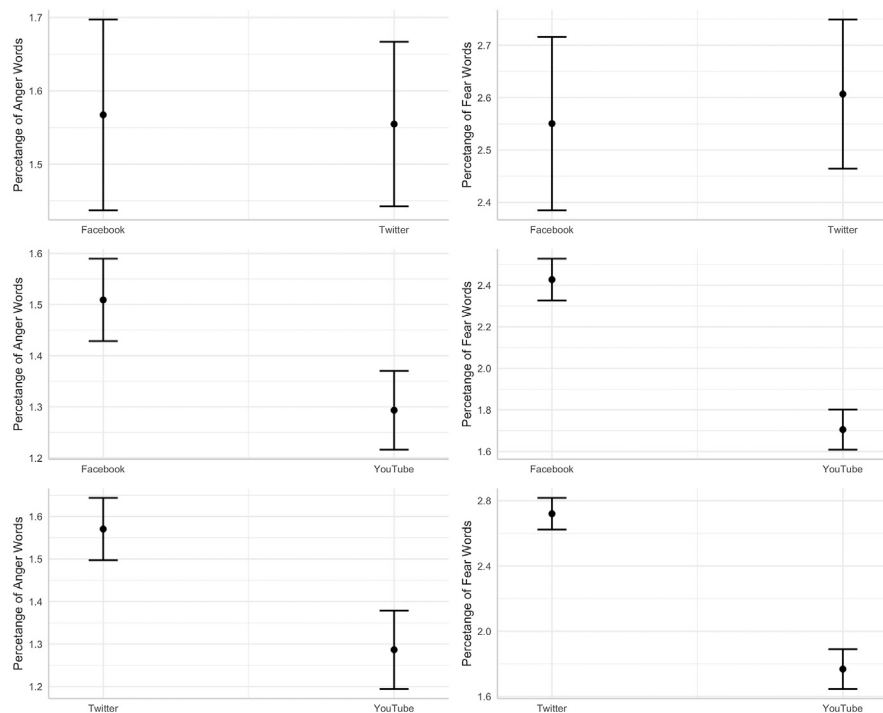
FIGURE 1 | Pairwise Comparison on the Use of Anger and Fear across Facebook, Twitter and YouTube on COVID-19 Content. Note: The estimated point in Figure 1 is the mean percentage use of an emotion for a platform, with 95% confidence interval. The top panel compares Facebook vs. Twitter in terms of the use of anger and fear; the middle panel compares Facebook vs. YouTube; the bottom panel compares Twitter vs. YouTube.

are more similar, we saw fewer differences. Although we observed a slightly lower percentage of fear words on Facebook (2.55%) than on Twitter (2.61%), the difference is not statistically significant ($p = 0.63$). For anger, there was no significant difference between the two platforms, too ($p = 0.89$). In sum, in response to our first two research questions, we found that shared channel platforms (Twitter, Facebook) contained more fear and anger language than independent channel platforms (RQ1, RQ2).

Topics in COVID-19 Content

We also examined how topics varied in COVID-19 content across platforms. Recall that this series of tests is designed to answer RQ3, in which we wanted to understand whether the topics, as extracted through the Structural Topic Model, would vary across platforms. Our intention here is to highlight variations in topic, not necessarily to do a deep dive into the topics themselves. To accomplish that, we are going to largely focus on the distribution of topics by platform rather than the content of the topics. A full list of the topics that were extracted from the STM results are included in **Supplementary Table S1**). Again, this is focusing only on the COVID-19 content from these alternative influencers, who have demonstrated a pattern of spreading misinformation and radicalized messages on social media (Lewis, 2018).

Figures 2–4 below show pairwise comparisons between the three platforms. As with the pairwise comparisons above, these

results only include data from alternative influencers with accounts on both platforms. Results are shown with a vertical line at zero indicating the non-significant relationship point and topics are points with 95% confidence intervals. Points and intervals that do not overlap the zero line are statistically associated with whichever platform represents that side of the line. We have ordered the topics by the strength of their association with one platform over the other, with the topics with the strongest associations at the top and those with the lowest (or more equally shared between the platforms) at the bottom. What we are looking for here is divergence trends between the relationships. If there are differences in how topics are deployed by platform, then we ought to see different distributions of topics. Moreover, if our contention that platform structure matters, then we ought to see similarities between the distribution of Facebook vs. YouTube and Twitter vs. YouTube. The reason for that is that Facebook and Twitter are similar in our categorization and should have similar patterns of topics.

Our anticipated relationship is exactly what we see. Facebook and Twitter do have divergences in content, but 47 of the 92 topics are non-significant. We use a dashed gray line to indicate the point at which topics above the line are statistically associated with one platform more than another at the $p < 0.05$ level. In comparison, a great deal more topics differ on those platforms when compared to YouTube (69 topics for Facebook and YouTube and 68 topics for Twitter and YouTube). Our

FIGURE 2 | Pairwise comparison of topics for Facebook and Twitter.
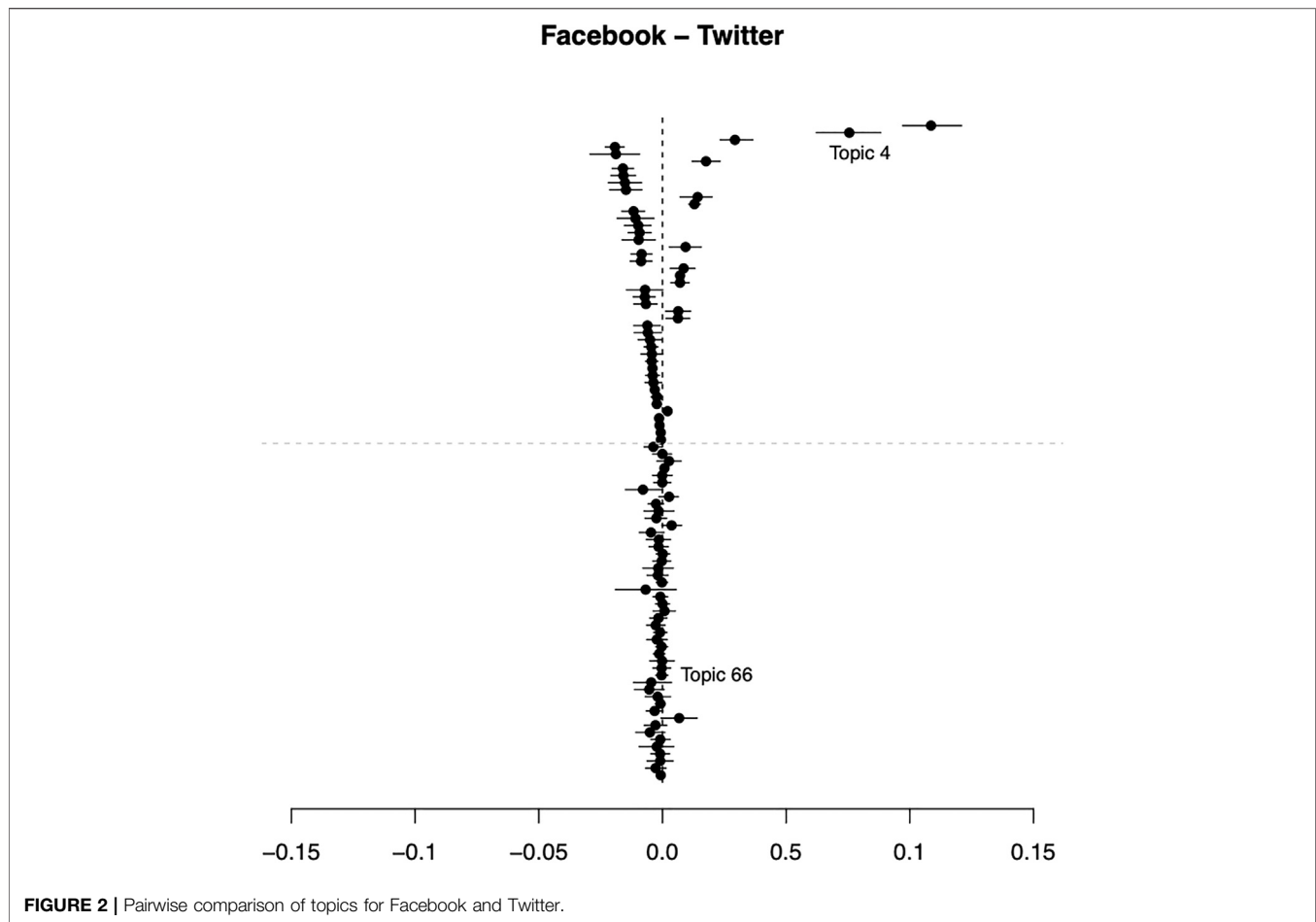
argument, as we presented above, is that topics should differ based on audience and channel and we see that represented in the relationships here. That is, alternative influencers' COVID-19 posts on Twitter and Facebook are associated with similar topics; in contrast, YouTube content about COVID-19 that is posted by these same influencers is dissimilar from Twitter and Facebook. There are topic differences between Facebook and Twitter, of course, though many are close to the 0 line, suggesting that the magnitude of difference is lower.

In practice, this means that alternative influencers discuss similar topics in COVID-19 content on Facebook and Twitter, whereas their YouTube videos contain different considerations, connections, and topics. While we are primarily interested in uncovering whether topics vary systematically as a function of platform audience and channel, the substance of these topic differences is also important to evaluate. Perhaps the most interesting finding concerns topics closely related to COVID-19 that are strongly associated with different platforms. For example, Topic 4 (differentiated by the words: coronavirus, pandem, covid, travel, februari, downplay, and panic) is explicitly about COVID-19, using language we might expect to be common to all platforms' COVID-19 content. However, what we find is that discussion of Topic 4 is unequally distributed across platforms. Topic 4 is more closely associated with Twitter

than Facebook by a fair margin (see **Figure 2**). Additionally, it appears in YouTube content more than Facebook or Twitter. That is, across content that mentions COVID-19, this topic is more likely to appear on YouTube than the other platforms and that users of YouTube may be systematically more exposed to this topic than users of other platforms are. We see a different pattern concerning Topic 66, which appears to concern critical care COVID patients and the outbreak in Italy (top words are: ventil, icu, model, itali, beard, bed, peak). This topic is more closely associated with Twitter and Facebook than YouTube. Contrasted to the more general discussion of COVID-19 in Topic 4, Topic 66 is more specific and potentially more fear inducing. These differences in topics related to COVID-19 between narrower audience, shared channel platforms (Facebook and Twitter) and broader audience, independent channel platforms (YouTube) support our contention that topics are not equally distributed by platform and that these differences may be driven by these platform characteristics.

Though we selected alternative influencers because of existing evidence that they spread misinformation on political and scientific topics (Lewis, 2018), the STM topics also offer evidence that these actors are likely spreading misinformation surrounding COVID-19, and that exposure to misinformation may vary by platform. For example, Topic 23 (differentiating

FIGURE 3 | Pairwise comparison of topics for Facebook and YouTube.
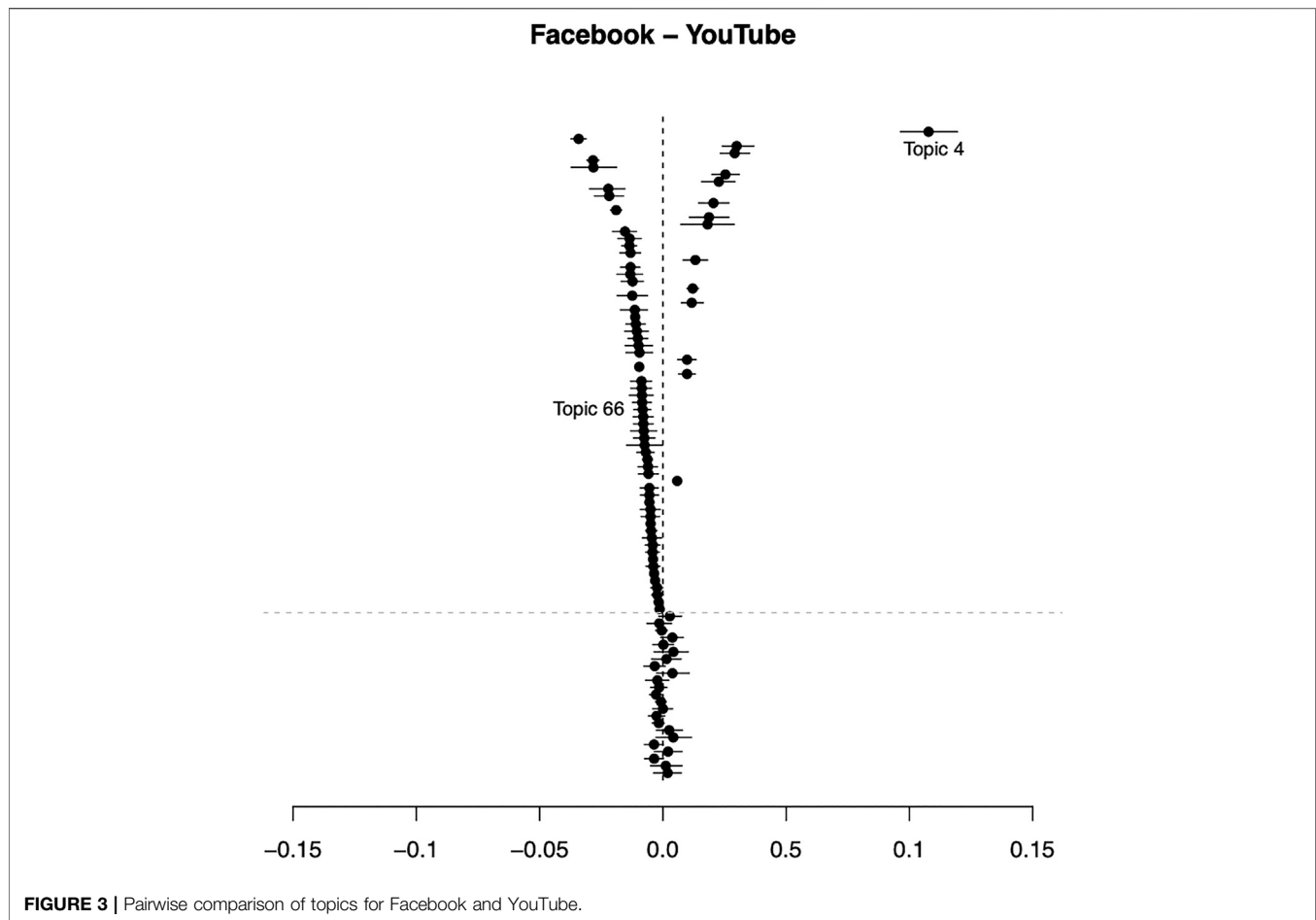
words: chines, china, wuhan, taiwan, hong, kong, beij), which appeared to focus on the Chinese origins of or blame for COVID-19 (e.g., "China, of course, appears to have worked alongside the WHO to hide the virus's true nature, leaving many countries, including the United States, unprepared for the severity of the coronavirus epidemic." Facebook post from the Daily Wire), was more prevalent on Facebook than on YouTube or Twitter, and more prevalent on Twitter than YouTube. Similarly, allegations of protesters committing crimes (Topic 75; top words: riot, portland, protest, loot, rioter, antifa, violenc) and antisemitic claims (Topic 92; top words: jewish, jew, roger, semit, holocaust, conspiraci, milo) are more common on Facebook than Twitter and are more common on Twitter than YouTube. Additionally, alternative influencers' allegations of "fake" mainstream news (Topic 45; top words: press, cnn, journalist, fox, fake, media, news) are similarly prevalent on Twitter and Facebook, but less common on YouTube.

DISCUSSION

Past works stress that misinformation preys on our emotions; attention to, sharing of, and belief in false information is often associated by emotions like anger and fear (Maratos, 2011;

Weeks, 2015; Vosoughi et al., 2018). This study presents a novel examination how emotion varies in COVID-19 content likely to contain misinformation across prominent communication platforms. As we showed, emotional language on YouTube differed substantially from the other two platforms, Twitter and Facebook. When communicating about COVID-19, alternative influencers used more anger and fear words on Facebook and Twitter compared to YouTube. In part, this could be due to a technical feature in which the actor is limited by the length of the post, and thus needs to maximize emotion use to draw continuous attention and interaction from the audience. In comparison to YouTube, Twitter and Facebook are more interactive and competitive, and so this observation suggests that content on shared channel platforms contains greater emotional language than independent channel platforms, likely to draw audience attention (RQ1, RQ2). As a reminder, we consider platform structures such as audience and channel to exist on a spectrum, and that our classifications are about these platform's relative positions to one another, not hard and fast rules. We did not find many differences in the use of fear and anger language. Across all platforms, alternative influencers' COVID-19 content contained a greater proportion of fear-words than anger-words. This may be attributable to the topic; at the time of data collection, COVID-19 cases were rising nationally,

FIGURE 4 | Pairwise comparison of topics for Twitter and YouTube.
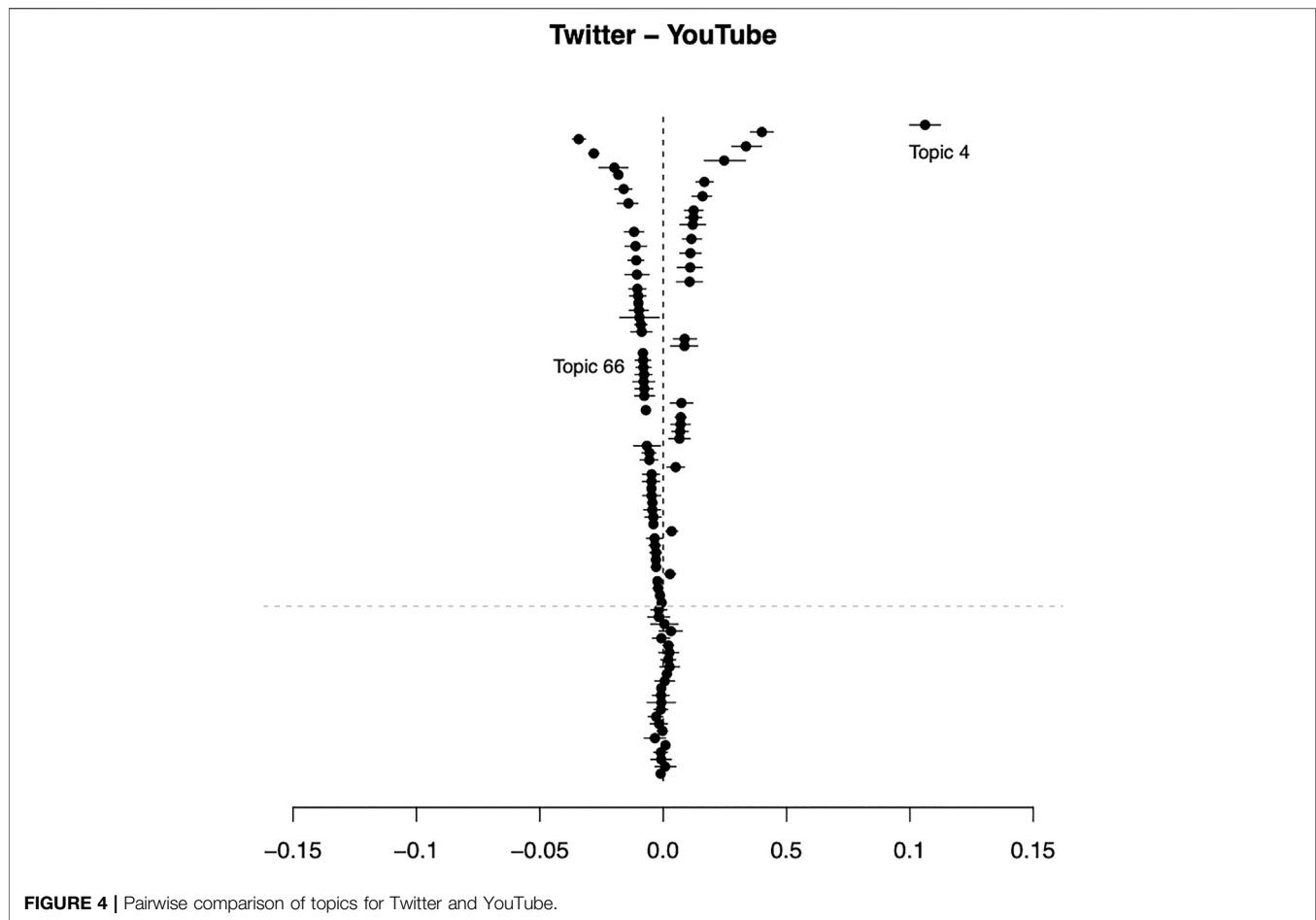
and a vaccine had not yet been approved. These results are important to the study of misinformation, which tends to be presented with more emotional language that facilitates its spread. We do note that, while Facebook and Twitter content contained similar levels of anger, Facebook content had slightly more fear language than Twitter content about COVID-19. It is not immediately clear why this is the case; we note that though the differences are significant, with such a large corpus we are likely to find significant differences with similar magnitudes to what we see here. Our estimation is that the difference, while statistically notable, is not functionally meaningful. However, as always, further work will need to investigate whether this result reflects a systematic difference attributable to the platforms or is a function of the topic of COVID-19.

We also highlighted how the topics in content surrounding mentions of COVID-19 on these platforms vary in systematic ways. Results show that narrow audience and shared channel platforms (Facebook and Twitter) discuss similar topics surrounding COVID-19 but vary in systematic ways from more broad audience, independent channel platforms (YouTube) (RQ3). The content of these variations is also notable, though we discussed just a few of the topics themselves. Further, while many of the topics are quickly

identifiable as COVID-19 related, some are not. In our view, the tangential connection between some topics and COVID-19 is not as large of an issue as it may seem. We were primarily interested in how the substance of COVID-19 content, as observed with these topics, would vary as a function of the audience and channel of the platform. We argue here that our work shows both systematic variations in content and meaningful topic associations with different platforms. We also want to point out that the accounts studied here are identified as members of the Alternative Influencer Network: individuals or organizations that spread alternative facts about social issues to foment radicalization and challenge established norms (Lewis, 2018). It remains difficult to distinguish disinformation campaigns from misinformation inadvertently spread by alternative media, particularly on an issue like COVID-19, in which best available information changes quickly (Freiling et al., 2021). In response to calls for better understanding the close connection between disinformation and alternative facts across platforms (Ong and Cabanes, 2019; Wilson and Starbird, 2020), our paper demonstrates how platform characteristics are associated with different topics and emotions that facilitate misinformation spread in the cross-platform ecosystem at the post-normal science and post-truth age (Funtowicz and Ravetz, 1993; Fischer, 2019).

Strengths and Limitations

This study proposes a novel framework for building theoretically-informed expectations of how content is likely to differ across communication platforms, which we apply and test in the context of alternative influencers' COVID-19 content. We do this by drawing on a novel dataset, namely, all publicly available Facebook, Twitter, and YouTube content posted by alternative influencers (Lewis, 2018). With this data, we are able to test expectations about how a platform's audience and channel shape content likely to contain misinformation. Previous work into misinformation has largely focused on single-platform studies, yet by comparing such content on different platforms, we offer novel insight into how platform structure might enable or inhibit the spread and acceptance of misinformation.

There are also limitations worth noting. First, and perhaps foremost, we limit this study to the spread of misinformation and specifically COVID-19 misinformation. Our results are necessarily limited to that specific topic. However, our intention is to highlight how platforms are fundamentally different and encourage scholarship along those lines. In addition to our study, there is also evidence of platform audience and channel playing crucial roles in political campaigning (Hiaeshutter-Rice, 2020). Further, while we were able to collect all publicly available content, we were not able to retrieve content that had been removed (either by the influencer or the platform) or content by alternative influencers who had been banned from different platforms (e.g., Gavin Mclnnes, the founder of the Proud Boys). Social media platforms are not uniform in their terms of service or their application of punitive actions for those who violate the terms of service by spreading misinformation or hate speech. Therefore, it is possible that initial content posted on platforms was more or less similar than our results indicate, with observed differences resulting from platforms' inconsistencies in reporting and removing content. Even if content on these platforms was initially similar before being subjected to moderation, it remains that users of different social media platforms see different emotional cues and associated topics between more broad, independent platforms and more narrow, shared platforms. In addition, alternative influencers who have not been banned are likely to be aware of platforms' terms of service and moderation practices, which would inform the content they share. This brings up a related point: we focus on alternative influencers, raising the question of whether these findings can generalize across other content creators. We suspect that there are similarities between influencers and the general population of these sites as the overarching structures of the sites are the same. However, we also suspect that influencers may be more adept at using the sites as well as operating with a slightly different set of goals. Thus, we constrain our findings to influencers and leave open the possibility for further study of users as a whole. A final limitation concerns the insight gained from this study's methodological approach. Though we are able to broadly describe differences in emotion and topics in alternative influencers' content *via* computational content analytic methods, additional close reading of these posts could reveal additional connections and information about the content of misinformation being spread by these actors regarding COVID-19.

CONCLUSION

This study offers insight into the under-researched area of how the audience and channel of platforms shape the structure of information to which individuals are exposed. This work is particularly important to understanding why and how misinformation is shared and believed online, as well as for informing corrective interventions tailored to specific platforms and audiences.

Perhaps more importantly, audiences differ by platform. That is to say, audience demographics fundamentally differ from one another from platform to platform (Perrin and Andrews, 2020) with older generations on Facebook and younger ones on YouTube and Twitter. What this means, functionally, is that audiences are being systematically exposed to different content (as we have shown here) and that those differences are likely not randomly distributed across the population. While many people use multiple sites, as audiences become further segmented into different platforms as their primary source of information, our results suggest that they will have access to different information than if they used a different site. This has potentially serious implications for how citizens understand political and social issues.

These findings also suggest several practical implications for those involved in mitigating and correcting misinformation online. Corrective interventions need to be tailored to respond to content differences across platforms; for instance, when correcting misinformation on shared channel platforms, whose content contains stronger negative emotions, the corrective message may need to utilize more positive emotions like hope (Newman, 2020) and positive framing (Chen et al., 2020a) than corrective interventions for independent channel platforms. For social media companies, understanding what emotional language and topics are used by alternative influencers to spread misinformation on different platforms may enable companies to develop a more sophisticated, platform-specific moderation strategies (Gillespie, 2018). Finally, our findings further suggest that users should be more alert to manipulation in messages containing strong, negative emotions. Awareness and skepticism of anger-or fear-based messages may help individuals become more resistant to misinformation (Chen et al., 2020b; Pennycook et al., 2020).

Though this study offered novel insight into the ways in which platforms shaped the COVID-19 content of actors prone to spreading misinformation, there are many pathways for future work into the role that communication platforms play in enabling or inhibiting misinformation. Future work should investigate whether the patterns we observe here, regarding emotion and topic differences between platforms with different audiences and channels, are consistent across different issues (e.g., election misinformation). Additionally, it is not known whether content posted by actors who share more accurate information (e.g., NASA astronauts) differs by platform in similar ways as we

observe here. Finally, research into misinformation on social media must go further in tracking the movement of misinformation and rumors across platforms, with particular how platform structure gives birth to and amplifies false information.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.642394/full#supplementary-material

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Different Conspiracy Theories Have Different Psychological and Social Determinants: Comparison of Three Theories About the Origins of the COVID-19 Virus in a Representative Sample of the UK Population

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COVID-19 conspiracy theories have proliferated during the global pandemic, and their rapid spread among certain groups may jeopardize the public health response (e.g., undermining motivation to engage in social distancing and willingness to vaccinate against the virus). Using survey data from two waves of a nationally representative, longitudinal study of life in lockdown in the United Kingdom ($N = 1,406$), we analyze the factors associated with belief in three origin theories related to COVID-19, namely that it 1) originated in a meat market in Wuhan, China; 2) was developed in a lab in Wuhan, China; and 3) is caused by 5G mobile networks. Our findings suggest that political-psychological predispositions are strongly associated with belief in conspiracy theories about the virus, though the direction and effect sizes of these predictors vary depending on the specific content of each origin theory. For instance, belief in the Chinese lab conspiracy theory is strongly associated with right-wing authoritarianism (RWA), social dominance orientation (SDO), and general conspiracy ideation, as well as less reliable news sources, distrust in scientists, and anxiety about the pandemic. Belief in the 5G network conspiracy theory is strongly associated with SDO, distrust in scientists, while less strongly with conspiracy ideation and information from social networks/media; RWA is strongly negatively associated with belief in the 5G conspiracy theory, with older and more wealthy individuals somewhat less likely to endorse it. The meat market origin theory is predicted by intolerance of uncertainty, ethnocentrism, COVID-19 anxiety, and less so by higher income, while distrust in scientists is negatively associated with this origin story. Finally, belief in COVID-19 conspiracy theories is associated with negative public health behaviors such as unwillingness to social distance and vaccinate against the virus. Crucially, our findings suggest that the specific content of COVID-19 conspiracy theories likely determines which individuals may be most likely to endorse them.

Keywords: COVID-19, conspiracy theories, right-wing authoritarianism, social dominance orientation, predisposition, motivated reasoning

It is virtually not assimilable to our reason that a small lonely man felled a giant in the midst of his limousines, his legions, his throng, and his security. If such a nonentity destroyed the leader of the most powerful nation on earth, then a world of disproportion engulfs us, and we live in a universe that is absurd.

- From Oswald's Tale: An American Mystery by Norman Mailer, on the public's obsession with conspiracy theories about the assassination of John F. Kennedy Christmas cancelled. Thank you, China.- Nigel Farage, Twitter, December 2020

INTRODUCTION

Major world events are known to spawn conspiracy theories. This may be due, at least in part, to proportionality intuitions that render mundane explanations for important events inadequate and unsatisfying (Leman and Cinnirella, 2007; Douglas et al., 2019). Thus, the notion that Princess Diana died because her driver was drunk, or that John F. Kennedy was felled by a lone gunman, threatens to engulf us in Norman Mailer's "world of disproportion."

Likewise, the COVID-19 pandemic is an event of immense global significance. The pandemic has occasioned massive social and economic upheaval, including nationwide lockdowns, school closures, the postponement or cancellation of major public events, and the largest global recession since the Great Depression of the 1930s. At the time of writing, the pandemic is already responsible for millions of deaths worldwide.

As with Kennedy's assassination, the COVID-19 pandemic has proven to be fertile ground for conspiracy theories. Some theories, for example, deny the existence of the virus or downplay its severity altogether. Such theories may attribute COVID-19 "propaganda" to assumed nefarious actors such as the United States government (and its plans to link passports with vaccination records as a means of totalitarian control; Rischel, 2020, March 24) or to the purported vested interests of Bill Gates and the World Health Organization (McGreal, 2020, May 14). Yet, as Nigel Farage's blithe tweet illustrates, a number of COVID-19 origin theories are intended to stoke hostility toward foreigners and foreign interests, which comports with the first reported cases in Wuhan, China. Examples include origin theories that posit the virus was engineered by the Chinese government, either in a laboratory as a biological weapon or with the introduction of 5G mobile technology (i.e., ostensibly causing the virus through radiation for which COVID-19 is merely a cover-up; Henley and McIntyre, 2020, October 26; Ahmed et al., 2020; Bruns et al., 2020). While such theories may satiate the need for narrative order among those individuals prone to conspiratorial thinking, they are also animated by intergroup dynamics of conflict and threat. In fact, recent studies on COVID-19 conspiracy theories have demonstrated that predispositions like party identification and ideology are associated with belief in such theories above and beyond a general conspiratorial mentality, though admittedly these reported effects may be context dependent (e.g., Uscinski et al., 2020).

Here we analyze the factors associated with belief in three theories regarding the origin of the COVID-19 pandemic, which at the time of data collection (April 2020) were most prominent: 1) that it originated in a meat market in China (a theory widely held in the early days of the pandemic but now contested); 2) that it originated in a laboratory in Wuhan, China; and 3) that it was caused by the rollout of the 5G mobile network. In the study, we consider the Wuhan laboratory and 5G theories as classic conspiracy theories, which we will explain in subsequent sections, while the meat market origin story serves as a baseline because it falls short of the core definition of a conspiracy theory.

Using data from two waves of a nationally representative, longitudinal dataset collected during the United Kingdom lockdown in 2020 ($N = 1,406$), we analyze several potential factors that may explain belief in COVID-19 origin theories. In particular, we focus on interplay between the specific content of each theory and the political-psychological predispositions that motivate its belief. We also control for several other socio-demographic factors, as well as political orientation, information sources about the pandemic, distrust in scientists, and COVID-19 anxiety, all of which may impact support for conspiracy theories. Our results suggest that political-psychological predispositions such as right-wing authoritarianism (RWA) and social dominance orientation (SDO) are statistically significant and substantively interesting predictors of belief in various COVID-19 origin stories. Moreover, and in contrast to previous research, the effects of these latent predispositions are distinct from and sometimes larger than that of an underlying conspiracy mentality, depending on the content of the specific conspiracy theory in question. Finally, we show that belief in conspiracy theories is associated with certain negative public health attitudes, for example, predicting motivations to violate social distancing guidelines and the unwillingness to vaccinate against COVID-19.

In the sections that follow, we address two research questions: What political-psychological predispositions predict belief in unsubstantiated COVID-19 origin theories? And what implications do these conspiracy beliefs have for health-related behaviors? We contribute to the literature by positing a motivational model of belief in COVID-19 origin theories (see also Miller et al., 2016; Douglas et al., 2017), in which we argue the importance of political-psychological predispositions as motivational factors in explaining susceptibility to belief in conspiracy theories, as well as their behavioral consequences.

THEORY

Belief in (COVID-19) Conspiracy Theories

Conspiracy theories are unsubstantiated explanations of major events with a twist -- that powerful and malevolent actors are involved in secret plots for their own benefit to the detriment of the common good (Goertzel, 1994; Uscinski and Parent, 2014). They generally consist of complex storylines that are hidden from public scrutiny, thus making them especially resistant to falsification (Lewandowsky et al., 2012). Most importantly,

conspiracy theories function to protect entrenched beliefs by discounting contrary evidence as the product of a conspiracy (Lewandowsky et al., 2013). Indeed, some conspiracy theories predict such contrary evidence, evincing what Boudry (2020) calls a "warped epistemology." Hence, conspiracy theories may even serve a valuable purpose for individuals by allowing them to maintain certain beliefs in the presence of contradictory evidence (Douglas et al., 2017).

A striking finding in the literature on conspiracy theories, however, is that belief in one conspiracy theory tends to predict belief in others (Goertzel, 1994). This is not epistemically problematic when conspiracy theories are mutually consistent or reinforcing. Yet, studies have found that even flagrantly contradictory conspiracy theories are positively correlated in endorsement. For example, Wood et al. (2012) reported that participants who believed Princess Diana faked her own death were also more likely to believe she was murdered. Such findings imply that conspiracist ideation is driven by a conspiratorial worldview, perhaps characterized by higher-level rejection of official explanations (Franks et al., 2017). Indeed, the tendency to believe in conspiracy theories is associated with narcissism (Cichocka et al., 2016), and those highly disposed to believe in conspiracy theories are especially likely to endorse theories which they think are only believed by a minority (Imhoff and Lamberty, 2017).

Yet, conspiracy thinking may also confer a sense of control during periods of perceived uncertainty or threat (Sullivan et al., 2010; Uscinski et al., 2017). Miller (2020), for example, has recently amassed evidence for the "monological belief system" conception of conspiracy theories (e.g., see Goertzel, 1994) in the context of COVID-19, finding that contradictory COVID-19 conspiracy beliefs are positively related in endorsement, though this finding was partially explained by personal uncertainty (i.e., the more uncertain people were about themselves, the world, and the future, the more intercorrelated their evaluations of conspiracy theories). This adds to previous work demonstrating that people are more likely to endorse conspiracy theories when conditions of uncertainty and stress are salient (van Prooijen and Jostmann, 2013; Swami et al., 2016), and that intolerance of this uncertainty is related to a tendency to seek simplifying explanations often involving external and threatening agents (Darwin et al., 2011). Given the uncertainty caused by the global pandemic, it is perhaps unsurprising that people may grasp onto conspiracy theories as a security blanket.

In line with the theory of monological belief systems--that there is a general conspiracist mentality underpinning belief in specific conspiracy theories--we hypothesize that endorsement of one specific theory will be positively associated with belief in others (Hypothesis 1a); and that conspiracist ideation will be associated with belief in specific COVID-19 origin theories (Hypothesis 1b). However, these associations may be limited in helping us understand the diversity in conspiracy belief during the pandemic. Thus, in the sections that follow, we propose a motivational model of belief in various COVID-19 origin theories.

A Motivational Model of Belief in Conspiracy Theories

Research on motivated reasoning suggests that individuals are biased information processors, who seek out and accept information that conforms to their existing predispositions, while expending considerable effort to discount that which challenges strongly held priors (Taber and Lodge, 2006; Kahan, 2012). For example, Tappin et al. (2017) reported evidence of desirability bias in the context of the 2016 United States election campaign: Individuals presented with polling evidence about the anticipated election outcome updated their beliefs more if the evidence was consistent (vs. inconsistent) with their preferred result. Similarly, Hartman and Newmark (2012) found that Republicans and ideological conservatives were especially predisposed to believe negative rumors about former President Barack Obama because of their different party identification and strong dislike of him.

We argue that two important political-psychological predispositions that may be associated with belief in COVID-19 origin theories are right-wing authoritarianism (RWA) and social dominance orientation (SDO). Both RWA and SDO emerged from research investigating different individual-level factors that explain prejudice and are thought to represent two types of right-wing personalities (Altemeyer, 1981; Diaz-Veizades et al., 1995; Duckitt, 2001; Sibley et al., 2006; Wilson and Sibley, 2013). In the Dual Process Motivational Model, for example, Duckitt (2001) theorized that two sets of motivational schemas, threat-control and competition-dominance, are the foundations of RWA and SDO, respectively, and that these dimensions were responsible for distinct forms of prejudice. For instance, while RWA and SDO both predict prejudice toward lower status groups, RWA-based prejudice typically categorizes outgroups as dangerous as threatening to the security and safety of the ingroup or dissident as representing a symbolic threat to social norms and cohesion (Shaffer and Duckitt, 2013; Kauff et al., 2015; Crowson and Brandes, 2017; Faragó et al., 2019). Conversely, SDO-based prejudice typically categorizes outgroups as inferior, weak, or undeserving (Duckitt, 2001; Ho et al., 2015).

However, the exact relationships that RWA and SDO have with conspiracy belief remains unclear. In the development of the Conspiracy Mentality Scale, for example, Imhoff and Bruder (2014) note the importance of recognizing the distinction between prejudice toward lower status groups (e.g., minority ethnic or religious groups), which is associated with RWA and SDO, and prejudice toward higher status groups (e.g., the wealthy), which is not associated with RWA and SDO. Yet, conspiracy mentality is generally related to prejudice against high-status and powerful groups or members of society, which are perceived as less likable and more threatening compared to low-status and weaker groups (Imhoff and Bruder, 2014). A consistent finding in the literature, then, is that conspiracy mentality predicts belief in conspiracy theories more strongly than RWA and SDO (Dyrendal et al., 2021).

In contrast, Richey (2017) presented an alternative theory in which those with authoritarian personalities are more likely to support conspiracy beliefs due to higher levels of anxiety and difficulty with higher order thinking, which has recently been supported by work that presents a positive association between conspiracy mentality and RWA, SDO and political conservatism (van der Linden et al., 2020; Dyrendal et al., 2021). Yet, Richey's work focused exclusively on birtherism (i.e., that former United States President Obama is not an American citizen) and trutherism (i.e., that former United States President Bush and the Republican Party knew of 9/11 prior to the

TABLE 1 | Sample demographics (*n* = 1,406) benchmarked against British Election Study (BES) Wave 19 (*n* = 32,177).

Variable	Category		Proportion	Bes W19 proportion
Age	18–24		0.055	0.042
	25–34		0.151	0.089
	35–44		0.174	0.130
	45–54		0.218	0.170
	55–64		0.221	0.231
	65–74		0.153	0.261
	75+		0.027	0.078
Gender	Male		0.517	0.468
	Female		0.481	0.532
	Other/Prefer not to say		0.002	—
Ethnicity	White		0.930	0.942
	Ethnic minorities (excluding white minorities)		0.070	0.044
	Prefer not to say		—	0.010
	NA		—	0.005
Education	Other qualification or no qualifications		0.556	0.684
	Degree education		0.444	0.316
Gross household income	Study categories	BES W19 categories		—
	£0–15,490	£0–£14,999	0.198	0.184
	£15,491–£25,340	£15,000–£24,999	0.179	0.206
	£25,341–£38,740	£25,000–£39,999	0.184	0.264
	£38,741–£57,930	£40,000–£59,999	0.221	0.186
	£57,931 or more	£60,000 or more	0.217	0.159

attack). Nor did it control for SDO, which has been found elsewhere to predict scores on the General Conspiracist Belief scale, along with anxious attachment, interpersonal trust, and a Manichean world view (Green and Douglas, 2018).

Noting the divergent findings on the ability of predispositions to predict conspiracy belief, Wood and Gray (2019) highlight that psychologists tend to treat conspiracies as a unitary construct rather than engaging with the specific content of different conspiracy theories. They note that some conspiracy theories reinforce the RWA-associated view that the world is a threatening place, but that others present a view of the world that is incompatible with RWA, in which authority figures are corrupt, and leaders and traditions are social control mechanisms that must be resisted. In their findings, for example, RWA was positively associated with pro-establishment conspiracy beliefs but was uncorrelated with anti-establishment conspiracy beliefs (i.e., those suggesting that powerful groups are conspiring to restrict individual freedoms). Anti-establishment beliefs were moderately positively correlated with SDO. Wood and Gray (2019) speculate that a dislike of the deviant groups behind anti-establishment conspiracies, which present a material threat to social order, could partly explain the lack of association for RWA. Thus, the model proposes that RWA predicts a susceptibility to a belief in certain conspiracies that are compatible with the individual's existing worldview.

As discussed above, both RWA and SDO are associated with heightened sensitivity to certain types of threat (Duckitt, 2001; Duckitt and Fisher, 2003; Stenner, 2005; Duckitt, 2006; Duckitt and Sibley, 2009; Duckitt and Sibley, 2010). Those high in RWA, which is motivated by a belief that the world is an inherently threatening place, are particularly sensitive to threats posed by dangerous or dissident outgroups, while those high in SDO are

particularly sensitive to the threat of competition from outgroups that challenge societal hierarchies or the dominance of the ingroup. Of the three explanations for the origin of the coronavirus examined in the present paper, it seems likely that people high in RWA would find the theory that the coronavirus was a bioweapon developed by China's military as inherently threatening. In this theory, China's proliferation of bioweapons presents an external danger in the form of a security threat from a potentially hostile political rival, and a social threat in the form of a deviant or dissident political ideology, communism, to which people high in RWA are sensitive (Kauff et al., 2015; Crowson and Brandes, 2017; Faragó et al., 2019). It is also feasible that those high in SDO would be sensitive to the competitive threat this theory poses. In the bioweapon origin theory, an international competitor is trying to gain a military advantage that might threaten international hierarchies and challenge Britain's ability to leverage military power in the international arena, which is compatible with the underlying "competitive jungle" worldview of SDO. Moreover, the bioweapon theory presents a situation that could be used to justify more aggressive foreign policy positions or increased militarization in the United Kingdom. RWA and SDO are both associated with nationalism, support for aggressive foreign policy, and military action (Pratto et al., 1994; Doty et al., 1997; McFarland and Mathews, 2005; Terrizzi and Drews, 2005; Crowson et al., 2006; Jackson and Gaaertner, 2010; McFarland, 2015; Lindén et al., 2018). Therefore, we expect that RWA and SDO will be positively associated with belief in the Chinese lab origin story (Hypothesis 2).

Conversely, the links between predispositions and the 5G origin theory appear less clear cut. While the 5G origin theory taps into a potential security threat, the development of 5G technology in the United Kingdom had the support of the

government, and therefore is less compatible with an RWA worldview that would be largely pro-establishment. Rather, the various forms of 5G origin theories are often linked to the virus via somewhat convoluted and contradictory mechanisms, some of which claim the virus is real but caused by 5G, and some of which claim it is a hoax altogether (Sturm and Albrecht, 2020). One such conspiracy claims that COVID-19 is a pretense to cover-up to the negative health effects of 5G radiation established by those profiteering from the technology (Bruns et al., 2020). Such a claim is consistent with theory that predicts people high in SDO may be more likely to perceive dishonesty as an accepted norm in a highly competitive world, in which people do whatever is necessary to succeed (De keersmaeker and Roets, 2019), and is supported by evidence from a UK sample showing a positive association between SDO and belief COVID-19 is a hoax (Imhoff and Lamberty, 2020). A consistent theme running through the proliferation of 5G conspiracy theories has been their mobilization by partisan groups, in particular their assimilation into and conjoining with pre-existing conspiracies frequently espoused in far-right networks (Bruns et al., 2020). SDO has been found to positively predict identification with far right groups, and subsequent intent to engage in extreme and violent actions toward outgroups, providing a justification for beliefs and actions that benefit the ingroup (Bai, 2020). Relatedly, §) has argued that motivation to believe in conspiracy theories is greater when they are related to a salient group identity such as the far right. Therefore, given the proliferation of 5G conspiracies through far-right networks, the extremity of the intent and actions associated with it (e.g., the burning of 5G towers; Jolley and Paterson, 2020), and the consistency of its content that sees the world as competitive and actors as self-interested, we predict SDO will be positively associated with the 5G origin theory (Hypothesis 3).

Yet, we have no strong expectations regarding the association between RWA and 5G belief, and similarly no strong expectations regarding RWA and SDO and belief in the Chinese meat market theory. Our reasoning is that the former does not tap into threats to the social order or status of the ingroup, while the latter is not really a conspiracy theory (i.e., it does not involve intentional actions by a powerful and malevolent group).

Public Health Implications

Finally, endorsement of COVID-19 conspiracy theories may affect critical public health issues such as adherence to social distancing rules and attitudes toward vaccination. Experimental evidence suggests exposure to conspiracy theories reduces the intent to engage in health-promoting behaviors, such as visiting a doctor, and that the relationship is mediated by decreased trust in health professionals (Natoli and Marques, 2020). More recently, conspiracy mentality has been shown to reduce willingness to comply with preventative COVID-19 measures, such as national lockdowns, where they are mandated by governments or authority figures (Marinthe et al., 2020).

Again there is evidence that the content of a conspiracy theory matters for subsequent behavior. For instance, Imhoff and Lamberty (2020) report that claiming the virus was a hoax reduced compliance with social distancing but claiming the

virus was man-made had no effect. In this vein, social distancing motivations may be undermined if the severity of the virus is understated or if the scientific consensus on human-to-human transmission is questioned, as insinuated by claims it is caused by 5G radiation or that the pandemic lockdowns were only a pretense for the cover-up and/or rollout of 5G networks (Bruns et al., 2020). Similarly, a number of conspiracy theories make unfounded claims regarding the supposed dangers of vaccines (Sturm and Albrecht, 2020). Indeed, social network analysis of the spread of COVID-19 conspiracies details the prominence of a conspiracy theory which overlaps across those origin theories tested in this study, suggesting the virus was engineered in China, but that its full effects will be realized via a vaccine that is activated by 5G (Bruns et al., 2020: 19).

Thus, given the negative effect of conspiracy belief on health promoting behaviors, and their potentially corrosive effect on trust in medical interventions and the consensus on human transmission, we expect belief in our set of conspiracies to be negatively associated with social distancing motivations (Hypothesis 4a) and positively associated with vaccine rejection (Hypothesis 4b).

MATERIALS AND METHODS

Data

The data for this study come from a nationally representative longitudinal survey of adults living in the United Kingdom during the early phases of the COVID-19 global pandemic. Participants were recruited by Qualtrics from March 23rd to 28th, 2020 (Wave 1: $N = 2{,}025$), and were recontacted from April 22nd to May 1st, 2020 (Wave 2: $n = 1{,}406$, recontact rate = 69%). Data for Wave 1 of the survey occurred during the first week of the strict national lockdown in the United Kingdom, while follow-up data for Wave 2 was collected approximately 1 month later during the lockdown and 3 months after the first confirmed COVID-19 case there, which saw rapidly increasing infections. These data comprise part of a longitudinal, multi-country study that aims to assess the psychological, social, economic, and political impact of the COVID-19 virus in the general population (McBride et al., 2020).

Although the sample was drawn from non-probability methods, research suggests that Qualtrics approximates probability-based samples reasonably well when quotas are used (Zack et al., 2019). Thus, we employed stratified quota sampling matched against known demographics in terms of age, gender, and household income within the United Kingdom. We also present a summary **Table 1** of demographics benchmarked against Wave 19 of the British Election Study, which was collected using similar survey methods. McBride et al. (2020) provide a more detailed description of the panel recruitment, sampling methodology (including post-stratification weights and analysis of panel attrition), and explanation of all measures administered in the study. The full panel dataset will be deposited to the United Kingdom Data Archive and Open Science Framework approximately six months after data collection for the project has been completed.

TABLE 2 | Descriptive statistics of key measures.

Variable	Mean	SD	Wave	Description
Dependent variables				
Meat market belief	0.64	0.29	2	Slider scale from 0 to 100, scaled 0–1
Wuhan lab belief	0.38	0.33	2	Slider scale from 0 to 100, scaled 0–1
5G belief	0.11	0.22	2	Slider scale from 0 to 100, scaled 0–1
Motivation to engage in social distancing	0.82	0.19	2	4-Item subscale of reflective motivation from the COM-B model, alpha = 0.87, scaled 0–1
Willingness to accept a vaccine	—	—	2	Willingness to accept a hypothetical COVID-19 vaccine for themselves? Willing: 67.6% ("yes"); reluctant: 32.4% ("May be" = 23.4%, "No" = 9.1%)
Independent variables				
Conspiracy ideation	0.57	0.2	1	5-Item conspiracy mentality scale, alpha = 0.85, scaled 0–1
RWA	0.51	0.17	1	6-Item very short Authoritarianism scale, alpha = 0.68, scaled 0–1
SDO	0.36	0.18	1	8-Item SDO_7 scale, alpha = 0.84, scaled 0–1
Left-right scale	0.49	0.2	1	Self-reported placement on a political scale, ranging from 1 (left) - 10 (right), scaled 0–1
Ethnocentrism	0.57	0.25	2	2-Item scale, alpha = 0.82, scaled 0–1
Distrust of scientists	0.34	0.25	2	Ordinal degree of distrust in scientists, scaled 0–1
COVID-19 anxiety	0.61	0.26	2	Slider scale from 0 (not at all) to 100 (extremely anxious), scaled 0–1
Intolerance of uncertainty	0.49	0.2	2	12-Item scale, alpha = 0.91, scaled 0–1
News consumption: Elite	0.38	0.48	2	Dummy for those who read "elite-level" newspapers (yes = 1; none = 0)
News consumption: Mid-level	0.32	0.47	2	Dummy for those who read "mid-level" newspapers (yes = 1; none = 0)
News consumption: Tabloid	0.27	0.44	2	Dummy for those who read tabloid newspapers (yes = 1; none = 0)
Information from family and friends	0.38	0.28	2	Ordinal measure of extent of COVID-19 information received from family and friends, scaled 0–1
Information from social media	0.3	0.32	2	Ordinal measure of extent of COVID-19 information received from social media, scaled 0–1
Age	0.45	0.21	2	Continuous variable, scaled 0–1
Gender	0.48	0.5	2	Dummy variable (female = 1)
Income	0.52	0.36	1	Ordinal gross income bands (2019), scaled 0–1
Education	0.44	0.5	1	Dummy for university education (Bachelor's degree or higher = 1)

Dependent Variables

To assist interpretation and comparison of effect sizes, we rescaled all of the continuous variables described below to range from zero to one. Descriptive statistics for all measures included in our analyses are available in **Table 2**, which also details the study wave in which they were collected.

Theories About the Origin of COVID-19

Respondents indicated the degree to which they believed various COVID-19 origin stories using a slider scale ranging from 0 to 100. This yielded three outcomes concerning belief in the following:

1. "COVID-19 originated in a meat market in Wuhan, China" ($M = 0.64$, $SD = 0.29$);
2. "COVID-19 was developed in a lab in Wuhan, China" ($M = 0.38$, $SD = 0.33$);
3. "5G mobile networks are responsible for the current global pandemic" ($M = 0.11$, SD = 0.22).

The distributions for these three origin stories are displayed in **Figure 1**. Prior to data collection, we reviewed a number of potential conspiracy theories regarding COVID-19 (e.g., see Lynas, 2020, April 20). We selected these three origin theories because they varied along two theoretically interesting dimensions: 1) the degree to which they might be defined as conspiracy theories (low to high), and 2) the nature of the threat that they imply. For instance, the Wuhan lab origin theory is arguably the most conventional conspiracy theory according to the definition we have outlined above, implicating powerful actors in a malevolent plot. In contrast, the meat market

origin story is hardly a full-blown conspiracy theory because it was not created by a cabal of powerful people with selfish intentions.[1] And finally, the 5G theory is a conspiracy theory, but differs from the Wuhan laboratory theory in terms of the nature of the implied threat: Where the laboratory theory implicates a foreign military power and is framed as a potential matter of national security, the 5G theory is an anti-establishment conspiracy concerned with a coalition of powerful corporate, technological and government actors. This variation allows us to analyze the common drivers of belief in COVID-19 conspiracies, and to compare these to the factors related to more mainstream beliefs, but also how a differential sense of threat from a conspiracy theory produces diversity in subsequent propagation and behaviors.

Motivation to Engage in Social Distancing

Four items from the Capability, Opportunity, Motivation-Behaviour (COM-B) model of behavior change (Michie et al., 2011) were used to assess respondents' motivation to engage in social distancing behaviors ($M = 0.82$, $SD = 0.19$, alpha = 0.87).

Willingness to Take a COVID-19 Vaccine

Respondents were asked "If a new vaccine were to be developed that could prevent COVID-19, would you accept it?" Three

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[1] Indeed it is worth noting that due to the ongoing investigations into the origin of the virus, what is considered a conspiracy with regards to its origins is to a degree dependent upon time and context. At the time of writing the World Health Organization have explored both the weapons laboratory and meat market hypotheses; however, it is thought that neither origin theory is likely.
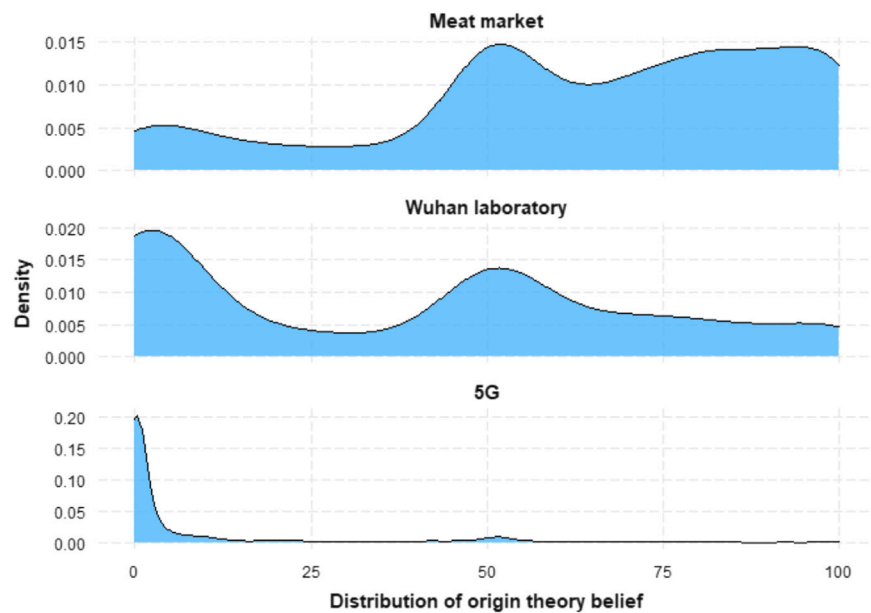
FIGURE 1 | Distributions of belief in COVID-19 origin stories.

response options were available: Yes (*n* = 939, 67.6%), No (*n* = 126, 9.1%), and Maybe (*n* = 325, 23.4%).

Independent Variables

As with the outcomes above, we rescaled all continuous predictors to range from 0 to 1 to aid interpretation and comparison of effect sizes.

Conspiracy Ideation

Conspiracy mentality (Imhoff and Bruder, 2014) was measured using five items (scored on an 11-point scale from 1 "Certainly not 0%" to 11 "Certainly 100%"), including: "I think that many very important things happen in the world, which the public is never informed about"; and "I think that events which superficially seem to lack a connection are often the result of secret activities" (*M* = 0.57, *SD* = 0.20, alpha = 0.85).

Right-Wing Authoritarianism

The 6-item Very Short Authoritarianism scale (Bizumic and Duckitt, 2018) was used to assess respondents' levels of authoritarianism. Participants indicated the extent to which they agreed with statements (on a 5-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree") such as follows: "It's great that many young people today are prepared to defy authority"; "What our country needs most is discipline, with everyone following our leaders in unity"; and "Our society does NOT need tougher government and stricter laws" (*M* = 0.51, *SD* = 0.17, alpha = 0.68).

Social Dominance Orientation

Respondents' levels of social dominance orientation were assessed using the 8-item social dominance orientation scale (SDO-7; Ho et al., 2015). Respondents were asked the extent to which they favored

statements (on a 5-point Likert scale ranging from 1 "Strongly oppose" to 5 "Strongly favor") such as the following: "An ideal society requires some groups to be on top and others to be on the bottom"; "Some groups of people are simply inferior to other groups"; and "We should do what we can to equalize conditions for different groups" (*M* = 0.36, *SD* = 0.18, alpha = 0.84).

Political Orientation

One question (adapted from the British Election Study 2017) asked respondents how they would describe their political affiliation on a 10-point scale ranging from 1 "left-wing" to 10 "right-wing" (*M* = 0.49, *SD* = 0.20).

Ethnocentrism

Two items to measure ethnocentrism were adapted from Davidov (2011): "The world would be a better place if people from other countries were more like the British" and "Generally speaking, Britain is a better country than most other countries". Responses were scored on 5-point Likert scales from 1 "strongly disagree" to 5 "strongly agree" (*M* = 0.57, *SD* = 0.25, alpha = 0.82).

Distrust in Scientists

Respondents were asked the extent to which they trusted scientists. Responses were scored on a 5-point Likert scale ranging from 1 "completely trust" to 5 "do not trust at all" (*M* = 0.34, *SD* = 0.25).

COVID-19 Related Anxiety

Respondents' degree of specific anxiety about the COVID-19 pandemic was assessed using a single visual slider scale, ranging from 0 "not at all anxious" on the left-hand side to 100 "extremely anxious" on the right-hand side (*M* = 0.61, *SD* = 0.26).

TABLE 3 | Correlations among COVID-19 origin theories.

Origin belief	Meat market	Wuhan lab	5G network
Meat Market	—	—	—
Wuhan Lab	**−0.097**	—	—
5G Network	−0.041	**0.330**	—

Note: N = 1,406. Cell entries are Pearson's correlations (r). Statistically significant correlations printed in bold (two-tailed test, p < 0.05).

Intolerance of Uncertainty

Respondents' intolerance of uncertainty, which is thought to play a key role in the etiology and maintenance of worry, was assessed using the 12-item Intolerance of Uncertainty Scale (IUS) (Buhr and Dugas, 2002). The IUS has a good construct validity (Birrell et al., 2011), and recent psychometric research has shown that it is best scored as a single dimension (Shihata et al., 2018). All 12 items are scored on a 5-point Likert scale ranging from 1 "not at all characteristics of me" to 5 "entirely characteristic of me". The IUS has excellent internal consistency, good test–retest reliability over a five-week period, and convergent and divergent validity when assessed with symptom measures of worry, depression, and anxiety (Buhr and Dugas, 2002) (M = 0.49, SD = 0.20, alpha = 0.91).

Sources of Information About COVID-19

Respondents were asked to indicate, from a list of the mainstream newspapers, their preferred news source (either in print or online), as a proxy measure for quality of news source and partisan news consumption. Responses to these items were dummy coded by elite news (M = 0.38, SD = 0.48), mid-level news (M = 0.32, SD = 0.47), and tabloid news (M = 0.27, SD = 0.44). In addition, respondents were asked the extent to which they received information about COVID-19 from 1) family and friends (M = 0.38, SD = 0.32) and 2) social media (M = 0.30, SD = 0.32).

Socio-Demographic Indicators

Respondents also provided their gender, age, and gross annual household income, each of which were used for quota sampling, as well as their highest level of education (no qualifications; O-level/GCSE or similar; A-level or similar; diploma; undergraduate degree; postgraduate degree; technical qualification; or other).

RESULTS

COVID-19 Origin Theories

To begin, we examine the correlations among beliefs in the respective COVID-19 origin theories. Recall, that we hypothesized that endorsement of one origin theory will be positively associated with belief in others (Hypothesis 1a). **Table 3** displays the Pearson's correlations (*r*) between each belief, with all estimated correlations that are statistically significant at the 0.05 level (two-tailed) listed in bold. Consistent with prior research, we find that the two COVID-19 conspiracy theories -- that the virus originated from a Wuhan

laboratory or 5G mobile networks -- are moderately positively associated (*r* = 0.330). However, the meat market origin theory appears weakly negatively associated with both major conspiracy theories (Wuhan lab, *r* = -0.097; *r* = -0.041), which is contrary to previous findings on COVID-19 origin beliefs (e.g. Miller, 2020). In sum, these descriptive results suggest that there is a moderately positive association between some but not all of the COVID-19 origin theories; their content seems to matter.

Next, we turn to our test of the factors that predict belief in various COVID-19 origin theories. If we are correct -- that political-psychological predispositions like RWA and SDO are important yet differential predictors of conspiracy theory endorsement depending upon their specific content -- then we should see different patterns for different conspiracy theories. To this end, we regressed each COVID-19 origin theory on political-psychological predispositions -- for example, conspiracy ideation, RWA, and SDO -- as well as several control variables outlined in the previous section, using ordinary least squares (OLS).[2] Missing values were removed using listwise deletion.[3] As such, we present the results of three models: Model 1 (Wuhan laboratory), Model 2 (5G network), and Model 3 (meat market).

To aid in interpretation, we present the estimated coefficients for our main political-psychological predictors (with 95% confidence intervals) across each conspiracy theory in **Figure 2**; the full regression results are available in **Table 4** (for additional model specifications relating to the 5G origin theory, please see the **Supplementary Appendix A2**).[4] The dashed vertical line represents the null hypothesis (i.e., *b* = 0); plot points to the right of this vertical line indicate a positive association with belief in the listed conspiracy theory; plot points

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[2]Due to the non-normality of the 5G origin belief dependent variable, and issues of heteroscedasticity in the residuals, we ran two supplementary tests on this belief scale. The first involved transforming the dependent variable using the inverse hyperbolic sine (IHS) transformation and subsequently fitting an OLS regression. The IHS transformation approximates the natural logarithm for large values of the dependent variable, but unlike the log transformation, it can accommodate zero values (Burbidge et al., 1988:123,126; Zhang et al., 2000:169). The IHS transformation involves estimating a parameter (θ) using the concentrated log likelihood (Burbidge et al., 1988), but in our application the parameter increased in value indefinitely. Therefore, we use $\sinh^{-1}(x)$ as a case of the IHS transformation that retains the aforementioned benefits with regards to zero and large values, and one which is frequently applied to long-tailed distributions (MacKinnon and Magee, 1990:324; Williams, 2017; Bellemare and Wichman, 2020). The second supplementary test was a Poisson regression, with a parameter added to adjust for overdispersion (31.86), without which the standard errors may be biased. We estimated the Poisson regression model using maximum likelihood. For both supplementary models, the results broadly confirm those of the initial OLS model in terms of statistical significance and effect size, with the exception of the effect of RWA. Therefore, to allow easier comparisons across origin stories, we present the OLS model results for 5G in the sections that follow, with any differences between these results and the supplementary models highlighted where necessary. We present the full results of the supplementary models in the Appendix.

[3]Missing values were as follows: Three missing for gender, 4 from distrust of scientists, and 9 from the vaccination acceptance outcome. Therefore, for Models 1 to 4, N = 1,399, and for Model 5, N = 1,390. In short, the number of missing data is relatively small across all models presented.

[4]All Variance Inflation Factors (VIFs) were below 2, suggesting that multicollinearity was not an issue among the various predictors in the models.

to the left, suggest a negative association. Statistically significant results correspond to estimates for which the 95% confidence intervals do not include zero (i.e., those that do not cross the dashed vertical reference line). Finally, recall that all variables have been scaled to range from 0 to 1, which means that while they are not measured in the same units, they do display the associated change in each outcome for a minimum to maximum change in the predictors. For example, a 1-unit change in RWA is equivalent to increasing from those who scored lowest to highest on the 6-item Very Short Authoritarianism scale.

Looking at the results in **Figure 2** (and **Table 4**), we can clearly see that different conspiracy theories have different psychological and social determinants. In other words, the pattern of coefficient plots is not consistent across panels A, B, and C. For example, conspiracy ideation has a relatively large and statistically significant effect on belief in the Wuhan laboratory origin ($b = 0.27$, se = 0.04, $p < 0.001$), a relatively small though still statistically significant effect on 5G belief ($b = 0.07$, se = 0.03, $p < 0.05$), and a near-zero, non-significant effect on meat market belief ($b = -0.01$, se = 0.04, $p = 0.81$). Thus, we find some support for Hypothesis 1b, but our findings suggest the content of each origin theory conditions these effects.

Our regression results also provide support for Hypothesis 2, as we find statistically significant effects of both RWA and SDO on belief in the Wuhan laboratory theory (RWA: $b = 0.15$, se = 0.05, $p < 0.01$; SDO: $b = 0.23$, se = 0.05, $p < 0.001$), the latter of which has the second largest effect size in the model. As expected, the effect of SDO on 5G belief is positive and relatively large ($b = 0.25$, se = 0.04, $p < 0.001$), which is also substantially larger than the effect size of conspiracy ideation as previously noted. However, in line with our expectations, we find a negative effect of RWA on 5G belief ($b = -0.11$, se = 0.04, $p < 0.01$),[5] again reinforcing the notion that the content of each COVID-19 conspiracy theory motivates belief differently depending on an individuals' underlying predispositions. Once again, RWA and SDO are not statistically significant predictors of belief in the meat market origin theory (RWA: $b = -0.06$, se = 0.05, $p = 0.26$; SDO: $b = -0.02$, se = 0.05, $p = 0.66$). Overall, however, our results provide support for Hypothesis 3.

It is worth noting that a number of other psychological factors also differentially predict belief in various COVID-19 conspiracy theories. For instance, ethnocentrism is a statistically significant and reasonably strong predictor of belief in all three origin theories, which we might expect given the linkages of all origin theories to China in some way or another. Likewise, distrust in scientists is a statistically significant and reasonably large predictor of Wuhan lab and 5G beliefs, but it negatively predicts endorsement of the meat market origin theory. COVID-19 anxiety predicts support for Wuhan lab and meat market beliefs, but not 5G networks, while intolerance of uncertainty only predicts support for the meat market origin

theory. Again, the effect sizes vary considerably across conspiracy theories. News consumption has predictable associated effects: obtaining news from family and friends increases support for classic conspiracy theories, as does reading tabloids or other non-elite news sources. Finally, those individuals who earn less and are less educated are somewhat more likely to believe COVID-19 conspiracy theories, but again the size of the effect and its statistical significance appears to be content dependent.

Before moving on to public health attitudes, we visualize the estimated effects of our main political-psychological predispositions across all three of the COVID-19 origin theories in **Figure 3**. What is immediately apparent is that the predicted effects on beliefs vary considerably by predisposition and, of course, by the conspiracy theory in question.

Attitudes Toward Public Health

We conducted additional analyses seeking to understand the potential effect of conspiracy beliefs on attitudes toward public health policies, namely motivation to engage in social distancing and willingness to accept a COVID-19 vaccine. To this end, we regressed social distancing motivation on the predictor variables from the previous models, plus the three COVID-19 origin theory belief scales, using OLS. The results are presented in full in the **Supplementary Appendix A3**. Using the same predictor variables, we conducted a multinomial logit regression on willingness to accept a vaccine, with the baseline set to "yes", also presented in full in **Supplementary Appendix A3**. Here, we present the unstandardized coefficients of motivation to social distance (with 95% confidence intervals) for visual inspection in **Figure 4**, and in **Figure 5** we present the marginal effects of selected predictor variables (i.e., those that are statistically significant or theoretically interesting) in relation to respondents' willingness to vaccinate, again with 95% confidence intervals.

Closer inspection of **Figure 4** reveals that COVID-19 conspiracy theories do affect attitudes toward public health, albeit in different directions. For instance, belief in the 5G origin theory is statistically significant and negatively associated with social distancing, accounting for a 14-point reduction in motivation. This finding is perhaps unsurprising, given that a vaccine would do little to prevent the perceived damage caused by 5G networks. By contrast, the effect of Wuhan laboratory origin belief is positively signed, near zero, very small, and not statistically significant. Thus, these results provide partial support for Hypothesis 4a, in particular where belief in the 5G theory is concerned. Belief in the meat market origin theory is positively associated with social distancing motivations, though the estimate is relatively small at 7-percentage points. While the effect of general conspiracy ideation is also positive, equivalent to a 5-percentage point increase, this predictor just falls below a threshold for statistical significance.

Interestingly, the largest relative effects on motivations to social distance are observed from the key political-psychological predispositions. For example, SDO is associated with a large and statistically significant reduction in motivation, accounting for a 21-point decrease in social distancing. In contrast, RWA is associated with a relatively large and

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[5]It is worth noting that in supplementary models 3a and 3b, this finding was statistically non-significant, and the effect size reduced (see **Supplementary Appendix A2**). Therefore, this finding should be treated with more caution than others which were replicated in the supplementary models.
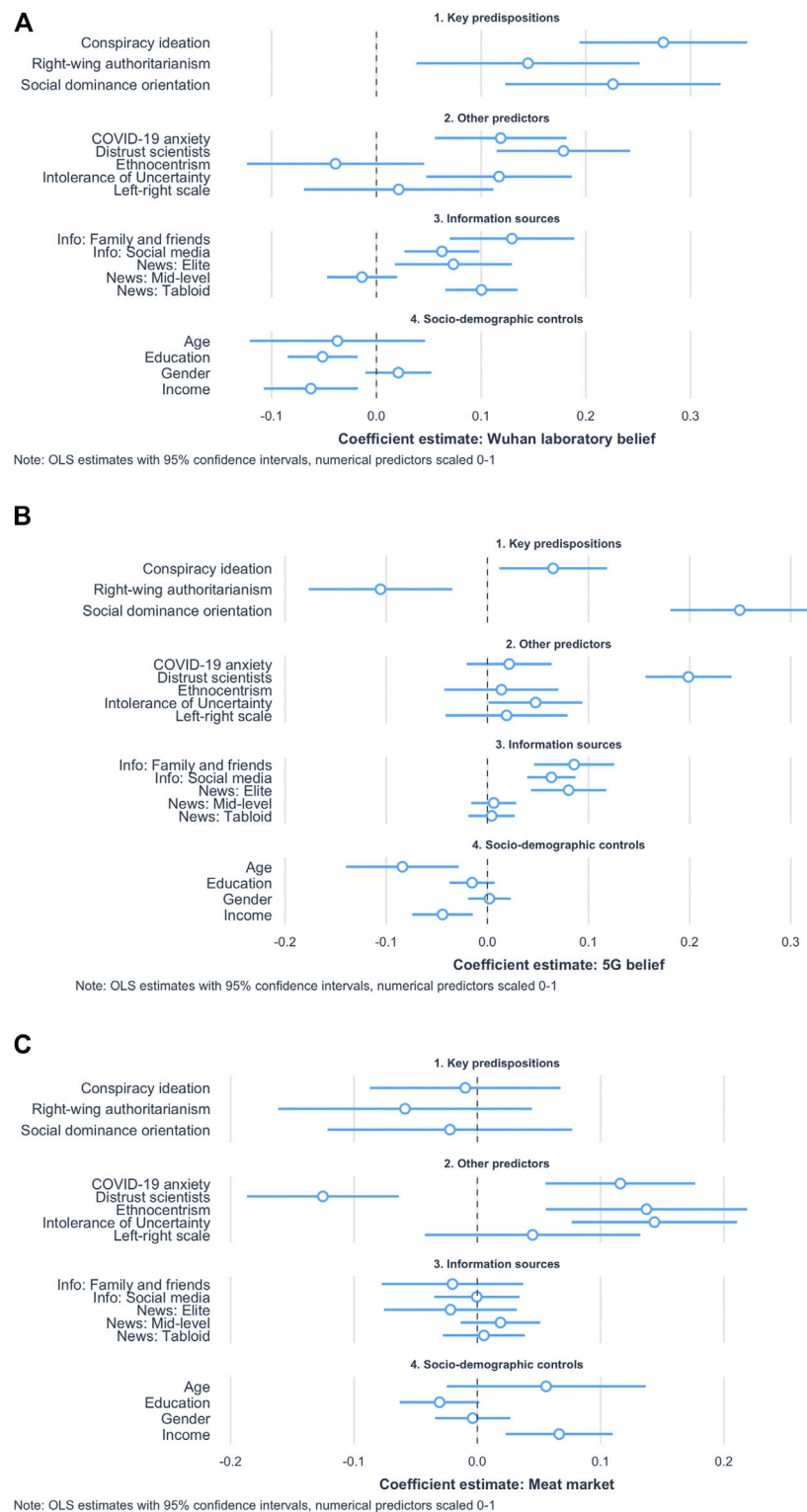
FIGURE 2 | Estimated coefficients for predictors on belief in different COVID-19 origin theories. **(A)** Origin theory: Wuhan lab, **(B)**. Origin theory: 5G network, **(C)**. Origin theory: Meat market.

TABLE 4 | OLS regression results for belief in each COVID-19 origin theory.

	Dependent variable		
	Wuhan lab	**5G network**	**Meat market**
Conspiracy ideation	0.274*** (0.041)	0.065* (0.027)	−0.010 (0.039)
RWA	0.145** (0.054)	−0.106** (0.036)	−0.059 (0.052)
SDO	0.226*** (0.052)	0.249*** (0.035)	−0.022 (0.051)
Left-right scale	0.021 (0.046)	0.019 (0.031)	0.045 (0.045)
Ethnocentrism	0.117*** (0.035)	0.048* (0.024)	0.144*** (0.034)
Distrust in scientists	0.179*** (0.033)	0.199*** (0.022)	−0.125*** (0.031)
COVID-19 anxiety	0.119*** (0.032)	0.022 (0.021)	0.116*** (0.031)
Intolerance of uncertainty	−0.039 (0.043)	0.014 (0.029)	0.137** (0.042)
Elite news	−0.014 (0.017)	0.006 (0.011)	0.019 (0.016)
Mid-level news	0.100*** (0.018)	0.004 (0.012)	0.005 (0.017)
Tabloid news	0.063*** (0.018)	0.063*** (0.012)	−0.0004 (0.018)
Info: Family and friends	0.129*** (0.030)	0.086*** (0.020)	−0.020 (0.029)
Info: Social media	0.074** (0.028)	0.080*** (0.019)	−0.022 (0.027)
Gender	0.021 (0.016)	0.002 (0.011)	−0.004 (0.016)
Age	−0.037 (0.043)	−0.084** (0.028)	0.056 (0.041)
Income	−0.063** (0.023)	−0.044** (0.015)	0.066** (0.022)
Education	−0.051** (0.017)	−0.015 (0.011)	−0.031 (0.016)
Constant	−0.175*** (0.052)	0.097** (0.034)	0.444*** (0.050)
Observations	1,399	1,399	1,399
R2	0.254	0.235	0.068

*Note: *p < 0.05; **p < 0.01; ***p < 0.001.*
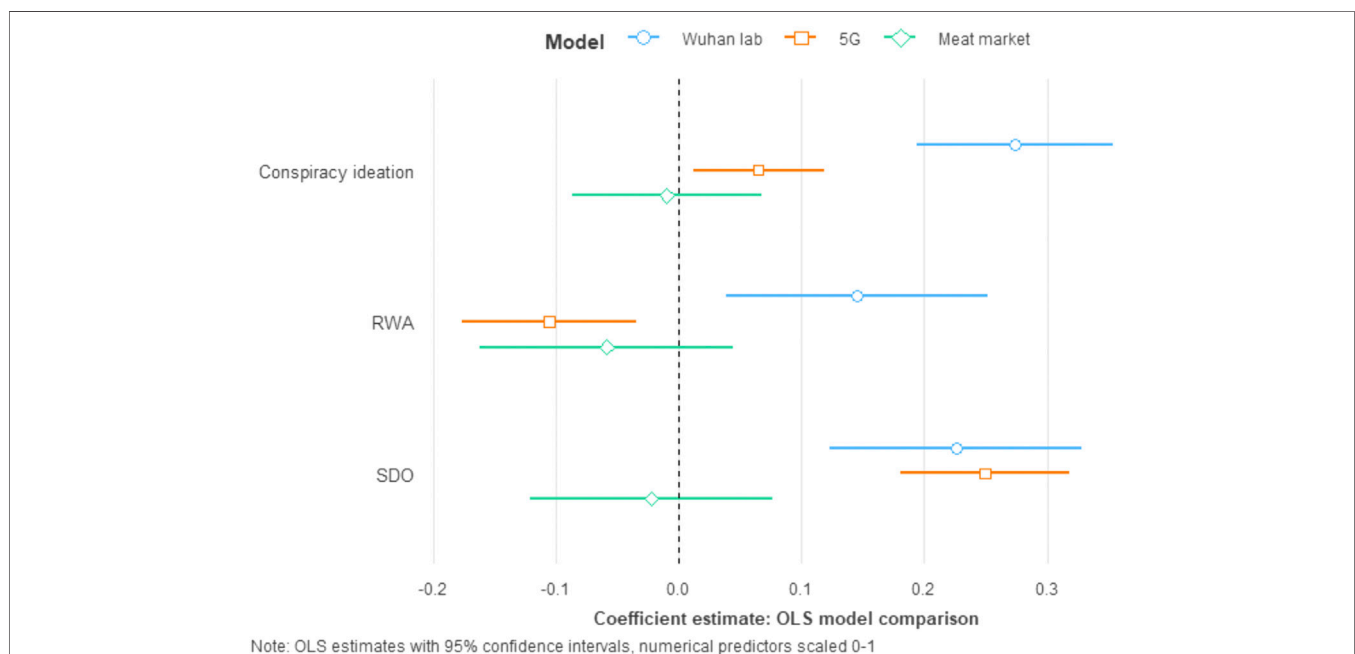
FIGURE 3 | Estimated coefficients for political-psychological predispositions on belief in different COVID-19 origin theories.

statistically significant increase in motivation, representing a 12-point increase in this outcome. Finally, distrust in scientists decreases motivation (by 15 points), while age increases it (by 17 points). These results suggest that certain factors may have a direct effect on social distancing, for instance by reducing empathy or stimulating skepticism toward scientific advice (Eiser et al., 2009; Bentley and Cowan, 2021).

Looking at the plotted marginal effects from the willingness to vaccinate models (in **Figure 5**), we see that belief in both the 5G and Wuhan lab conspiracy theories is associated with a statistically significant increase in vaccine reluctance (i.e., responding "no"). We also present the full set of relative risk ratios and average marginal effects from these models in the Appendix (see **Supplementary Appendix A4**). Political-

FIGURE 4 | Estimated coefficients for motivation to engage in social distancing.

FIGURE 5 | Marginal effects of selected predictors on willingness to take a vaccine.
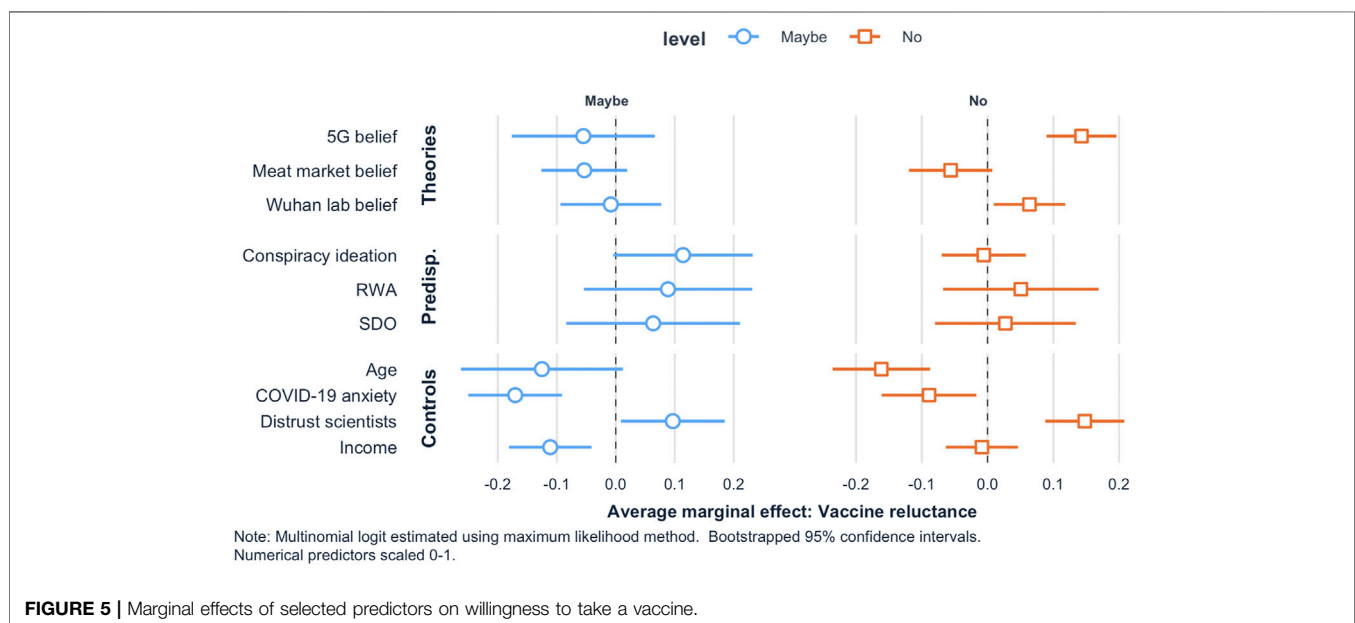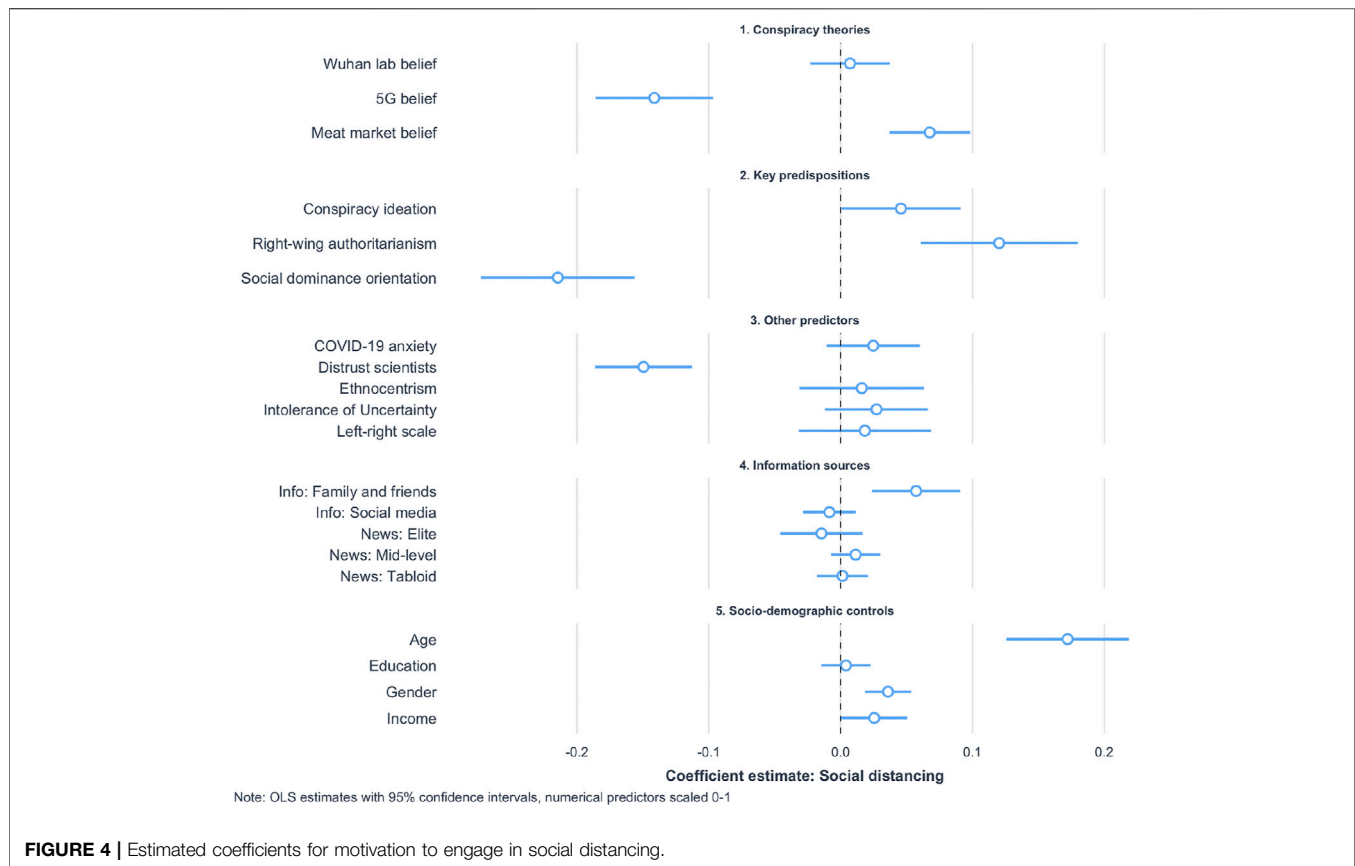
psychological predispositions like conspiracy ideation, RWA, and SDO, however, do not appear to be associated with a statistically significant direct effect on willingness to vaccinate. Belief in the meat market theory is negatively signed but not statistically significant for both vaccine rejection and vaccine hesitancy. Overall, we consider the results as providing support for Hypothesis 4b. We should also note that other factors like age, income, and COVID-19 anxiety decrease vaccine reluctance, while distrust in scientists appears to increase it.

TABLE 5 | Summary findings from our hypothesis tests.

Hypothesis	Results
Endorsement of one COVID-19 conspiracy theory will correlate with endorsement of another (Hypothesis 1a)	Supported
Conspiracist ideation will be positively associated with belief in COVID-19 origin theories (Hypothesis 1b)	Supported
RWA and SDO will be positively associated with belief in the Chinese lab origin theory (Hypothesis 2)	Supported
SDO will be positively associated with the 5G origin theory (Hypothesis 3)	Supported
Belief in COVID-19 conspiracy theories will be negatively associated with social distancing motivation (Hypothesis 4a)	Partially supported - belief in 5G origin theory negatively associated with social distancing motivation, but no effect of wuhan laboratory belief
Belief in COVID-19 conspiracy theories will be positively associated with vaccine rejection (Hypothesis 4b)	Supported

DISCUSSION

In this study we have tested hypotheses regarding the factors that predict COVID-19 origin theories, including two that we think fit the definition of a conspiracy theory (i.e., the virus originated in a Chinese laboratory and the current pandemic has been caused by 5G wireless technology), as well as one plausible, yet contested origin theory (i.e., the virus originated in a Wuhan meat market). We also studied the implications of these conspiracy theories for attitudes toward public health: 1) Motivation to engage in social distancing, and 2) willingness to accept a COVID-19 vaccine. The results of these hypothesis tests are summarized in **Table 5**. Overall, our results provide support for the notion that belief in COVID-19 conspiracy theories is associated with political-psychological predispositions that align with the specific content of each origin theory. Our results also highlight the negative consequences of conspiracy theories for effective public health interventions.

Previous research has found that there is a general disposition to believe in conspiracy theories, which has sometimes been referred to as a "conspiracy mentality" (Goertzel, 1994; Bruder et al., 2013). Our findings are consistent with this literature, as we report that a general measure of conspiracy ideation is associated with the Wuhan lab theory albeit less so with the 5G theory. Yet, our findings also raise some questions about the monological belief system model of conspiracy theories, at least in the case of COVID-19, as well as the explanatory power of conspiracy mentality to predict subsequent behaviors (Imhoff and Lamberty, 2020; Miller, 2020). In both of our conspiracy theory models, the effect size of conspiracy ideation is smaller than the findings of recent studies that also control for political predispositions like partisanship (e.g. see Uscinski et al., 2020). Of course, differences in effect sizes across studies could be partly due to differences in research design, measures, and analyses' for example Uscinski et al. (2020) used belief that the virus was purposefully made and spread as their outcome variable, whereas we look at COVID-19 origin theories that may be intentional but differ in terms of their potential plausibility and the nature of the implied threat.

We argue, however, that it is this latter source of variation-- and the specific content of the theories themselves--that underlies our primary contribution: Different conspiracy theories have different psychological and social determinants. Both RWA and SDO are strong predictors of belief in the Wuhan laboratory conspiracy theory, while belief in the 5G conspiracy theory is only positively associated with SDO; RWA, in fact, decreases endorsement in 5G belief. Our findings suggest these underlying predispositions may motivate differential beliefs depending upon, for example, the specific threats triggered by the content of a conspiracy theory, though we acknowledge we do not measure this directly.

Our differential findings between RWA and COVID-19 conspiracy theories is inconsistent with previous research suggesting a positive association between authoritarianism and conspiracy theories, in general (Bruder et al., 2013; Richey, 2017); however, our results are in line with more recent work that indicates a susceptibility of those high in RWA to conspiracy theories conforming to their worldview (Wood and Gray, 2019). For instance, RWA has shown to be associated with pro-military positions, and those high in RWA are particularly sensitive to threats to both security and the social order (Pratto et al., 1994; Doty et al., 1997; McFarland and Mathews, 2005; Terrizzi and Drews, 2005; Crowson et al., 2006; Jackson and Gaaertner, 2010; McFarland, 2015; Lindén et al., 2018). In this respect, a susceptibility of those high in RWA to a specific belief in the Wuhan lab (i.e., bioweapons) theory seems logical.

A similar case was put forward for why those high in SDO would be specifically susceptible to the Wuhan lab theory; however, SDO also predicted belief in the 5G conspiracy theory. While it might seem unexpected that this preference should be associated with conspiracy belief, previous research has reported a similar magnitude of association to that reported here (e.g., see Bruder et al., 2013), and recent research has reported a moderate positive association between SDO and belief COVID-19 that was man-made (Imhoff and Lamberty, 2020). As suggested in our theoretical discussion above, this association may be indicative of a relationship between SDO and anti-establishment conspiracy belief, in which conspiracy accounts are more plausible for those that see the world as naturally hierarchical, ruthless, and a "dog-eat-dog" competition (De keersmaeker and Roets, 2019). Perhaps, then, a theory in which the United Kingdom government has risked or deliberately compromised the health of the population to get ahead technologically, or in which the negative health effects of

5G are hidden as part of a corporate cover-up, might seem more plausible to those high in SDO. Moreover, although this is speculative, the present study cannot rule out the possibility that the responses given by those high in SDO are expressive rather than truthful responses (e.g., see Hartman and Newmark, 2012; Richey, 2017). In other words, perhaps those high in SDO are reporting a belief in the 5G theory due to a desire to express a related opinion that they hold, rather than because they truly believe 5G causes COVID-19. Those high in SDO are particularly sensitive to the economic threat of outgroups and are motivated toward socio-economic dominance (Craig and Richeson, 2014; Ho et al., 2015); it is therefore conceivable that those high in SDO are expressing an attitude about the reliance on Chinese technology during the development of the 5G network, or a more indirect sense of threat from the economic consequences inherent to national lockdowns. It is also possible that the link between 5G and China is more salient to those high in SDO, and their response here is motivated by prejudice (Duckitt, 2001; Ho et al., 2015). Alternatively, perhaps indicating belief in conspiracies in this context is related to a deeper desire to spread conspiracy beliefs, which fits with Lobato et al. (2020) findings.

Amongst our other predictors, distrust in scientists was a strong predictor of both Wuhan laboratory and 5G belief, consistent with previous research suggesting trust in sources is a key motivator of subsequent behavior, but that trust in knowledgeable experts may be undermined where they are perceived as withholding information or possessing ulterior motives (Eiser et al., 2009). Similarly, the influence of political and informational factors on the perceived plausibility of COVID-19 origin theories draws attention to the fact that conspiracy theories are to some extent social phenomena (Kreko, 2015). Both conspiracy theories were associated with obtaining information about the pandemic from family and friends and tabloid newspapers, and 5G belief was uniquely predicted by receiving information from social media.

The more plausible meat market origin theory differed from both of the conspiracy theories by being positively associated with intolerance of uncertainty, which we would expect, whereas this construct had no effect on the conspiracy theories. This is perhaps a counterintuitive finding given evidence of the role uncertainty plays in conspiracy belief (e.g. van Prooijen and Jostmann, 2013). However, it is notable that one mechanism through which uncertainty affects conspiracy belief is through over-attentiveness to prior judgements of the morality of conspiracy protagonists (ibid.), which may not be a salient factor for people's judgements of the protagonists in our conspiracy theories, such as the 5G network. Moreover, the effect of uncertainty in these studies was demonstrated on conspiracies involving political and military espionage that posed no direct threat to the participants (ibid.), whereas we have argued the Wuhan laboratory and 5G origin theories may motivate belief via predispositions due to an increased sense of normative threat.

In addition to revealing general and specific influences on theories about the origins of the COVID-19 virus, our findings also reveal the effects of these theories on willingness to take part in public health interventions. Our findings provide an interesting comparison to those of recent studies that found that belief the virus was a hoax, but not belief the virus was man-made, reduced social distancing compliance, and that conspiracy mentality negatively predicted compliance with self-isolation to prevent transmission (Imhoff and Lamberty, 2020; Marinthe et al., 2020). Willingness to comply with social distancing was positively associated with the meat market theory but negatively with the 5G theory, despite the content of a number of 5G conspiracy theories which implied the virus is man-made. In addition, we find a small positive effect of conspiracy ideation on social distancing. Rather, our findings may suggest the more salient factor for social distancing is whether the conspiracy implies human transmission. The lack of effect for the Wuhan laboratory theory is congruent with this assertion, given it still implies human transmission. Nevertheless, these reflections on our results are largely exploratory and a matter for further research as they provide nuance on our initial hypothesis that conspiracy belief would be negatively associated with social distancing. Both conspiracy theories were also associated with skepticism about vaccines, perhaps reflecting the fact that these theories are both strongly associated with distrust in scientists or the established relationship between conspiracy belief and rejection of the biomedical model (Lamberty and Imhoff, 2018). These observations highlight the fact that conspiracy theories are a potentially severe threat to public health.

Our study has a number of strengths and limitations that must be acknowledged. The main strengths were a large, representative sample of the United Kingdom population, who had provided a rich dataset encompassing social, demographic, psychological, and political variables. The major limitations were that we had measurements of only three origin theories, which means that we differ from recent research that explicitly models belief that the virus is a hoax (Imhoff and Lamberty, 2020; Uscinski et al., 2020), although as noted above, for some believers in the 5G theory this may be implied. Also, our COVID-19 origin theory measures were observational and cross-sectional, limiting our ability to make stronger causal inferences.

Finally, the findings we outline may be relatively bounded by context, which potentially limits their generalizability. In the first instance, the relationship between predispositions and conspiracy belief, we have argued, will be partly dependent upon the sense of threat implied by conspiracy content. But further than this, Marinthe et al. (2020) find conspiracy mentality reduces compliance with preventative public health behaviors primarily when they are mandated by authorities, rather than aversion to the behavior itself. In a similar sense, the aversion to social distancing and vaccination we find among conspiracy theory believers may be partly mediated by a rejection of government mandates, as opposed to the specific behaviors perse. It is plausible that in a context where social distancing and vaccination are not normatively encouraged by government that the relationship with conspiracy belief would be suppressed, though it is unlikely to completely disappear, given the anti-scientific themes running through many conspiracy theories.

Yet, we would argue an important implication of our work is the need for public health agencies to consider conspiracy theories in their planning and interventions that might mitigate these effects. Despite evidence of relative stability, neither SDO nor RWA are immutable; rather, we have argued that they are predispositions that are sensitive to the current context, including the salience of perceived threats to the social order and security of the ingroup (Duckitt and Sibley, 2016:192,199; Stenner, 2005: 14–19). Interventions will therefore need to be part of multifaceted strategies that reflect the complexity of conspiracy theory proliferation, as well as how they might interact with predispositions, with interventions targeted at both the purposeful propagators of conspiracy theories and the susceptible receivers of misinformation. For example, Uscinksi et al. (2020) have recently argued that if partisan cues exacerbate the propagation of conspiracy beliefs (at least in the United States), then partisanship may also be mobilized to provide corrective information. While we find no effect of political orientation in our work, there are parallels in that perhaps the group identities salient to people high in RWA and SDO can be mobilized, for instance by having trusted sources within skeptical communities help seed reliable information. The feasibility and efficacy of strategies, given the strongly held prior beliefs of such groups, remains an open question for both practitioners and researchers.

Concerning susceptible receivers, research has demonstrated some success in "inoculating" people against conspiracy theories, either by being pre-warned about them or by taking part in exercises, for example presented as computer games, in which they are asked to generate "fake news" themselves (see van der Linden et al., 2020). Strategies such as these may be amenable to mass dissemination, but this would require public health agencies to include the tracking of conspiracy theories in their pandemic planning and be ready to intervene as widely as possible at the earliest opportunity.

DATA AVAILABILITY STATEMENT

The full dataset and R script files are available at the Open Science Framework: https://osf.io/v2zur/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the ethical committee approval of the University of Sheffield (Reference number 033759). The patients/participants provided their written informed consent to participate in this study.

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AUTHOR CONTRIBUTIONS

TH: Contribution to the design of the study; Drafting or revising manuscript; Data analysis. MM: Contribution to the design of the study; Drafting or revising manuscript; Data analysis. TS: Contribution to the design of the study; Drafting or revising manuscript. RM: Contribution to the design of the study; Drafting or revising manuscript. KB: Contribution to the design of the study; Drafting or revising manuscript. SB: Contribution to the design of the study; Drafting or revising manuscript. JGM: Contribution to the design of the study; Drafting or revising manuscript. PH: Contribution to the design of the study; Drafting or revising manuscript. LL: Contribution to the design of the study; Drafting or revising manuscript. AM: Contribution to the design of the study; Drafting or revising manuscript; Ethical approval. LM: Contribution to the design of the study; Drafting or revising manuscript. OM: Contribution to the design of the study; Drafting or revising manuscript. JM: Contribution to the design of the study; Drafting or revising manuscript. MS: Contribution to the design of the study; Drafting or revising manuscript. FV: Contribution to the design of the study; Drafting or revising manuscript. RB: Contribution to the design of the study; Drafting or revising manuscript; Final approval.

FUNDING

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.642510/full#supplementary-material

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Social Media, Cognitive Reflection, and Conspiracy Beliefs

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A growing number of Americans stay informed about current events through social media. But using social media as a source of news is associated with increased likelihood of being misinformed about important topics, such as COVID-19. The two most popular platforms—Facebook and YouTube—remain relatively understudied in comparison to Twitter, which tends to be used by elites, but less than a quarter of the American public. In this brief research report, we investigate how cognitive reflection can mitigate the potential effects of using Facebook, YouTube and Twitter for news on subsequent conspiracy theory endorsement. To do that, we rely on an original dataset of 1,009 survey responses collected during the first wave of the coronavirus pandemic in the United States, on March 31, 2020. We find that using Facebook and YouTube for news increases conspiracy belief (both general and COVID-19 specific), controlling for cognitive reflection, traditional news media use, use of web-based news media, partisanship, education, age, and income. We also find that the impact of Facebook use on conspiracy belief is moderated by cognitive reflection. Facebook use increases conspiracy belief among those with low cognitive reflection but has no effect among those with moderate levels of cognitive reflection. It might even decrease conspiracy belief among those with the highest levels of cognitive reflection.

Keywords: social media, cognitive reflection, conspiracy theories, COVID-19, misinformation

INTRODUCTION

A growing number of Americans get their news online, and increasingly on social media platforms like Facebook. The number of people in the United States who fall into that category has doubled since 2013.[1] It has become conventional wisdom in public discourse that misinformation and conspiracy theories have become more widespread since the advent and growth of social media platforms.[2] Research has shown that social media is indeed ripe for spreading misinformation (Vosoughi et al., 2018; Wang et al., 2019; Swire-Thompson Lazer 2020), and getting your news on social media is associated with increased likelihood of being misinformed about important topics, such as vaccines (Stecula et al., 2020). In addition to being more misinformed, social media users are more likely to be exposed to various conspiracy theories (Mitchell et al., 2020), and work has found that use of social media

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[1]https://www.digitalnewsreport.org/survey/2020/united-states-2020/.
[2]See, for example, https://www.forbes.com/sites/petersuciu/2020/09/11/conspiracy-theories-have-gained-traction-since-911-thanks-to-social-media/?sh=361413483ddb.

for news correlates with conspiratorial worldview (Foley and Wagner, 2020). This has likely only been exacerbated during the global COVID-19 pandemic, where seemingly countless conspiracy theories about the novel coronavirus, its origins, and COVID-19 vaccines, have gone viral on various social media platforms.[3]

Most stories reinforcing COVID-19 conspiracy theories tend to originate from fringe online sources and social media posts (Papakyriakopoulos et al., 2020), and those who get their news on social media are more likely to be misinformed about basic facts surrounding COVID-19 (Baum et al., 2020; Bridgman et al., 2020). At the same time, as social media platforms like Facebook continue to grow their user bases, and as increasing number of Americans use these platforms for informing themselves about current events, it is clear that not everyone who uses these platforms endorse conspiracy beliefs. This highlights the need to understand the heterogenous effects that these platforms have on different people using them. In this brief research report, we focus on one factor that might mitigate the effects of social media use: cognitive reflection.

A growing body of work has focused on the link between susceptibility to various forms of misinformation and broad "cognition," as measured by various concepts including analytical thinking, numeracy skills, or various thinking styles (Pennycook et al., 2018; Guess et al., 2019; Roozenbeek et al., 2020). One particular strain of work focusing on thinking styles found that people who are more reflective (as operationalized by the Cognitive Reflection Test, described in more detail below) are less likely to believe misinformation and generally better at discerning between truth and falsehood (Pennycook and Rand, 2019; Ross et al., 2019; Bago et al., 2020; Pennycook and Rand, 2020).

Cognitive reflection is the capacity to override gut reactions. People engage in two distinct cognitive processes: those executed quickly with little conscious deliberation, and those that are slower and more reflective, sometimes called System one and System two thinking (Kahneman, 2013; Stanovich and West, 2000). System one thinking occurs spontaneously, is intuitive, and does not require attention, while System two thinking requires effort, motivation, and concentration. System one thinking employs mental shortcuts (heuristics) which under certain circumstances can lead to bias in information processing. It is what provides us with an intuitive or gut response to new information. System two thinking is logical and calculating, and can avoid the biases of System one thinking. From a neuroscientific perspective, System one thinking has been associated with activity in regions of the brain known as the Default Mode Network (Gronchi and Giovannelli 2018). The DFN is active during "unconstrained and internally focused cognitive processes" (Spreng 2012). Activity in the DFN has been found to be decreased when individuals engage in attention-demanding cognitive tasks. Simultaneously, activity in parts of the brain known as the task-positive network are more active during such tasks (Fox et al., 2005), suggesting it is associated with System two thinking.[4]

The Cognitive Reflection Test (CRT) is a measure of the ability of individuals to override and ignore incorrect intuition (System 1) and to instead engage in deeper reflection (System 2) to find the correct answer (Frederick 2005). Importantly, while CRT correlates with other measures of cognitive ability, cognitive reflection is more than intelligence or education (Frederick 2005; Toplak et al., 2011). In other words, it measures something conceptually distinct from other measures of intelligence, as evidenced by the moderate correlations between other intelligence tests and the CRT, and specifically the disposition to resist answering a question with an (incorrect) response that first comes to mind (Frederick 2005).

In the context of this study, cognitive reflection is important because conspiracy theories explicitly prey on System one thinking. Most conspiracy theories are designed to appeal to emotions, intuitive thinking, and gut reactions (Hofstadter, 1966; Hibbing et al., 2014; Radnitz and Underwood, 2015; van Prooijen, 2018). This suggests that not all social media users will be affected by the content they encounter on social media in the same way. Those more cognitively reflective will be more resistant to the conspiratorial content that they might encounter on these platforms, because they are better equipped to resist the intuitively appealing conspiratorial claims, and apply System two cognitive resources to determining the veracity of the conspiratorial content. They are also less likely to encounter such content to begin with, because they likely are better at curating a more reliable information environment on Facebook, Twitter, or YouTube. Previous work suggests that higher levels of cognitive reflection were associated with increased ability to discern fake and real news, and generally more responsible social media use (Pennycook and Rand, 2019; Mosleh et al., 2021). Those less cognitively reflective, on the other hand, will likely be more receptive to these conspiracies, because they are more likely to succumb to the intuitive gut reactions that these conspiracies appeal to. They are also likely to be less skilled at curating a landscape with reliable sources of information, and are therefore more likely to be exposed to these stories on social media platforms. We test the potential mitigating effect of cognitive reflection on the relationship between social media use and conspiracy belief. This is our first contribution.

The most popular social media platforms in the United States for current affairs are Facebook, YouTube, and Twitter.[5] However, mostly because of data availability issues, Twitter remains the most studied platform by researchers. Facebook and YouTube, despite being vastly more popular among average Americans,[6] remain relatively understudied in comparison to Twitter, which tends to be used by both political and media elites, but only about a quarter of the American public. Furthermore, survey-based research frequently combines social media usage into a single measure (e.x., Stecula et al., 2020), but looking at these platforms individually is important, given that differences between them

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[3]One prominent example of this was the Plandemic video that went viral in early May on social media before being taken down–https://www.bbc.com/news/uk-53085640.

[4]It has been found that some tasks can activate both networks (Spreng 2012).

[5]https://www.digitalnewsreport.org/survey/2020/united-states-2020/.

[6]According to a 2020 report by the Pew Research Center, and consistently with their previous work, 25% of Americans use Twitter, while 68% use Facebook and 74% use YouTube. That does not mean that the user base of these more popular platforms is without biases, but, on average, they are more widely used by an average American than Twitter.

means that different social media platforms could have different effects on people accepting conspiracy theories.

Research has shown that how information is presented (whether in text or in video form) affects how it is received (Neuman et al., 1992; Sydnor, 2018; Goldberg et al., 2019). Images (e.g., video) are processed automatically and fast, while the processing of text is controlled and slow (Powell et al., 2019). Most recent work has found that video is slightly more persuasive than text across different domains (Wittenberg et al., 2020). This suggests that different social media platforms might have different effects on their consumers. YouTube, for example, is a video platform, while Twitter and Facebook are primarily text based, although both allow for posting of photo and video content. At the same time, Twitter and Facebook are also different, in terms of length of an average post being longer on Facebook, but also in terms of the user base being much broader on Facebook. Given these differences, it is possible that their effects on conspiracy belief vary. It is also possible that the moderating effect of cognitive reflection differs across platforms. The ability to stop and override a gut reaction, and to engage in slow, effortful information processing may be easier when information is presented as text rather than a fast-paced video. This all highlights the need to examine the different social media platforms individually. In this research report, we disaggregate the effects of YouTube, Twitter and Facebook. This is our second contribution.

METHOD

Our data comes from an original survey of 1,009 adult Americans conducted using Lucid on March 31, 2020, during the first wave of the COVID-19 pandemic. The sample is generally representative of the United States population due to demographic (age, gender, ethnicity, and region) quotas employed by Lucid. Previous research has shown that Lucid provides a high-quality source of opinion data (Coppock and McClellan, 2019). To further ensure our sample is reflective of the general American public, we generated raking weights based on race, ethnicity, and educational attainment benchmarked to the United States Census's Current Population Survey from February 2018.

Our dependent variable is a measure of agreement with four conspiracies, two of which are about COVID-19 and two of which are more general in nature. Our strategy was to select prominent conspiracies that could have an appeal across the political spectrum. COVID-19 conspiracies are new, but emerged during the global pandemic, when an unprecedented number of people have been following the news. Conspiracy surrounding the 9/11 terrorist attacks have been relatively mainstream in the past two decades, and the Jeffrey Epstein suicide has captivated the news media's attention for several weeks. We asked: For each of the statements below, please indicate whether you agree or disagree with it:

1. Certain United States government officials planned the attacks of September 11, 2001, because they wanted the United States to go to war in the Middle East.

2. Jeffrey Epstein did not kill himself, but was murdered by powerful people who he had "dirt" on.
3. The Chinese government developed the coronavirus as a bioweapon.
4. There is a vaccine for the coronavirus that national governments and pharmaceutical companies won't release.

Response categories were coded: Strongly disagree 1), Somewhat disagree 2), Somewhat agree 3), Strongly agree 4). The percent that strongly agreed with each conspiracy is: 12, 26, 19, and 14%, respectively. The Epstein conspiracy is a bit of an outlier here, mostly due to the media salience of Jeffery Epstein's suicide and the plethora of conspiracies that emerged in light of it among *both* Republicans and Democrats. We use the average level of agreement across these four issues as the dependent variable. The Cronbach's alpha coefficient is 0.80, highlighting that these four conspiracies do in fact "move together" and form a reliable scale. **Figure 1** shows that the distribution of this variable is fairly uniform with a slight right tail skew. It has a mean of 2.35 and a standard deviation of 0.83.

Use of Twitter, Facebook and YouTube for news was measured by asking the following: "Some people follow politics closely while others don't have time to do that or do not find it interesting. Now, thinking about your own news habits, how often do you get the news about current affairs from … " Response categories were coded: Never 1), Hardly Ever 2), Sometimes 3), Often 4).

We measure cognitive reflection using the standard three-item Cognitive Reflection Test (CRT). The CRT measure is the number of correct responses to the three questions:

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? please enter the number of cents below.
2. If it takes five machines 5 min to make five widgets, how long would it take 100 machines to make 100 widgets? please enter the number of minutes below.
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? please enter the number of days below.

This scale is a simple and widely used measure of the ability to reflect on a problem and resist providing the first response that comes to mind (Frederick, 2005). The resulting CRT scale has a range from 0 to 3. The mean (and standard deviation) are: 0.36 (0.74). The modal value is zero, with 77% of respondents getting none of the answers correct. A further 14% got one answer correct, 6% got two correct and 3% got all three correct.

Figure 2 shows the distribution of social media use for news (in the left panel) and the average CRT score for individuals at each level of use (in the right panel). We see that use of Twitter is lower than that of YouTube and Facebook. A full 58% of individuals say they never used Twitter for news. The corresponding numbers for YouTube and Facebook are 37 and 31%. At the other end of use, only 17% of individuals say they often used Twitter for news but 24 and 28% of individuals say they often use YouTube or Facebook.
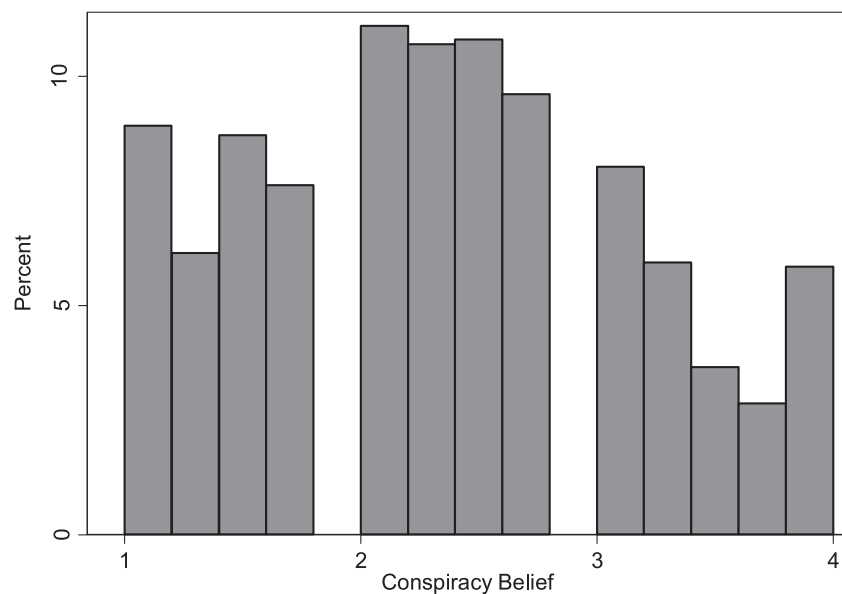
FIGURE 1 | Distribution of conspiracy belief.
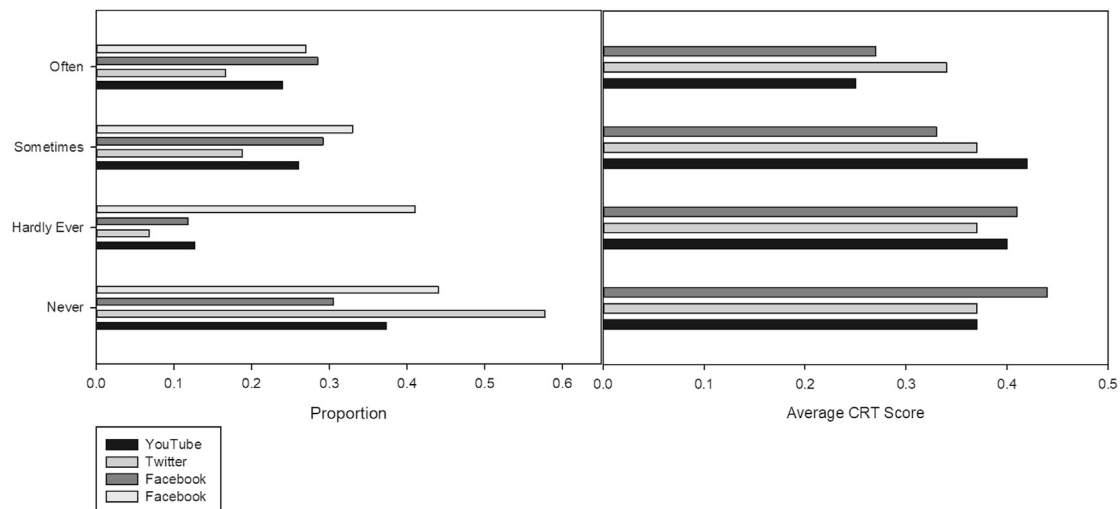
FIGURE 2 | Distribution of social media use and CRT scores.

We also see that the average CRT scores for those that never, hardly ever or sometimes use social media for news are equal to or higher than the average for the population as a whole. Those that often use Facebook or YouTube have lower CRT scores, on average. The difference between those that often use these social media platforms for news compared to those that never, hardly ever or sometimes use them is statistically significant (Facebook p-value = 0.035; YouTube p-value = 0.007). There is no such difference in CRT for those that often use Twitter.

In our models of conspiracy theory belief, we control for partisan identity (Democrat, Independent, Republican), traditional media use (average use of radio, national

newspapers or magazines, local newspapers, national television news and local television news for news.[7]), web based news (use of websites such as Buzzfeed, Vice, or Vox), age (in years), education (university degree), and gender (binary). Partisanship is an important control, because even though people from across the political spectrum can believe in conspiracy theories,

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[7]The question and response options for each source were the same as those for the social media platforms. The traditional media variable was created by taking the average across the traditional sources. The Cronbach's alpha scale reliability coefficient is 0.76.

FIGURE 3 | Effect of CRT and social media use for news on conspiracy belief.
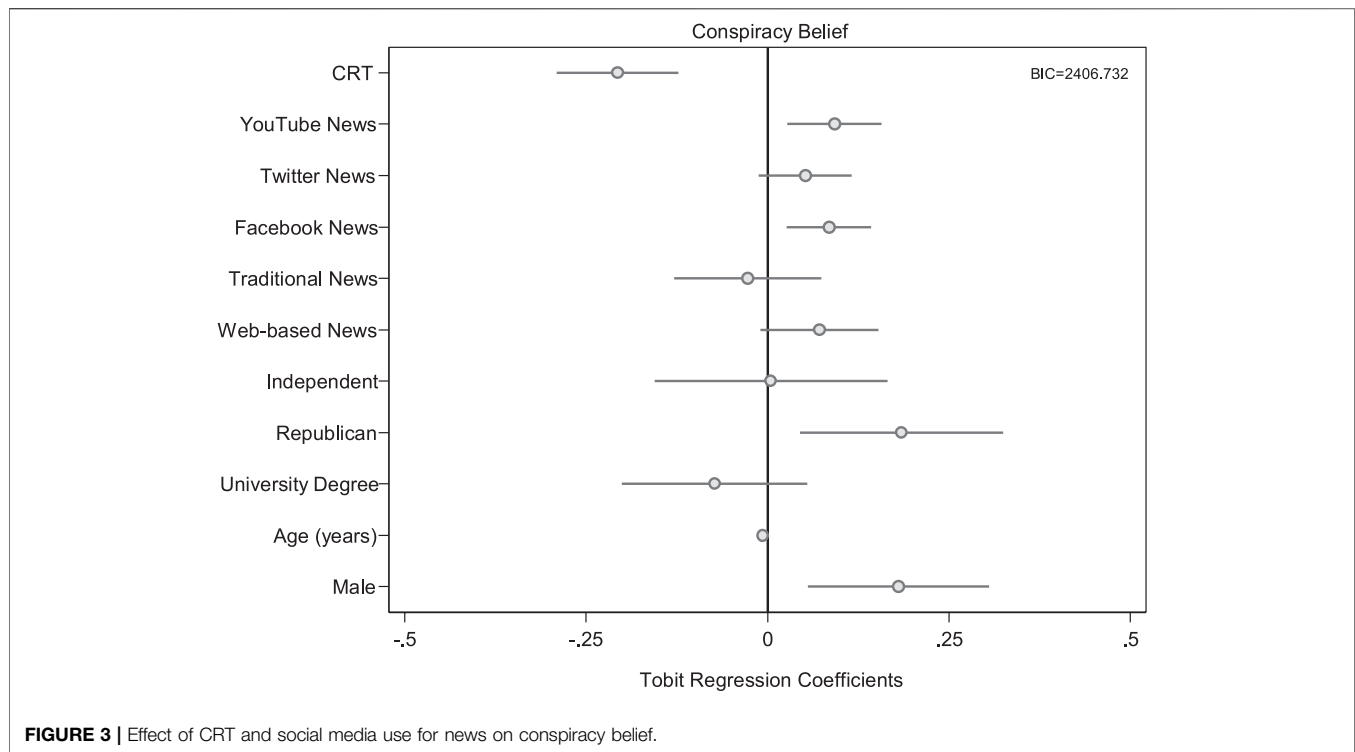
research has shown that the unique and highly politicized nature of COVID-19 conspiracies makes Republicans and conservatives more likely to endorse these specific theories (Uscinski et al., 2016; Uscinski et al., 2020). Partisanship might also influence the endorsement of the 9/11 and Epstein conspiracy theories. Furthermore, we control for traditional news consumption because previous work has found that consumers of such news sources are less likely to be misinformed, including about COVID-19 (Bridgman et al., 2020; Stecula et al., 2020).

RESULTS

We begin by regressing conspiracy theory belief on CRT, social media use and our control variables. We use a linear model, but to account for the fact that the dependent variable is bounded by 1 and 4, we use a Tobit model (results using OLS are very similar and provided in *Supplementary Information*).[8]

Looking at the results (**Figure 3**), we can immediately see that CRT has a statistically significant negative effect on conspiracy belief, and the use of YouTube and Facebook for news each have a statistically significant positive effect on conspiracy theory belief.[9] Twitter does not have a statistically significant effect (*p*-value = 0.11). Identifying as Republican (as opposed to a Democrat) and being male

(as opposed to female) have statistically significant positive effects, and age has a statistically significant negative effect. The magnitude of the CRT effect is that getting one additional question correct (out of 3) reduces conspiracy belief by 0.21 (*p*-value < 0.001) on the one to four belief scale. This is a decrease of one quarter of a standard deviation on the belief scale. The magnitude of the effect of increasing CRT by one on the 0 to 3 CRT scale is greater than that of being a Republican vs. a Democrat (0.18; *p*-value = 0.010), although the effects are in the opposite direction. This is notable as partisanship has been shown to have a substantively important effect on belief in some conspiracies (Uscinski et al., 2016; Uscinski et al., 2020).

An increase of one on the one to four social media use scale increases conspiracy belief by 0.09 (*p*-value = 0.005) and 0.08 (*p*-value = 0.004) for YouTube and Facebook, respectively. For example, an individual that never uses Facebook or YouTube for news has an expected score of 2.1 on the conspiracy belief scale. An individual that "somewhat disagrees" with each of the conspiracy theories would obtain such a score. An individual that often uses Facebook and YouTube for news has an expected score of 2.6 on the conspiracy scale. An individual would have to "somewhat agree" or "strongly agree" with at least one of the conspiracies to obtain such a score. This suggests that for an "average individual", frequent use of Facebook and YouTube can mean the difference between disagreeing with each of the conspiracy theories and agreeing with at least one of the conspiracies. The social media effects are smaller than those for CRT but still potentially important.

We next re-estimate our model including an interaction between CRT and social media use. Looking at the results (**Figure 4**), we see that the interaction between Facebook use and CRT is statistically significant but the Twitter and YouTube

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[8]A power test indicates that our sample size allows us to detect an effect as small as 0.0088 with 80% power.

[9]Figures include 95% confidence intervals. Statistical significance is determined at the 0.05 level (two-tailed test).

FIGURE 4 | Effect of CRT and social media use for news and their interaction on conspiracy belief.
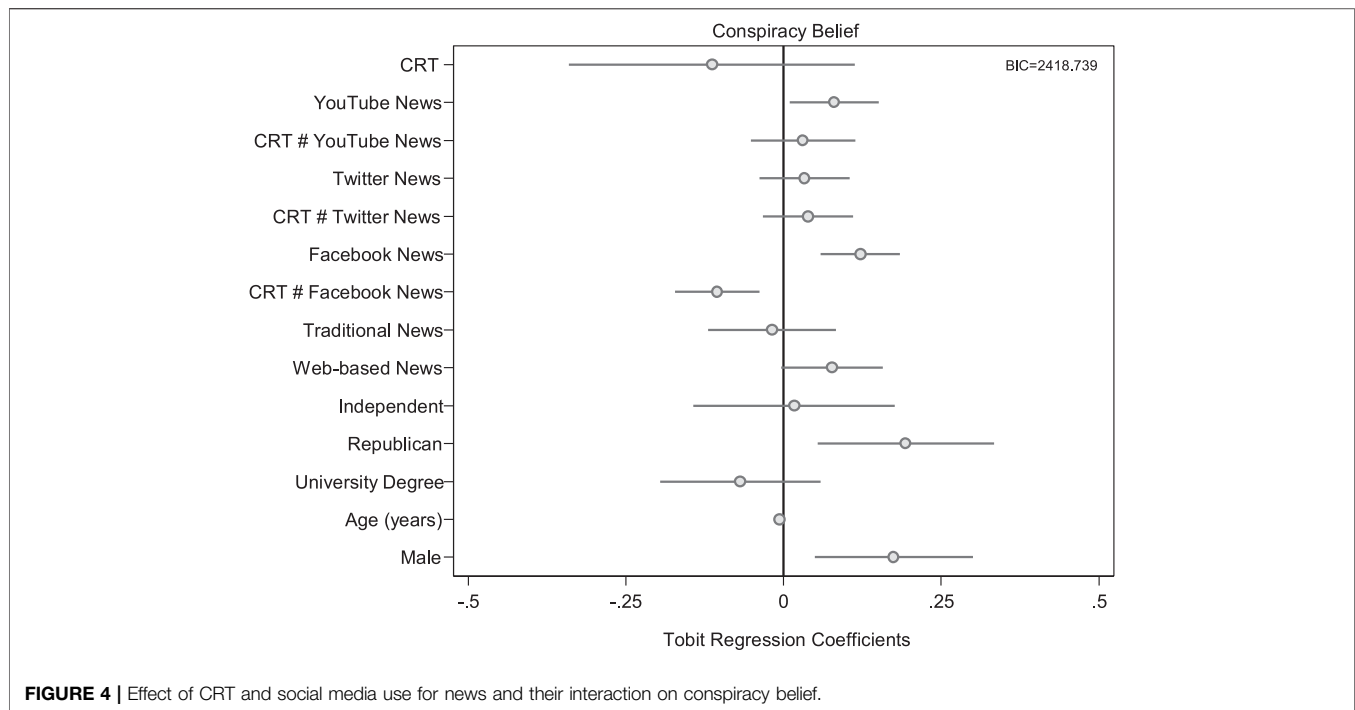
interactions are not. The negative Facebook interaction suggests that the effect of using Facebook as a source of news on conspiracy belief may be limited to those with low CRT. At the lowest level of CRT (obtained by 77% of individuals), an increase of one on the Facebook use scale increases conspiracy belief by 0.12 (p-value < 0.001). For example, an individual that never uses Facebook for news and has a CRT score of 0, has an expected score of 2.2 on the conspiracy belief scale. As before, an individual that somewhat disagrees with each of the conspiracy theories would obtain such a score. An individual that often uses Facebook for news and has a CRT score of 0, has an expected score of 2.6 on the conspiracy scale. Again, an individual would have to somewhat or strongly agree with at least one of the conspiracies to obtain such a score.

For those with higher CRT scores, the effect of social media use is mitigated. For those that had CRT scores of 1 or 2 (obtained by 20% of individuals), the effects of Facebook are substantively small or negative and not statistically significant. At the highest level of CRT (obtained by 3% of individuals), an increase of one on the Facebook use scale actually decreases conspiracy belief by 0.19 (p-value < 0.041). Meanwhile the effect of YouTube use on conspiracy belief is positive at all levels of CRT and the effect of Twitter is not significant at any level.

DISCUSSION

Consistent with previous work, we find that using social media as a source of news is associated with greater likelihood of endorsing various conspiracy theories. Importantly, and in line with our expectations, the effects vary for different social media platforms and different levels of cognitive reflection. The effects are limited

to the two biggest social media platforms: Facebook and YouTube, but not Twitter. At the same time, cognitive reflection mitigates these effects for Facebook. In other words, among Facebook users, it is those who easily succumb to gut reactions that are significantly more likely to believe in conspiracy theories, while those high in cognitive reflection, who can slow down and resist the incorrect intuitive answers, are unaffected by Facebook use or even less likely to endorse these conspiracies.

These findings suggest that cognitive reflection is an important moderator that can mitigate the relationship between conspiracy theories and social media use. At the same time, it also highlights that different platforms might influence their users differently. Facebook is primarily a text based social media platform that allows some photo and video content. Twitter is similar but with much shorter average text (and a smaller user base). These differences might explain why we do not see effects for Twitter use. YouTube, on the other hand, is a video platform. Video is processed automatically, while the processing of text is controlled (Powell et al., 2019), so a YouTube video is a more passive form of engagement than reading a Facebook post and, in general, tends to be more persuasive than text (Wittenberg et al., 2020). This may be why cognitive reflection does not mitigate the effects of YouTube use. System two just does not have the same opportunity to engage on YouTube compared to Facebook. This has potentially important implications, as there are indications that Facebook's user base in the United States is in decline, while the YouTube user base is increasing, and YouTube is more popular among young people.[10] Future research should be mindful of the distinctions between platforms and explore these differences in more detail.

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[10]https://www.digitalnewsreport.org/survey/2020/united-states-2020/

Our findings also have implications for the battle against conspiracy theory belief. On the one hand, there exists potential for social media platforms to motivate users to engage in more reflective thinking. As previous work has found, it is possible to prime reflective thinking (Deppe et al., 2015). Furthermore, recent research suggests that shifting attention to accuracy increases the quality of news that people share on Twitter (Pennycook et al., 2021). This is a kind of intervention that social media platforms could easily implement to increase users' focus on accuracy (Pennycook et al., 2021).

On the individual level, even with the necessary cognitive resources (e.g., vocabulary, numeracy), cognitive reflection requires individuals to be aware of the need to override System one thinking in a given context (conflict detection), and inhibit the intuitive response (sustained inhibition) long enough to deliberately apply cognitive resources to the situation (Bonnefon 2018). Bonnefon (2018) suggests that sustained inhibition is the part of this process most in need of training. We suggest that media literacy courses/training at both the secondary and postsecondary levels be studied for its ability to teach the need to override intuitive responses, sustain inhibition and apply cognitive resources in the context of social media. This is particularly important given the potential consequences of conspiracy theories about COVID-19. The conspiracies surrounding the vaccine will likely proliferate as the efforts to vaccinate national populations across the world become more intense, potentially lowering vaccination rates (Lindholt et al., 2020).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Pennsylvania IRB and the Simon Fraser University Research Ethics Board. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

Both authors designed the survey, collected the data, conceived of the manuscript, and wrote and edited the manuscript. MP conducted the analysis.

FUNDING

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Check for updates

A Pandemic of Misbelief: How Beliefs Promote or Undermine COVID-19 Mitigation

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Sustained and coordinated social action is needed to combat the spread of the novel coronavirus disease 2019 (COVID-19). Health practitioners and governments around the world have issued recommendations and mandates designed to reduce the transmission of COVID-19 by influencing the social behaviors of the general public. Why and when are some people unwilling to take action to protect themselves and others from the effects of this public health crisis? We find that belief in COVID-19 consensus information (by the self or perceptions of scientists' beliefs), are consequential predictors of COVID-19 mitigation behaviors. Importantly, support for COVID-19 conspiracy theories predicted decreased, whereas perceived understanding of COVID-19 predicted increased, belief in COVID-19 consensus information. We also implemented an Illusion of Explanatory depth paradigm, an approach to examining knowledge overestimation shown to reduce confidence in one's understanding of complex phenomena. By requiring participants to elaborate upon COVID-19 conspiracies, we experimentally increased understanding of these theories, which led, in turn, to ironic increases in support for the conspiracy theories and undermined perceived understanding of COVID-19 information for a notable portion of our participants. Together, our results suggest that attention given to COVID-19 conspiracies may be misguided; describing or explaining the existence of COVID-19 conspiracies may ironically increase support for these accounts and undermine knowledge about and willingness to engage in COVID-19 mitigation.

Keywords: conspiracy, fake news, COVID-19, health communication, causal reasoning and explanation

INTRODUCTION

Sustained and coordinated social action is needed to combat the spread of the coronavirus disease 2019 (COVID-19; Van Bavel et al., 2020), a pandemic that has claimed the lives of millions and will continue to threaten the safety and well-being of many more in the foreseeable future (World Health Organization, 2020a). Health organizations, medical professionals, and governments around the world have issued recommendations and mandates designed to reduce the transmission of COVID-19 by influencing the social behaviors of the general public (Centers for Disease Control, 2020; Götz et al., 2020). These initiatives—such as frequent handwashing, the use of protective facemasks, and social distancing—have indeed been effective at slowing the transmission of the virus and reducing the likelihood of illness (Anderson et al., 2020; Cohen and Corey, 2020; Haushofer and Metcalf, 2020; Prather et al., 2020).

The success with which behavioral mitigation is able to reduce disease contagion largely depends on widespread and voluntary compliance among individual members of the general public (Bish and

Michie, 2010; West et al., 2020). While large majorities of the general public in the U.S. support and engage in behavioral mitigation measures (Pew Research Center, 2020a; Pew Research Center, 2020b), there nonetheless remains a sizable minority who do not (cf. Motta et al., 2020). Why and when are some people unwilling to take action to protect themselves and others from the effects of the COVID-19 pandemic? With the widespread dissemination of inaccurate or unreliable information about COVID-19 (Brennen et al., 2020), where conspiracy theories run amok (Miller, 2020), and prominent political leaders misrepresent the severity of the pandemic and the efficacy of purported treatments (Sharma et al., 2017; Woodward, 2020), understanding how individuals acquire and use knowledge about COVID-19 is of central importance to containing its spread.

PREDICTORS OF COVID-19 MITIGATION BELIEFS AND BEHAVIORS

A literature examining predictors of COVID-19 beliefs about and voluntary compliance with behavioral mitigation recommendations is burgeoning. Engaging in mitigation behaviors is predicted by perceptions of the self (Bruine de Bruin and Bennett, 2020); perceptions of key others (Pfattheicher et al., 2020; Merkley and Loewen, 2021); individual traits such as thinking style (Pennycook et al., 2020; Teovanovic et al., 2020) and partisanship (Calvillo et al., 2020; Clinton et al., 2020; Druckman et al., 2020; Gollwitzer et al., 2020); as well as consumption of mainstream media outlets (Allington et al., 2020; Bridgman et al., 2020; Motta et al., 2020).

Much research has also focused on the implications of what some have described as an "infodemic" (Bridgman et al., 2020; World Health Organization, 2020b; Teovanovic et al., 2020), which refers to the widespread acceptance of unreliable and unverified information regarding the COVID-19 pandemic (for a review, see van Mulukom et al., 2020 preprint; Depoux et al., 2020; Kouzy et al., 2020; Mian and Khan, 2020; Motta and Callaghan, 2020). Such misperceptions of COVID-19 and distrust in experts who provide COVID-19 information reduce perceptions of risk and social distancing compliance (Bridgman et al., 2020; Merkley and Loewen, 2021). Furthermore, distrust in expertise promotes COVID-19 conspiracy theories (Uscinski et al., 2020), with belief in COVID-19 conspiracy theories being found to be the most consistent predictor of not engaging in protective health behaviors (Teovanovic et al., 2020). In short, misinformation and misperceptions can have deleterious consequences for accurate COVID-19 beliefs, with pernicious effects on behavioral mitigation.

Given the importance of accurate knowledge concerning the risk, transmission, and mitigation of COVID-19, a primary goal of public health recommendations and communication during the pandemic is to increase public understanding and align belief with consensus scientific information (Finset et al., 2020; Van Bavel et al., 2020). Even during the peak of the pandemic, some still underestimate the risk or severity of disease, or otherwise lack

sophisticated knowledge concerning COVID-19 (e.g., Al-Hasan et al., 2020; Allcott et al., 2020; Druckman et al., 2020; Grossman et al., 2020). Understanding what factors keep people from accepting scientific information about COVID-19, and how this shapes mitigation behavior, is therefore needed.

CURRENT RESEARCH

In this paper, we examine beliefs about scientifically supported COVID-19 information and its implications for COVID-19 mitigation behaviors. In a Pilot Study (see Supplemental Materials) that utilized data from an Amazon MTurk survey (N = 261), we find that belief in consensus information concerning COVID-19, and the perceptions that scientists also hold these beliefs, are associated with past and future COVID-19 mitigation behaviors, net a host of constructs known to covary with COVID-19 mitigation behaviors (Hypothesis 1). These results are largely consistent with prior research concerning the most proximate and consequential predictors of COVID-19 mitigation behaviors (Clark et al., 2020; Hornik et al., 2020; Marsh et al., 2021).

Importantly, the Pilot Study also demonstrates that support for conspiracy theories about COVID-19 correlated with significantly decreased, whereas perceived understanding of COVID-19 information correlated with significantly increased, belief in COVID-19 consensus information. The main focus of the current research is to better understand how these factors---conspiracy theories about and perceived understanding of COVID-19--shape belief in consensus COVID-19 information. We approach this issue in two ways.

First, we examine if the perception that one understands information related to COVID-19 correlates with belief in and engagement with mitigation behaviors. Prior research suggests that laypeople's understanding of disease symptomology can shape their perception of effective treatment (Marsh and Zeveney, 2015; Marsh and Romano, 2016). Further, self-perceived causal understanding is closely tied to perceptions of causal understanding among scientists or experts (Sloman and Rabb, 2016; Rabb et al., 2019), the latter of which has been directly implicated in COVID-19 mitigation behaviors (Marsh et al., 2021). These findings suggest that perceived understanding, by *both* the self and scientists, of how COVID-19 spreads could translate to increased belief in and compliance with behavioral mitigation. We found evidence consistent with this prediction in the Pilot Study, and the current research provides an additional test of this hypothesis (Hypothesis 2).

However, perceived understanding of COVID-19 consensus information may not necessarily result in adopting mitigation behaviors. In general, people often hold a shallow or incorrect understanding of how things in the world actually work (Rozenblit and Keil, 2002). Instead, people are frequently overconfident in their own knowledge, perceiving themselves as able to understand the causal underpinnings of many complex phenomenon in daily life, despite lacking the ability to properly ascertain their own competence in many domains (Wilson and Keil, 1998; Rozenblit and Keil, 2002; Dunning et al.,

2003; Fernbach et al., 2013; Zeveney and Marsh, 2016). Overestimation of one's knowledge about the causes of autism relative to medical experts, for example, is associated with low levels of actual knowledge and reduced vaccine uptake (Motta et al., 2018). Similarly, Teovanovic et al. (2020) demonstrated that individuals who overestimate their knowledge (indexed as deviation between self-reported and objective levels of knowledge) about COVID-19 reported reduced compliance with COVID-19 behavioral guidelines. Other investigations in the political domain indicate that those with inflated confidence in their causal understanding of political phenomena adopt more extreme issue-positions and are more likely to endorse conspiracy theories (Fernbach et al., 2013; Raimi and Leary, 2014; Marsh and Vitriol, 2018; Vitriol and Marsh, 2018). Given these findings, the relationship between perceived understanding and beliefs about COVID-19 deserve more empirical investigation.

The second way we examine the underpinning of belief in consensus COVID-19 information is by investigating the role of conspiratorial beliefs. Consistent with other research examining the implications of COVID-19 misperceptions (Bridgman et al., 2020; Roozenbeek et al., 2020; Teovanovic et al., 2020) and the result of our Pilot Study, we hypothesize that COVID-19 conspiracy theories will undermine belief in consensus information concerning COVID-19 (Hypothesis 3). More importantly, we try to experimentally undermine belief in conspiracy theories by exposing to people what they do not understand about these theories. To do this, we use an Illusion of Explanatory Depth paradigm (IOED; Rozenblit and Keil, 2002), a paradigm robustly shown to help expose people to the shallowness and limits of their explanatory understanding (Alter et al., 2010; Zeveney and Marsh, 2016). Specifically, in the IOED paradigm, the act of generating a causal explanation for a phenomenon exposes the limitations of one's knowledge, resulting in a drop in confidence in one's understanding.

In the political domain, those who maintain high levels of confidence in their understanding of politics and public policy, post-explanation, are also more extreme and conspiratorial in their political views (Fernbach et al., 2013; Vitriol and Marsh, 2018). We hypothesize that the act of explaining the causal logic behind prominent COVID-19 conspiracies will reduce confidence in one's perceived understanding of these theories, which in turn should be correlated with decreased overall endorsement of COVID-19 conspiracies (Hypothesis 4). If this hypothesis is confirmed, then the current study may be the first to demonstrate how revealing illusions of explanatory depth regarding specific conspiracy theories can reduce support for these beliefs and, as a result, minimize some of its more pernicious implications. Nonetheless, we advance our predictions with caution because, to date, the IOED paradigm has only been used to explain well-known or mainstream phenomena (e.g., faucets, election outcomes). As such, it is an open question of how explaining a conspiracy theory may influence understanding and uptake of that theory.

EXPERIMENTAL STUDY

In summary, our Experimental Study was designed with two goals: 1) to examine the underpinnings of COVID-19 conspiracy theories by utilizing an IOED paradigm to experimentally manipulate perceived understanding of COVID-19 conspiracies, and 2) to replicate the correlational observations of the Pilot Study on an independent sample. To achieve these two goals, we used a two-wave panel study. At Wave 1 (W1; November 30th to December 1st in 2020) participants completed measures of perceived understanding of and beliefs in consensus COVID-19 information, and a battery of measures known to correlate with endorsement of conspiracy theories. We also had participants rate their familiarity with a series of COVID-19 conspiracy theories.

At Wave 2 (W2; December 2nd–December 4th in 2020), we experimentally manipulated perceived understanding of COVID-19 conspiracies using an IOED paradigm (Rozenblit and Keil, 2002). After engaging in the IOED task, participants completed our understanding and belief measures for consensus COVID-19 information. We additionally had participants rate their support for COVID-19 conspiracy theories tested at W1 and the extent to which they were engaging in and planning to engage in COVID-19 mitigation behaviors. These measures will allow us to see how completing a task that should expose limited understanding of conspiracy theories and reveal the illusion of understanding changes endorsement of those theories. This design also allows us to examine if the IOED paradigm influences perceived understanding and belief for COVID-19 consensus information that stands in conflict with those conspiracy theories.

Overview of Hypotheses

We investigate the following hypotheses:

1. Belief in consensus information concerning COVID-19, and the perceptions that scientists also hold these beliefs, will correlate positively with past and future COVID-19 mitigation behaviors.
2. Perceived understanding, by both the self and scientists, of COVID-19 consensus information, will correlate with increased belief in COVID-19 consensus information.
3. Support for COVID-19 conspiracy theories will undermine belief in consensus information concerning COVID-19.
4. The act of explaining the causal logic behind prominent COVID-19 conspiracies will reduce confidence in one's perceived understanding of these theories, which in turn should correlated with decreased overall endorsement of COVID-19 conspiracies.

Participants and Procedures

We recruited 399 U.S. Citizens participants from Amazon MTurk in November of 2020 (57.3% females; age $M = 42.81$, $SD = 13.49$; 74% identify as White; and 78.4% have earned at least a Bachelor's degree). Of W1 participants, 58% or 232 were retained at W2[1]. Participants who did or did not return for the W2 survey did not

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[1]Due to a coding error, only 27% of participants in the Pilot Study and 80% of participants in the main Study completed demographic measures. For these reasons, we use these data to describe our sample but do not control for demographic characteristics in our model specification.

significantly differ in mean-levels of W1 belief in consensus COVID-19 information, perceived understanding of consensus COVID-19 information, cognitive sophistication, conspiratorial predispositions, and partisanship ($ps > 0.05$). However, participants who returned for W2 were significantly more ideologically conservative than participants who did not (W1 Only $M = 3.51$, $SD = 1.93$; W1 and W2 $M = 3.93$, $SD = 1.88$; $t = 2.17$, $p = 0.031$). The demographic characteristics of the two waves are highly similar (see **Supplementary Table S4** in the Supplemental Materials).

At W1, participants completed measures of 1) perceived understanding of consensus COVID-19 information, 2) beliefs in consensus COVID-19 information, 3) cognitive sophistication, 4) conspiratorial predispositions, and 5) familiarity with different COVID-19 conspiracies[2], and 6) control variables. Measures of belief and understanding were assessed first, in random order, followed by the remaining set of measures. Participants were then contacted two days after data collection for W1 was complete to participate in the W2 survey.

At the start of W2, participants completed the IOED paradigm developed by Rozenblit and Keil (2002; see Fernbach et al., 2013; Zeveney and Marsh, 2016). All participants first learned how to rate their understanding of phenomena on a 7-point scale (1 = very vague understanding, 7 = very thorough understanding) using the same instructions we provided before evaluating perceived understanding of consensus COVID-19 information (see Supplemental Materials). Participants then reported how well they understood three COVID-19 conspiracies, presented in random order; 1) "How the Chinese government engineered the coronavirus (COVID-19) as a bioweapon to wage war on America and Western countries", 2) "How powerful people have used coronavirus (COVID-19) to orchestrate panic, close down businesses, and destroy capitalism", and 3) "How the actual infection rate for the coronavirus (COVID-19) has been misreported in order to cover up how many people have been infected". These conspiracies were selected because they had the highest mean-level support in the Pilot Study.

After reporting their level of understanding of the three COVID-19 conspiracies, participants were randomly assigned to one of two IOED conditions. In the "explanation" condition, participants engaged in a traditional IOED paradigm in which they were asked to explain how each conspiracy theory works as follows (adapted from Rozenblit and Keil (2002); see Supplemental Materials). In contrast, participants who were assigned to the "description" condition, which served as our control group, were asked to list all of the characteristics of each conspiracy they could think of (adapted from Zeveney and Marsh, 2016).

We used these two different IOED manipulations because traditionally generating a causal explanation is what reveals the limitation of one's causal understanding (Zeveney and Marsh, 2016). For example, Vitriol and Marsh (2018) asked people to explain how a range of public policies work, using instructions with a strong emphasis on explicitly identifying causal connections. Fernbach et al. (2013) adopted a similar approach but compared participants in the explanation condition to participants who listed reasons they agreed or disagreed with a policy. Only when participants were required to explain the policies was the illusion revealed. However, we are uncertain how the act of description will function with implausible beliefs like conspiracy theories. Accordingly, we originally conceived of the description condition as a control group for the effect of explanation, but are open to how it may function in this context.

After generating an explanation or description of a single conspiracy, participants then again rated their level of understanding for that conspiracy. This process was repeated for each of the remaining conspiracies, in random order. Participants' pre-IOED ratings were averaged across the three conspiracies for each participant to form an indicator of self-reported confidence in one's understanding of COVID-19 conspiracies. Participants' post-IOED ratings were similarly averaged to form an indicator of self-reported confidence in one's understanding of COVID-19 conspiracies post-explanation or post-description.

After the IOED paradigm, participants again completed measures of 1) perceived understanding of consensus COVID-19 information, 2) beliefs in consensus COVID-19 information, and also completed measures of 3) endorsement of COVID-19 conspiracy theories and 4) COVID-19 mitigation behavior.

Measures

Means (SD), alphas, and intercorrelations of all measures are available in **Table 1**. All continuous variables were rescaled to run from 0–1 for easier interpretation and comparison of effect sizes. Full wording, items, and instructions can be found in the Supplemental Materials if it is not in the main text.

Perceived Understanding of Consensus COVID-19 Information.

At the start of W1 and after the IOED paradigm at W2, participants completed a set of questions that measured their perceived understanding of nine different elements of COVID-19 that tapped understanding of the disease's transmission, prevention measures, and effects on the body. We refer to these nine items as measuring consensus COVID-19 information. Participants reported in random order the extent to which they understood these consensus pieces of information, as well as how well "scientists and public health experts" understood this information. Participants were provided with instructions based on those used in the illusion of explanatory depth literature to guide their rating of understanding. Higher values represented increased perceived understanding of consensus COVID-19 information.

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[2]Participants were asked to rate how familiar (1 = Not familiar at all, 2 = Slightly familiar, 3 = Moderately familiar, 4 = Very familiar, 5 = Extremely familiar) they were with each of the three COVID-19 conspiracies used in the W2 IOED paradigm ($M = 3.23$, $SD = 1.03$) and a non-conspiratorial item ("Some people believe that the coronavirus (COVID-19) panic originated in Wuhan China. Others do not believe this"; $M = 4.05$, $SD = 1.04$). Thus, familiarity with the conspiracy theories was lower than the non-conspiratorial item and below the mid-point, but not so low as to constrain variability in responding.

TABLE 1 | Mean, SD, Cronbach's alpha, and correlations between all continuous variables used in study one.

Variables	M	SD	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
(1) Partisanship	0.45	0.35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(2) Party certainty	0.82	0.22	—	0.08	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(3) Ideology	0.46	0.32	—	*0.87	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(4) Ideology certainty	0.76	0.24	—	0.07	*0.65	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(5) Political knowledge	0.85	0.19	0.69	-0.02*	*0.32	0.00	*0.31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(6) Mainstream media	0.76	0.26	—	0.01	*0.28	0.04	*0.30	*0.18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(7) Local media	0.56	0.31	—	-0.07	*0.11	-0.07	*0.13	-0.03	*0.24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(8) Partisan media	0.53	0.13	—	-0.03	*0.13	-0.02	*0.13	0.07	*0.11	-0.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(9) Political engage	0.64	0.25	0.80	-0.05	*0.40	-0.08	*0.41	*0.27	*0.24	*0.18	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(10) COVID-19 worry	0.66	0.25	0.53	*-0.36	-0.06	*-0.39	-0.09	-0.11	0.08	*0.18	0.08	0.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(11) Conspiratorial predisp	0.42	0.27	0.93	*0.26	-0.08	*0.24	-0.06	*-0.19	0.07	*0.15	*-0.18	-0.06	-0.10	—	—	—	—	—	—	—	—	—	—	—	—	—
(12) CRT	0.53	0.29	0.71	-0.04	*0.12	-0.09	*0.22	*0.34	*0.10	-0.08	0.05	*0.16	-0.08	*-0.23	—	—	—	—	—	—	—	—	—	—	—	—
(13) Personal understand W1	0.74	0.19	0.91	*-0.15	*0.19	*-0.18	*0.14	0.03	*0.25	*0.16	0.09	*0.24	*0.32	-0.09	-0.08	—	—	—	—	—	—	—	—	—	—	—
(14) Science understand W1	0.84	0.18	0.93	*-0.30	*0.18	*-0.32	*0.13	0.09	*0.14	0.09	*0.11	*0.21	*0.41	*-0.24	*0.13	*0.61	—	—	—	—	—	—	—	—	—	—
(15) Personal belief W1	0.78	0.22	0.94	*-0.44	*0.13	*-0.51	0.08	0.06	0.05	*0.13	*0.10	*0.16	*0.59	*-0.36	*0.10	*0.51	*0.66	—	—	—	—	—	—	—	—	—
(16) Science belief W1	0.84	0.18	0.93	*-0.25	*0.16	*-0.30	*0.13	*0.11	*0.12	*0.16	*0.10	*0.22	*0.42	*-0.25	*0.14	*0.45	*0.65	*0.68	—	—	—	—	—	—	—	—
(17) Pre-IOED understand	0.38	0.29	0.84	*0.30	-0.07	*0.33	-0.01	*-0.16	0.07	*0.13	-0.09	-0.03	*-0.14	*0.54	*-0.26	0.04	*-0.24	*-0.34	*-0.28	—	—	—	—	—	—	—	—
(18) Post-IOED understand	0.42	0.30	0.87	*0.26	-0.03	*0.29	0.04	-0.09	0.03	0.07	-0.07	-0.01	*-0.17	*0.33	*-0.18	0.09	*-0.17	*-0.28	*-0.20	*0.75	—	—	—	—	—	—	—
(19) Personal understand W2	0.75	0.18	0.90	*-0.23	*0.15	*-0.29	*0.15	0.07	*0.27	*0.22	0.10	*0.17	*0.37	*-0.25	-0.01	*0.65	*0.51	*0.58	*0.44	-0.08	0.07	—	—	—	—	—	—
(20) Science understand W2	0.83	0.20	0.94	*-0.31	*0.21	*-0.37	0.13	0.11	0.12	0.06	0.09	0.11	*0.40	*-0.31	*0.17	*0.49	*0.77	*0.69	*0.54	*-0.34	*-0.28	*0.55	—	—	—	—	—
(21) Personal belief W2	0.76	0.24	0.94	*-0.47	0.07	*-0.54	0.06	0.09	0.00	0.13	0.12	0.10	*0.54	*-0.45	0.10	*0.48	*0.64	*0.89	*0.65	*-0.38	*-0.30	*0.56	*0.73	—	—	—	—
(22) Science belief W2	0.84	0.19	0.94	*-0.31	*0.20	*-0.37	*0.13	*0.16	0.06	0.11	0.05	*0.16	*0.42	*-0.27	0.11	*0.38	*0.54	*0.65	*0.67	*-0.30	*-0.25	*0.42	*0.66	*0.73	—	—	—
(23) COVID-19 cons	0.22	0.19	0.74	*0.34	-0.11	*0.36	-0.11	*-0.23	-0.07	0.01	*-0.16	-0.07	*-0.17	*0.56	*-0.27	-0.11	*-0.35	*-0.48	*-0.45	*0.56	*0.41	*-0.28	*-0.37	*-0.49	*-0.43	—
(24) COVID-19 behavior	0.78	0.24	0.78	*-0.36	-0.04	*-0.44	-0.08	0.03	0.01	0.10	0.07	0.00	*0.49	*-0.27	0.10	*0.32	*0.35	*0.65	*0.34	*-0.28	*-0.28	*0.37	*0.46	*0.60	*0.46	*-0.24

Notes. †p < .10. *p < .05. **p < .01.

Perceived Belief in Consensus COVID-19 Information

At the start of W1 and after the IOED paradigm at W2, participants rated how much they believed the same nine consensus COVID-19 pieces of information, again for themselves and for "scientists and public health experts", in random order (see Supplemental Materials for items). An independent measure of "belief" was computed for each referent group, separately, by taking mean responses across all items. Higher values represented increased belief in consensus COVID-19 information.

Cognitive Sophistication

At the start of W1, participants completed a measure of the Cognitive Reflection Test (CRT; Frederick, 2005), following the procedure used by Pennycook and Rand (2019), which combined modified versions of the original CRT items with additional non-numeric items from Thomson and Oppenheimer (2016). Participants were asked to provide an answer to seven items, such as: "If you're running a race and you pass the person in second place, what place are you in?", "A farmer had 15 sheep and all but eight died. How many are left?", and "If it takes 10 s for 10 printers to print out 10 pages of paper, how many seconds will it take for 50 printers to print out 50 pages of paper?". Correct responses were coded as a "1" and incorrect responses were coded as a "0". Responses were averaged across items and scaled such that higher values correspond with higher levels of cognitive sophistication.

Conspiratorial Predispositions

At the start of W1, participants completed a measure of conspiratorial predisposition (Edelson et al., 2017). Participants indicated, on a 7-point scale (1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree) the extent to which they agree or disagree with the following statements: 1) "Much of our lives are being controlled by plots hatched in secret places", 2) "Even though we live in a democracy, a few people will always run things anyway", 3) "The people who really run the country are not known to the voters", and 4) "Big events like wars, economic recessions, and the outcomes of elections are controlled by small groups of people who are working in secret against the rest of us". Responses were averaged across items and scaled such that higher values correspond with higher levels of conspiratorial predispositions.

Covid-19 Conspiracy Theories

Participants were asked to report the extent to which they believe in each of six different COVID-19 conspiracies (selected from Miller, 2020), including the belief that 1) "the government is hiding the vaccine", 2) "COVID-19" is a bioweapon engineered by the Chinese government to wage war on America and Western countries", 3) "the coronavirus (COVID-19) originated from drinking Corona beer", 4) "the coronavirus (COVID-19) panic has been an orchestrated effort by powerful people to close down businesses and destroy capitalism. Others do not believe this", 5) "the coronavirus (COVID-19) was originally engineered by the U.S. military", and 6) "that the infection rate in your country from coronavirus (COVID-19) is much higher than is reported, so as to cover up how many people have been infected. Others do not believe this". The items were presented in random order, and responses were coded such that higher values represent increased endorsement of conspiracy theories.

COVID-19 Mitigation Behaviors

At W2, participants indicated whether they had engaged in 11 different COVID-19 mitigation behaviors. Items included social distancing behaviors, sanitization behaviors, and mask wearing. This measure was computed by calculating the total number of "Yes" responses and dividing by the total number all items. Higher values indicate increased engagement in COVID-19 mitigation behavior.

Control Variables

We included in our analysis a set of control variables including: 1) political knowledge, 2) ideological self-placement, partisan identification, and certainty in both, 3) political engagement, 4) media consumption, and 5) concern about COVID-19. These variables were controlled for in all models unless explicitly noted otherwise. The Supplemental Materials provides complete information for how these constructs were measured and computed. High values correspond with higher level of knowledge, engagement, media consumption, COVID-19 concern, conservatism, republicanism, and ideological certainty.

RESULTS

Hypothesis 1: Does Belief in Consensus COVID-19 Information Correlate With Increased COVID-19 Mitigation?

We first sought to replicate the results of the Pilot Study that belief in COVID-19 consensus information (by the self or by scientists) would correlate with COVID-19 mitigation behaviors. To do so, we regressed using ordinary least-squares W2 COVID19 mitigation behavior on our control variables and either W1 or W2 independent variables. The results of this analysis are summarized in **Table 2**. Personal beliefs in consensus COVID-19 information correlated with mitigation behaviors at both time points (W1 personal beliefs, $b = 0.65$, CI 95% (0.48, 0.82), $p < 0.001$; W2 personal beliefs, $b = 0.42$, CI 95% (0.18, 0.59), $p < 0.001$) and perceptions of scientists' beliefs correlated with mitigation behaviors at W1 ($b = -0.19$, CI 95% (-0.37, -0.01), $p = 0.040$), but not W2 ($b = 0.07$, CI 95% (-0.12, 0.26), $p = 0.464$)[3]. Omitting personal belief from the model, perceptions of scientists correlated with mitigation behaviors, although this only obtained

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[3]These results are unchanged when including measures of perceived understanding of consensus COVID-19 information as covariates, suggesting that belief correlates with COVID-19 mitigation behavior independent of these constructs.

significance in W2 (W1, $b = 0.13$, CI 95% (-0.04, 0.31), $p = 0.142$; W2, $b = 0.32$, CI 95% (0.16, 0.61), $p < 0.001$). While perception of scientists' beliefs has an inconsistent relationship when accounting for other competing predictors of behavior (**Table 2**), both personal beliefs and perceptions of scientists' beliefs about COVID-19, at both W1 and W2, significantly correlated with increased COVID-19 mitigation behaviors without our control variables (see **Table 1**).

Hypothesis 2: Does Perceived Understanding Correlate With Increased Belief in Consensus COVID-19 Information?

Next, we tested what correlated with belief in COVID-19 consensus information (by the self or perceptions of scientists' beliefs). Our primary focus is to examine whether these two variables are associated with 1) perceived understanding of consensus COVID-19 information and 2) COVID-19 conspiracy theories, net the effect of our controls using ordinary least squares regression. The results of this analysis are summarized in **Tables 3**, **4**.

We regressed W2 personal belief and W2 perceptions of scientists' beliefs about COVID-19, separately, across a range of model specifications. In all models, we include our full set of control variables measured at W1 as well as W2 COVID-19 conspiracy theory endorsement. In our first model, we use W1 measures of perceived understanding and beliefs about COVID-19 as predictors, and in our second model we use W2 measures of perceived understanding and beliefs about COVID-19.

Consistent with the Pilot Study, our results indicate that believing consensus COVID-19 information at W2 was correlated with 1) higher personal understanding of COVID-19, measured at both W1 and W2, and 2) higher perceptions of scientists' understanding and beliefs about COVID-19, measured at both W1 and W2. Similarly, W2 perceptions of scientists' beliefs about consensus COVID-19 information was correlated with 1) increased perceptions that scientists understand consensus COVID-19 information, measured at both W1 and W2, and 2) increased personal beliefs in consensus COVID-19 information, measured at both W1 and W2. Personal understanding of consensus COVID-19 information did not correlate with perceptions of scientists' belief in consensus COVID-19 information.

Hypothesis 3: Does Belief in COVID-19 Conspiracy Theories Correlate With Decreased Belief in Consensus COVID-19 Information?

Importantly, however, belief in COVID-19 conspiracy theories at W2 correlated with significantly reduced personal belief, and perceptions of scientists' belief, in consensus COVID-19 information. Moving from the lowest to the highest levels of support for COVID-19 conspiracies corresponded with a decrease of approximately 16–23% and 10–14% in personal beliefs and perceptions of scientists' beliefs in COVID-19 consensus information, respectively.

Summary of Observational Findings

Overall, we have provided evidence that mitigation behaviors are correlated with belief in consensus COVID-19 information. Belief in this consensus information was strengthened by self and expert understanding of the information, and, importantly, weakened by endorsement of conspiracy theories. We next turn to exploring what could reduce endorsement of conspiracy theories.

Hypothesis 4: Will Revealing the Illusion of Explanatory Depth Reduce Perceived Understanding of COVID-19 Consensus Information and Support for COVID-19 Conspiracies?

We examined the IOED for both the explanation and description condition. To do so, a mixed 2 (time point: pre-IOED rating vs. post-IOED rating; within) x 2 (condition: explanation vs. description; between) ANOVA was used to compare differences in self-reported understanding of COVID-19 conspiracy theories, pre-IOED to post-IOED. This analysis indicated a significant main effect of time point ($F (1, 230) = 9.33$, $p = 0.002$; Overall pre-IOED $M = 0.38$, $SD = 0.39$; Overall post-IOED $M = 0.42$, $SD = 0.30$). There was no main effect of condition and there was not a significant interaction ($ps > 0.21$; Explanation pre-IOED $M = 0.35$, $SD = 0.29$; Explanation post-IOED $M = 0.40$, $SD = 0.30$; Description pre-IOED $M = 0.40$, $SD = 0.30$; Description post-IOED $M = 0.44$, $SD = 0.30$). Thus, we observe change in perceived understanding of conspiracies as a function of the IOED task. But, and in contrast to prior work on the IOED, instead of revealing the illusion and reducing perceived understanding, we observe significant increases in perceived understanding (see **Figure 1**).

We next explored whether an increase in understanding of COVID-19 conspiracy theories was common across all of our participants or, alternatively, driven by a subset of our participants. Across both conditions, 30.17% showed increased post-IOED ratings (description condition, 29.75%; explanation condition, 30.63%), 40.52% reported decreases in their ratings post-IOED (description condition, 41.32%; explanation condition, 39.64%), and 29.3% of participants showed zero change in their understanding ratings pre to post-IOED (description condition, 28.93%; explanation condition, 29.73%). In short, we find that the increase in post-IOED ratings is driven by a subset of our participants.

What differentiates people who increased their perceived understanding of conspiracies after the IOED task from people who did not? We examined whether overall cognitive sophistication and conspiratorial predisposition, known correlates of endorsement for conspiracies more generally, correlated with change in perceived understanding. We computed a difference score between perceived understanding (post-IOED minus pre-IOED), such that positive values correspond with increases in perceived understanding.[4] We regressed the IOED difference score (collapsed across IOED

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[4]We arrive at statistically similar results and conclusions when, instead of using a difference score, we control for pre-IOED perceived understanding and use post-IOED understanding as the predictor.

TABLE 2 | COVID-19 mitigation behavior (W2).

	COVID-19 mitigation behavior (W2)				
	b	95% CI	t	b	95% CI
Partisanship	0.11	−0.06, 0.28	1.28	0.13	−0.05, 0.30
Party certainty	−0.09	−0.23, 0.06	−1.14	−0.03	−0.19, 0.12
Ideology	−0.17	−0.37, 0.03	−1.72	−0.24*	−0.44, −0.04
Ideology certainty	−0.06	−0.19, 0.07	-0.87	−0.09	−0.23, 0.05
Political knowledge	0.12	−0.02, 0.26	1.69	0.10	−0.05, 0.24
Mainstream media	0.04	−0.06, 0.14	0.73	0.03	−0.07, 0.14
Local media	0.01	−0.07, 0.10	0.32	0.02	−0.07, 0.11
Partisan media	0.04	−0.14, 0.22	0.42	0.05	−0.14, 0.24
Political engage	-0.02	−0.13, 0.09	-0.33	−0.05	−0.17, 0.06
COVID-19 worry	0.14*	0.02, 0.26	2.28	0.18**	0.06, 0.30
COVID-19 cons	0.09	−0.07, 0.24	1.08	0.10	−0.06, 0.26
Science belief W1	−0.19*	0.48, 0.82	7.42	—	—
Personal belief W1	0.65***	−0.37, −0.01	-2.07	—	—
Science belief W2	—	—	—	0.07	−0.12, 0.26
Personal belief W2	—	—	—	0.42***	0.24, 0.60
Constant	0.33**	0.12, 0.54	3.09	0.30**	0.09, 0.51
N	232	—	—	232	—
F(dF)	15.26 (13, 218)	—	—	12.98 (13, 218)	—
R²	0.48	—	—	0.44	—

Notes. All variables recoded to run from 0 to 1 for ease of interpretation. *p < 0.05; **p < 0.01; ***p < 0.001.

TABLE 3 | Personal belief about COVID-19 (W2).

	Personal belief about COVID-19 (W2)					
	b	95% CI	t	b	95% CI	t
Partisanship	0.05	0.19, 0.81	0.81	0.00	−0.12, 0.11	−0.02
Party certainty	−0.05	0.07, −0.83	−0.83	−0.10	−0.20, 0.00	−1.95
Ideology	**−0.22	−0.07, −2.92	−2.92	−0.11	−0.24, 0.02	−1.64
Ideology certainty	0.04	0.14, 0.72	0.72	0.03	−0.06, 0.12	0.62
Political knowledge	*0.11	0.22, 2.02	2.02	0.05	−0.05, 0.14	0.96
Mainstream media	−0.11	−0.03, −2.61	−2.61	**−0.11	−0.18, −0.04	−3.11
Local media	0.00	0.07, −0.05	−0.05	0.03	−0.03, 0.09	0.95
Partisan media	0.05	0.19, 0.62	0.62	0.09	−0.04, 0.21	1.38
Political engage	−0.02	0.06, −0.55	-0.55	0.00	−0.07, 0.07	0.00
COVID-19 worry	***0.22	0.30, 4.73	4.73	***0.15	0.07, 0.23	3.81
COVID-19 cons	***−0.23	−0.11, −3.74	−3.74	**−0.16	−0.26, −0.06	−3.15
Science under. W1	*0.20	0.37, 2.28	2.28	—	—	—
Personal under. W1	***0.24	0.37, 3.55	3.55	—	—	—
Science belief W1	***0.30	0.44.4.10	4.10	—	—	—
Science under. W2	—	—	—	***0.36	0.24, 0.48	5.84
Personal under. W2	—	—	—	***0.23	0.11, 0.34	3.92
Science belief W2	—	—	—	***0.36	0.25, 0.48	6.08
Constant	**0.16	0.33, 1.89	1.89	***0.02	−0.12, 0.17	0.31
N	232	—	—	232	—	—
F(dF)	31.87 (14, 217)	—	—	48.48 (14, 217)	—	—
R²	0.67	—	—	0.76	—	—

Notes. All variables recoded to run from 0 to 1 for ease of interpretation. *p < 0.05; **p < 0.01; ***p < 0.001.

condition given the lack of differences found for that manipulation) on a model including all of our control variable measures and W1 measures of perceived understanding of and beliefs in consensus COVID-19 information, and both conspiratorial predispositions and cognitive sophistication (see **Table 5**). Whereas conspiratorial predispositions significantly correlated with increased perceived understanding of COVID-19 conspiracies after the IOED task (b = 0.16, CI 95% (0.08, 0.24),

$p < 0.001$), cognitive sophistication was not significantly related to change in perceived understanding (b = 0.01, CI 95% (−0.07, 0.08), $p = 0.876$).

Does change in understanding of conspiracies correlate with their endorsement? For this analysis, we regress support for COVID-19 conspiracies (measured at W2) on the full set of W1 controls variables and the IOED difference variable. This analysis is graphically represented in **Figure 2**. Results indicate

TABLE 4 | Scientists' belief about COVID-19 (W2).

	Scientists' belief about COVID-19 (W2)					
	b	**95% CI**	**t**	**b**	**95% CI**	**t**
Partisanship	0.04	−0.10, 0.17	0.56	0.03	−0.09, 0.15	0.47
Party certainty	0.06	−0.05, 0.18	1.05	0.08	−0.03, 0.18	1.43
Ideology	−0.03	−0.19, 0.12	−0.42	−0.01	−0.15, 0.13	−0.11
Ideology certainty	0.01	−0.09, 0.12	0.27	0.00	−0.10, 0.09	−0.02
Political knowledge	0.09	−0.02, 0.20	1.60	0.05	−0.05, 0.15	0.97
Mainstream media	−0.01	−0.09, 0.07	−0.24	0.00	−0.07, 0.08	0.05
Local media	0.00	−0.07, 0.06	−0.09	0.01	−0.05, 0.07	0.41
Partisan media	−0.11	−0.25, 0.04	−1.47	-0.10	−0.23, 0.03	−1.48
Political engage	0.03	−0.06, 0.12	0.63	0.02	−0.06, 0.10	0.55
COVID-19 worry	0.09	−0.01, 0.19	1.79	0.07	−0.02, 0.15	1.57
COVID-19 cons	*−0.13	−0.26, −0.01	-2.12	−0.10	−0.21, 0.01	−1.82
Science under. W1	**0.22	0.07, 0.38	2.79	—	—	—
Personal under. W1	−0.02	−0.16, 0.12	-0.27	—	—	—
Personal belief W1	***0.33	0.19, 0.47	4.59	—	—	—
Science under. W2	—	—	—	***0.26	0.13, 0.40	3.94
Personal under. W2	—	—	—	−0.08	−0.21, 0.04	−1.32
Personal belief W2	—	—	—	***0.40	0.27, 0.53	6.08
Constant	0.30	0.13, 0.47	3.50	0.27	0.13, 0.42	3.65
N	232	—	—	232	—	—
F(dF)	15.37 (14, 217)	—	—	22.89 (14, 217)	—	—
R^2	0.50	—	—	0.60	—	—

*Notes. All variables recoded to run from 0 to 1 for ease of interpretation. *p < 0.05; **p < 0.01; ***p < 0.001.*

that increased perceived understanding of conspiracies significantly correlated with increased support for COVID-19 conspiracies ($b = 0.22$, CI 95% (0.06, 0.37), $p = 0.007$; **Table 6**). To strengthen our inferences concerning whether increases or decreases in understanding of COVID-19 conspiracy theories, post-IOED, is driving this relationship, we computed two dummy-variables with categorization as "increase" or "decrease" coded as a "1", and the "no change" group as the referent, coded as a "0". This allows for a comparison between "increase" and "no change" or "decrease" and "no change". Compared to participants who did not show change in understanding post-IOED, those who increased understanding post-IOED were more likely to endorse COVID-19 conspiracies ($b = 0.06$, CI 95% (0.00, 0.12), $p = 0.053$); however, those who decreased understanding post-IOED were not any more or less likely to endorse COVID-19 conspiracies then those who did not change understanding post-IOED ($b = 0.003$, CI 95% (−0.05, 0.06), $p = 0.926$).
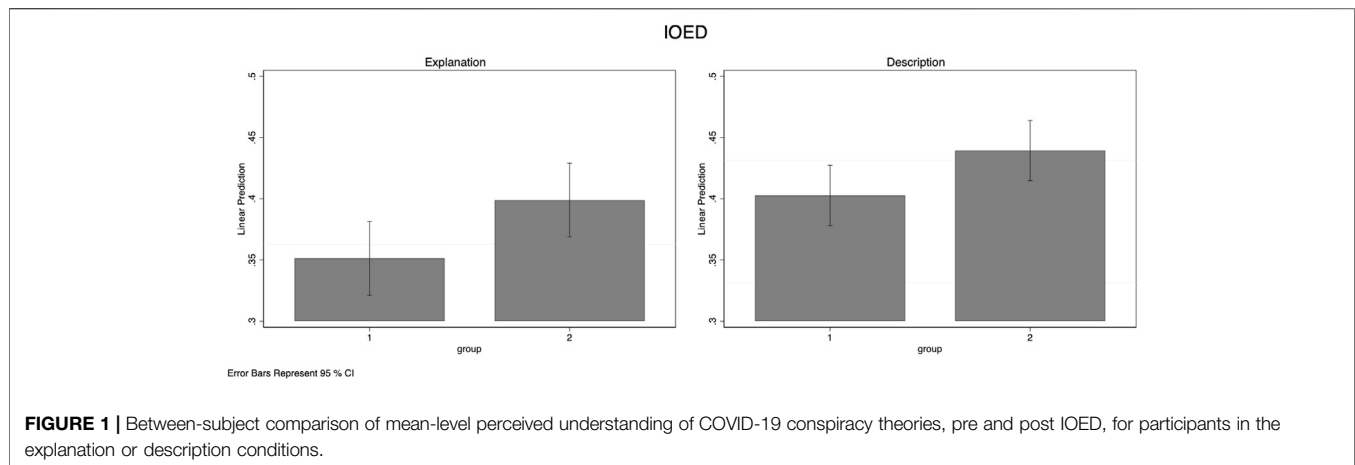
Finally, we examined the extent to which change in perceived understanding of COVID-19 conspiracies correlated with perceived understanding of consensus COVID-19 information. Here, we are able to take advantage of the panel design of our measures that straddled the IOED. We examined whether changes post-IOED in understanding of COVID-19 conspiracy theories correlated with W1 to W2 change in perceptions of one's own or scientists' understanding of consensus COVID-19 information, separately. For this analysis, we regress W2 dependent variables on W1 control variables, W1 and W2 measures of understanding and belief (other than what is estimated as the dependent variables), and the IOED difference score, interpreting coefficients for the latter as predicting W1 to W2 change in the dependent variables.

Results indicate that an increase post-IOED in perceived understanding of COVID-19 conspiracies correlated with significantly reduced perceived understanding of consensus COVID-19 information from W1 to W2 ($b = −0.21$, CI 95% (−0.33, −0.10), $p < 0.001$). In contrast, we did not observe a significant relationship between the IOED difference score and perceptions of scientists' understanding ($b = 0.03$, CI 95% (−0.07, 0.13), $p = 0.51$). These results are summarized in **Table 7**.

Again, we estimated the same models above for perceived understanding, but swapped in the two dummy-variables as an alternative to the IOED difference score. Results indicate that, compared to participants who did not show change in understanding post-IOED, those who increased understanding post-IOED were more likely to report W1 to W2 decreases in perceived understanding of consensus COVID-19 information ($b = −0.06$, CI 95% (−0.10, −0.01), $p = 0.013$); however, those who decreased understanding post-IOED were not significantly different from those who did not change understanding post-IOED ($b = 0.01$, CI 95% (−0.03, 0.05), $p = 0.745$).

DISCUSSION

We examined beliefs about consensus COVID-19 information and its implications for COVID-19 mitigation behaviors. We find that belief in COVID-19 consensus information (by the self or perceptions of scientists' beliefs) correlates with COVID-19 mitigation behaviors. Importantly, belief in COVID-19 consensus information was correlated with perceived understanding of COVID-19 consensus information. We also demonstrate that belief in COVID-19 conspiracies correlated

FIGURE 1 | Between-subject comparison of mean-level perceived understanding of COVID-19 conspiracy theories, pre and post IOED, for participants in the explanation or description conditions.

with significantly reduced belief in and perceptions of scientists' belief in COVID-19 consensus information. While we do observe significant bivariate correlations, perceived understanding and COVID-19 conspiracies do not correlate with COVID-19 behavioral mitigation independent of our control variables, consistent with the observations reported by Hornick et al. (2020). Together, these results indicate that perceived understanding and COVID-19 conspiracy theories may indirectly influence compliance with COVID-19 mitigation through its relationship to beliefs about COVID-19.

Importantly, we also implemented an IOED paradigm (Rozenblit and Keil, 2002) to experimentally manipulate perceived understanding of COVID-19 conspiracies and, consequently, influence support for these theories. Our findings with the IOED paradigm are important for two reasons. First, we provide a novel demonstration of how explanation or description influences understanding of phenomena generally seen as implausible or improbable. Prior research indicates that the act of explanation leads to reductions in belief confidence (Rozenblit and Keil, 2002; Fernbach et al., 2013; Vitriol and Marsh, 2018). However, for COVID-19 conspiracy theories, the act of explanation or description increased perceived understanding. While previous research has consistently shown a decrease in understanding after explanation alone (vs. description), we observed an equivalent increase for both the explanation and description conditions. We think that the lack of difference between our conditions helps illustrate why we find an overall increase. Our tested conspiracy theories are phenomena that people should have much less familiarity with than phenomena usually tested in IOED work (e.g., how a faucet works). Participants may have so little self-perceived knowledge about these conspiracy theories that the act of reflecting on conspiracy theories in any way may help generate information that was not previously believed or increased cognitive fluency in one's understanding of COVID-19 conspiracy theories in a way that inflates perceived validity (e.g., DiFonzo et al., 2016). This in turn may lead to greater perceptions of understanding. In this way,

instead of revealing the limitations of one's causal understanding, being tasked with explaining or describing the existence of implausible or improbable phenomena may ironically raise perceived causal understanding. Future research should seek to replicate and extend these observations across a broader range of conspiracy theories and epistemically suspect beliefs, using both description and explanation prompts, to better understand this phenomenon.
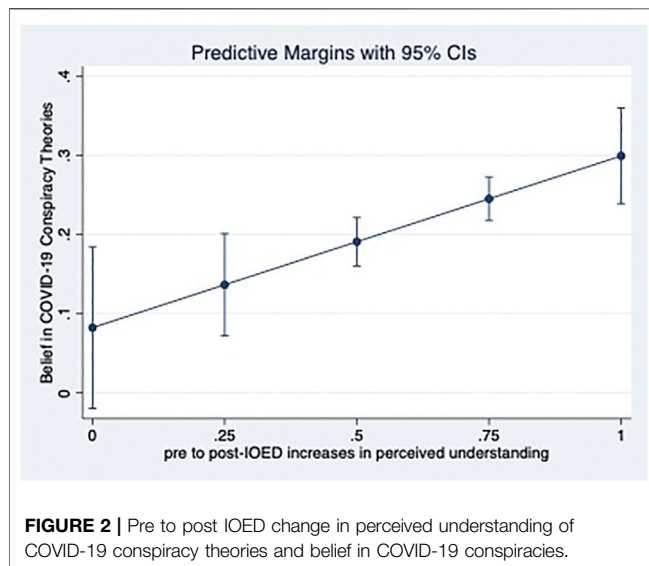
Our findings with the IOED paradigm are also important because we gain some leverage for causal inference regarding the consequences of COVID-19 conspiracies for perceived understanding and beliefs about COVID-19. Not all of our participants showed a pre to post-IOED increase despite an overall mean increase in ratings; while almost a third showed increased post-IOED ratings, 40% reported decreases in their ratings post-IOED, and less than a third of participants showed zero change in their understanding ratings pre to post-IOED. Pre to post-IOED increases were correlated with high levels of conspiratorial predispositions. Increases in understanding correlated with increased endorsement of COVID-19 conspiracies and reduced perceived understanding of COVID-19 consensus information. These results strengthen our claim that COVID-19 conspiracy theories are consequential for COVID-19 beliefs and behaviors. Our results also suggest that time and attention given to COVID-19 conspiracies may be misguided; describing or explaining the existence of COVID-19 conspiracies may ironically increase support for these accounts and undermine knowledge about, belief in, and willingness to engage in COVID-19 mitigation for those people already predisposed to believing in conspiracies. Instead, communications and recommendations from public health experts should focus, first and foremost, on increasing belief in and acceptance of consensus COVID-19 information and, secondarily, increasing understanding of this information (also see Rabb et al., 2019; Clark et al., 2020; Marsh et al., 2021).

Despite the strength of our evidence across both samples, our study is nonetheless limited by its exclusive reliance upon

TABLE 5 | Pre-IOED to Post-IOED change in understanding of COVID-19 conspiracies.

	Pre-IOED to Post-IOED change in understanding of COVID-19 conspiracies		
	b	95% CI	t
Partisanship	0.01	−0.12, 0.14	0.15
Party certainty	0.02	−0.09, 0.14	0.36
Ideology	−0.01	−0.16, 0.14	−0.12
Ideology certainty	−0.03	−0.13, 0.07	−0.55
Political knowledge	−0.03	−0.14, 0.08	−0.58
Mainstream media	0.04	−0.04, 0.12	1.02
Local media	0.03	−0.04, 0.09	0.82
Partisan media	0.05	−0.10, 0.19	0.64
Political engage	0.02	−0.06, 0.11	0.53
COVID-19 worry	0.03	−0.07, 0.12	0.55
Personal under. W1	−0.12	−0.25, 0.02	−1.67
Personal belief W1	0.09	−0.06, 0.24	1.17
Science under. W1	0.02	−0.15, 0.18	0.22
Science belief W1	-0.11	−0.25, 0.04	-1.43
Conspiratorial Predisposition	***0.16	0.08, 0.24	3.89
Cognitive sophistication	0.01	−0.07, 0.08	0.16
Constant	***0.58	0.41, 0.75	6.78
N	226	—	—
F(dF)	1.72 (16, 209)	—	—
R^2	0.12	—	—

Notes. All variables recoded to run from 0 to 1 for ease of interpretation. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

FIGURE 2 | Pre to post IOED change in perceived understanding of COVID-19 conspiracy theories and belief in COVID-19 conspiracies.

TABLE 6 | COVID-19 conspiracies.

	COVID-19 conspiracies		
	b	95% CI	t
Partisanship	0.02	−0.14, 0.18	0.24
Party certainty	−0.02	−0.16, 0.11	−0.35
Ideology	*0.19	0.01, 0.36	2.11
Ideology certainty	-0.02	−0.14, 0.11	−0.24
Political knowledge	**-0.19	−0.31, −0.06	−2.97
Mainstream media	-0.04	−0.13, 0.05	−0.87
Local media	0.03	−0.05, 0.11	0.79
Partisan media	−0.15	−0.32, 0.01	−1.81
Political engage	0.03	−0.07, 0.13	0.53
COVID-19 worry	−0.05	−0.15, 0.05	−1.02
Change in IOED understanding	**0.22	0.06, 0.37	2.73
Constant	**0.29	0.10, 0.47	3.02
N	232	—	—
F(dF)	6.33 (11, 220)	—	—
R^2	0.24	—	—

MTurk samples. MTurk samples may be older and more diverse than student samples, and more nationally representative than typical internet samples (e.g., Berinsky et al., 2012), but are not a representative, random sample of the American public. This limitation is particularly notable for correlational or observational studies. Further, our sample was limited to U.S. citizens. Future research should investigate the generalizability of our observations to samples more representative of the U.S. and the international community (e.g., Vitriol et al., 2019) in order to better understand beliefs about COVID-19 and its implications for COVID-19 mitigation behaviors. By understanding lay beliefs about COVID-19, public health practitioners can better identify who is likely to resist their advice and target those individuals with more effective messages designed to increase compliance. Doing so will help both individuals and their communities combat the spread of COVID-19 and the pandemics after that.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

TABLE 7 | Personal and Scientists Understanding (W2).

	Personal understanding (W2)			Scientists' understanding (W2)		
	b	95% CI	t	b	95% CI	t
Partisanship	0.09	−0.03, 0.20	1.52	0.03	−0.07, 0.12	0.53
Party certainty	−0.04	−0.14, 0.06	−0.75	0.07	−0.02, 0.16	1.61
Ideology	−0.11	−0.24, 0.02	−1.60	−0.01	−0.12, 0.11	−0.10
Ideology certainty	0.05	−0.04, 0.13	1.02	−0.02	−0.09, 0.06	−0.47
Political knowledge	−0.01	−0.10, 0.08	−0.24	−0.01	−0.08, 0.07	−0.14
Mainstream media	**0.10	0.03, 0.17	2.73	0.05	−0.01, 0.11	1.66
Local media	0.04	−0.02, 0.10	1.38	−0.02	−0.07, 0.03	−0.92
Partisan media	0.03	−0.10, 0.15	0.43	−0.05	−0.15, 0.05	−0.95
Political engage	0.01	−0.07, 0.08	0.14	0.00	−0.06, 0.07	0.15
COVID-19 worry	0.03	−0.05, 0.12	0.85	−0.04	−0.11, 0.03	−1.14
Science under. W1	*−0.19	−0.37, −0.01	−2.14	***0.66	0.53, 0.78	10.55
Science belief W1	0.05	−0.09, 0.19	0.65	***−0.25	−0.36, −0.13	−4.23
Personal under. W1	***0.41	0.29, 0.52	6.91	**−0.18	−0.29, −0.07	−3.33
Personal belief W1	0.09	−0.08, 0.26	1.06	0.12	−0.02, 0.26	1.66
Science under. W2	**0.24	0.09, 0.40	3.11	—	—	—
Science belief W2	−0.08	−0.22, 0.05	−1.20	***0.26	0.15, 0.37	4.66
Personal under. W2	—	—	—	**0.18	0.07, 0.29	3.11
Personal belief W2	0.09	−0.07, 0.26	1.13	**0.19	0.05, 0.33	2.70
Change in IOED understanding	***−0.21	−0.33, −0.10	-3.72	0.03	−0.07, 0.13	0.66
Constant	***0.32	0.17, 0.47	4.11	−0.01	−0.15, 0.12	−0.21
N	232	—	—	—	232	—
F(dF)	16.93 (18, 213)	—	—	—	36.19 (18, 213)	—
R^2	0.59	—	—	—	0.75	—

Notes. All variables recoded to run from 0 to 1 for ease of interpretation. *p < 0.05; **p < 0.01; ***p < 0.001.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Lehigh University Institutional Review Board (project title: The Illusion of Explanatory Depth).

AUTHOR CONTRIBUTIONS

JV and JM jointly generated the original research question and developed the project concept. Data preparation was conducted by JM and analysis was conducted by JV. JV generated the first draft of the manuscript and JM provided critical oversight and revision. All authors contributed to interpreting the results, drafting the manuscript, and approving the final version for submission.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2021.648082/full#supplementary-material

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Racialized Pandemic: The Effect of Racial Attitudes on COVID-19 Conspiracy Theory Beliefs

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As national and international health agencies rushed to respond to the global spread of a novel coronavirus (SARS-CoV-2, commonly known as COVID-19), one challenge these organizations faced was the spread of misinformation and conspiracy theories about the virus. Troublingly, much of the misinformation was couched in racialized language, particularly regarding the source of the virus and responsibility for its spread, fostering the development of related conspiracy theories. Media coverage of these conspiracy theories, particularly early on in the pandemic, had negative impacts on individuals' engagement in protective behaviors and concern with the spread of COVID-19. From extant work, racial resentment and white identity have been shown to be deeply woven into the fabric of contemporary American politics, affecting perceptions of public opinion even after accounting for social and political identities. While racial attitudes have been less studied in relation to conspiracy theory belief, we expect racial resentment and white identity to affect compliance with public health behaviors and COVID-19 conspiracy theory belief. Using observational and experimental survey data ($N = 1,045$), quota-sampled through Lucid Theorem (LT) in the spring of 2020, we demonstrate that framing the virus in racialized language alters endorsement of COVID-19 conspiracy theories, contingent upon levels of racial resentment and white identity and find that higher levels of conspiracy theory belief decreased compliance with preventative measures.

Keywords: racial attitudes, white identity, conspiracy theories, misinformation, COVID-19

INTRODUCTION

Starting early in 2020, the novel coronavirus (SARS-CoV-2, commonly known as COVID-19) rapidly spread across the globe, coupled by a wildfire of related misinformation and conspiracy theories. Media coverage of these conspiracy theories, particularly early on in the pandemic, had negative impacts on individuals' concern with the spread of COVID-19 (Motta et al., 2020) and engagement in protective behaviors (Chen and Farhart, 2020). Delayed responses, denials of pandemic severity, and misinformation and conspiracy theories about COVID-19 exacerbated the spread of the virus and slowed pandemic response, particularly in the U.S. (e.g., Abutaleb et al., 2020). As such, scholars turned to investigate why Americans might believe in coronavirus conspiracy theories, and how that conspiracy theory belief might further affect engagement with protective health behaviors.

Further, scholars have established that conspiracy theory belief is wide-spread with social and political consequences, globally traversing demographic, attitudinal, and political differences (e.g., Zonis and Joseph, 1994; Abalakina-Paap et al., 1999; Byford and Billig, 2001; Jolley and Douglas, 2014; Oliver and Wood, 2014; Uscinski and Parent, 2014). The causes and consequences of

conspiracy theory belief include various psychological, political, and situational factors. Specifically, van Prooijen and Douglas (2018) emphasize that conspiracy theory belief is consequential for health and safety, universal and widespread across historical and cultural contexts, emotional as conspiracy theory beliefs are often disconnected from deep, rational considerations, and lastly, socially tied to psychological motivations related to strong intergroup identity and intergroup conflict. Here, we are particularly interested in the first and fourth principles associated with COVID-19 conspiracy theory beliefs.

Uscinski et al. (2020) demonstrate that beliefs in COVID-19 conspiracy theories are most strongly predicted by individuals' rejection of expert information and official accounts of major events (denialism), a psychological predisposition to view major events as the product of conspiracy theories (conspiracy thinking), and political motivated reasoning (individuals' motivation to protect their partisan or ideological worldview). Further, Miller (2020) illustrates that the coronavirus pandemic has created a "perfect storm" to activate all three dimensions. Importantly, Miller (2020) demonstrates that rather than an entirely monological approach, e.g., Goertzel (1994), individual and situational factors interact to amplify CT beliefs to a greater extent than any single factor does on its own. This has potential consequences for impacting protective health behaviors, such as those recommended by the World Health Organization and the Centers for Disease Control and Prevention (CDC), as well as general pandemic-related behaviors. Oliver and Wood (2014) established that medical conspiracy theory beliefs are related to health behaviors. Consequently, some specific COVID-19 conspiracy theory beliefs had greater consequences for pandemic-related behaviors and vaccine intentions (Earnshaw et al., 2020; Imhoff and Lamberty, 2020; Kroke and Ruthig, 2021).

Troublingly, much of the misinformation and COVID-19 conspiracy theories have been couched in racialized language, particularly related to the source of the virus and responsibility for its spread. The pandemic began at a time when Donald Trump found political success from appealing to white racial grievances and nostalgia, while also scapegoating foreigners and immigrants (Sides et al., 2018; Jardina, 2019; Reny et al., 2019a,b; Reny and Barreto, 2020). The racialization of COVID-19 was a result of conservative political elites framing the coronavirus as a Chinese or Asian threat, which exacerbated anti-Asian attitudes associated with both concern about the disease and with xenophobic behaviors and policy preferences (Reny and Barreto, 2020). Historically, pandemics and the spread of infectious disease have been associated with heightened levels of prejudice, racial intolerance and xenophobia (Schaller and Neuberg, 2012; Kim et al., 2016; Elias et al., 2021). Relatedly, conspiracy theories often present an intergroup conflict such that a hostile outgroup, often those in powerful positions believed to be conspirators, is viewed as deceptive and threatening to a particular ingroup (e.g., van Prooijen and van Lange, 2014; van Prooijen and Douglas, 2018). As such, many of the COVID-19 conspiracy theories presented a direct ingroup threat to not only nationality but also those in racially dominant positions, from foreign entities, particularly China as the conspiratorial

outside force. The pandemic may also be more threatening to those who hold a deeper anti-vax identity (Motta et al., 2021). As such, this project seeks to extend these works to examine the interactive effects of racialized framing and identity threat on engagement with protective health behaviors and COVID-19 conspiracy theory belief.

We expect the racialized framing of some of the COVID-19 conspiracy theories to activate racial attitudes and racial identities, principally racial resentment and white identity for white populations as the foreign, external threats proposed from many COVID-19 conspiracy theories could be threatening to those in racially dominant positions. From extant work, we know that racial resentment and white identity are deeply woven into the fabric of contemporary American politics and scholars have consistently shown that racial attitudes affect perceptions of public opinion even after accounting for social identities such as partisanship and political ideology (Henderson and Hillygus, 2011; Knuckey, 2011; Filindra and Kaplan, 2016; Benegal, 2018; Jardina and Traugott, 2019).

We expect, however, that white identity and racial resentment function as two distinct forces in the realm of conspiracy theories. Scholars examining racial animus toward Black and African American people often focus on attitudes that combine assessments of negative stereotypes about work ethic and racial bias. Racial resentment is often utilized and understood to be the combination of anti-Black affect and the belief that Black people do not engage with traditional American values associated with protestant work ethic (Kinder and Sanders, 1996; Sears and Henry, 2005)[1]. These racial attitudes are easily primed by the social and political environment (Gilens, 1999; Tesler, 2012, 2015; Sheagley et al., 2017) and thus, should play a role in COVID-19 conspiracy endorsement when the theory is explicitly racialized[2]. Additionally, to the extent that protective health behaviors are seen as a tacit endorsement of the severity of the virus, individuals high in racial resentment may be less likely to engage in protective behaviors to avoid dissonance.

White identity, on the other hand, rather than serving as a proxy for racial attitudes among White people, acts as a distinct identity-protecting attitude (Jardina, 2019). Thus, individuals high in white identity are not simply expressing a dislike of racial out-groups, but are instead demonstrating strong in-group identity (Tajfel et al., 1979; Brewer, 1999). Although Jardina (2019) does not examine conspiratorial beliefs, her work suggests that events that are perceived as identity threatening lead to

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[1]Racial resentment, therefore, is not a clear-cut measure of racial prejudice for all Americans, but rather may also convey some ideological principles for conservatives (Feldman and Huddy, 2005; Huddy and Feldman, 2009). Nonetheless, it is a widely used measure of racial animus in political science and, as our results show, the concept has convergent validity with other measures of racism specially related to the COVID-19 pandemic.

[2]The evidence for racialized conspiracy theory belief is not extensive, but quite convincing. In particular, scholars have examined endorsement of the birtherism movement (Nyhan and Reifler, 2010; Tesler and Sears, 2010; Pasek et al., 2015; Berinsky, 2017; Enders et al., 2018; Jardina and Traugott, 2019) and perceptions of voter fraud (Wilson and Brewer, 2013; Udani and Kimball, 2017; Appleby and Federico, 2018). While nuanced, these findings all point consistently to a role for racial animus in predicting support for conspiracy theories, provided those theories are framed in racialized ways.

support for policies framed to alleviate that threat. Similar to the way that Jardina (2019) illustrates that mass opposition to immigration, to government outsourcing, and to trade policies are a function of white identity, we examine the threat to identity induced from the coronavirus pandemic. Unlike racial animus, we believe the pandemic itself serves as the identity threat, and thus white identity should positively predict conspiracy endorsement regardless of racial frames. Furthermore, we expect those high in white identity to seek to protect their in-group through behavior as well, resulting in greater engagement in protective health behaviors.

Thus, we expect both in-group affinity (white identity) and out-group hostility (racial resentment) to affect protective health behaviors and conspiracy theory belief during the early racialized coronavirus pandemic. As more politicians adopt racially charged rhetoric around whiteness (rather than anti-black, anti-Hispanic, anti-Muslim, etc. rhetoric) to avoid charges of overt racism (Mendelberg, 2001; Haney López, 2015), we expect this rhetoric to cue white identity more strongly than anti-black affect or racial resentment. While we expect those high in white identity to endorse conspiracy theories writ large as a psychological defense against identity threat, we believe instances of racialization are likely to be conditional on the framing of the conspiracy theory. We also expect racial resentment and white identity to exert countervailing effects on protective health behaviors.

Hypotheses

In sum, the current project tests the following hypotheses:

Hypothesis 1 (*Main Effects*): Individuals higher in white identity will be more likely to endorse conspiracy theories that individuals lower in white identity.

Hypothesis 2 (*Experimental Effects*): When the framing of a coronavirus conspiracy theory is racialized with an out-group target, racial resentment will have a *positive* impact on the endorsement of the conspiracy theory. When the framing of a conspiracy theory is racialized with an in-group target, racial resentment will have a *negative* impact on the endorsement of the conspiracy theory. White identity will have a *positive* impact on conspiracy theory endorsement, regardless of experimental frame.

Hypothesis 3a (*Protective Behaviors*): Above and beyond conspiracy belief, conspiratorial thinking and political identities, explicitly negative racialized perceptions of the coronavirus and racial resentment will have a *negative* effect on individuals' engagement with protective health behaviors in response to the pandemic;

Hypothesis 3b (*Protective Behaviors*): Above and beyond conspiracy belief, conspiratorial thinking and political identities, white identity will have a *positive* effect on engagement with protective health behaviors.

METHOD

This study utilized original observational data and a series of split-ballot survey experiments from a large ($N = 1,045$), non-probability but quota-sampled online survey of Americans

conducted through Lucid Theorem (LT)[3]. LT matches samples to Census demographics to approximate national representativeness. The study was fielded May 25–26, 2020. While analyses are conducted only on white respondents ($N = 727$), the broad demographics of our full sample, the question wording experiment cell sizes, and a correlation matrix of our main variables of interest are presented in the **Supplementary Materials**[4].

Conspiracy Theory Belief

Our first set of dependent variables focuses on three specifically racialized conspiracy theories related to COVID-19. We selected these prominent COVID-19 conspiracy theories from Miller (2020). Each conspiracy theory featured a set of experimental manipulations designed to alter the source behind the supposed conspiracy. The first question asks how likely it is that one of three groups [U.S. Government, China (racialized condition), the WHO] withheld information to make the pandemic appear less serious. The second asks how likely it is that one of three groups [U.S. Military, China (racialized condition), a foreign government] created the coronavirus as a bioweapon. To serve as a comparison, the third, which is not racialized, asks how likely it is that the pandemic is a plot perpetrated by one of three groups (Bill Gates, elites, global elites) to spread the virus *via* 5G. We first analyze these variables by pooling all responses across experimental conditions as well as subdivided by experimental condition (**Table 1**). In our experimental analyses, we utilize dummy variables for these conditions to examine the effect of treatment assignment on reliance on racial resentment and white identity. The cell sizes for the full sample and for white respondents only are available in **Supplementary Table 3**.

Protective Behavior

Our second set of dependent variables (**Table 1**) focuses on how respondents engage in protective behaviors related to the COVID-19 pandemic. While other scholars have focused more broadly on pandemic related behaviors (e.g., Imhoff and Lamberty, 2020), we focus here on the Centers for Disease Control and Prevention (CDC) recommended behaviors and those behavioral restrictions resulting from CDC recommendations made as of May of 2020. We first utilize an additive scale of eight items asking whether a respondent washed their hands regularly, avoided in-person dining in restaurants and bars, sanitized their work and living spaces, engaged in "no-touch" greetings when meeting people, changed their travel plans, worked from home, canceled previously scheduled social engagements, and used pick-up or delivery options from restaurants and stores (alpha = 0.70). This scale runs from 0 to 8. However, the scale is a limited measure as some respondents may not have been able to work from home or had travel plans to

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[3]Responses were anonymized and the online data collection, as opposed to face to face, assists with reducing social desirability bias in responses regarding racial resentment and white identity, as well as conspiracy theory endorsement. The study was not formally preregistered. All replication files are available on OSF *via* DOI 10.17605/OSF.IO/HXDJA.

[4]Our question wording experiments are sufficiently powered to test our hypothesized effects, at 0.80, alpha 0.05, with cell sizes above a minimum of 93.

TABLE 1 | Main effect of racial attitudes and experimental condition effects on conspiracy theory endorsement for white respondents only.

	Withheld information	Bioweapon	Spread by 5G	Withheld information	Bioweapon	Spread by 5G
Conspiratorial	0.10+	0.31*	0.27*	0.08	0.34*	0.28*
Thinking	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
"Chinese virus"	0.05	−0.08*	−0.13*	0.03	−0.07+	−0.12*
Is Racist	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Racial	−0.07	0.08	−0.04	−0.67*	−0.18*	−0.07
Resentment	(0.07)	(0.06)	(0.05)	(0.10)	(0.09)	(0.07)
White	0.23*	0.40*	0.43*	0.23*	0.41*	0.34*
Identity	(0.06)	(0.06)	(0.06)	(0.11)	(0.09)	(0.10)
Democrat	0.03	−0.04	−0.02	0.02	−0.04	−0.02
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Republican	0.08+	0.05	0.09*	0.08*	0.05	0.09*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Ideology	−0.02	0.01	0.00	−0.05	0.04	0.00
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)
Sex (female)	0.02	0.00	−0.01	0.00	−0.00	−0.01
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Hispanic	0.01	0.04	0.14*	0.04	0.05	0.14*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Midwest	0.01	−0.00	0.01	0.00	0.00	0.01
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)
South	−0.03	−0.01	−0.03	−0.03	0.01	−0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
West	−0.02	0.03	−0.00	−0.02	0.03	−0.00
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)
Education	−0.01	−0.02	−0.03	0.02	−0.04	−0.03
	(0.06)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Income	0.02	0.03	0.04	0.03	0.03	0.04
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Age	−0.22*	−0.18*	−0.27*	−0.18*	−0.15*	−0.26*
	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
Political	−0.06	−0.19*	−0.18*	−0.06	−0.19*	−0.18*
Knowledge	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Condition 1				−0.18*	0.03	−0.12+
				(0.08)	(0.07)	(0.06)
Condition 2				−0.63*	0.03	−0.09
				(0.07)	(0.07)	(0.07)
Condition 1 x				0.92*	0.33*	−0.00
Racial Resentment				(0.12)	(0.11)	(0.10)
Condition 2 x				0.95*	0.45*	0.08
Racial Resentment				(0.12)	(0.11)	(0.09)
Condition 1 x				−0.23+	0.03	0.18
White Identity				(0.13)	(0.12)	(0.13)
Condition 2 x				0.15	−0.06	0.07
White Identity				(0.13)	(0.13)	(0.14)
Constant	0.56*	0.14+	0.11	0.86*	0.09	0.17*
	(0.08)	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)
N	652	651	652	652	651	652
adj. R^2	0.067	0.265	0.371	0.296	0.385	0.369

*Standard errors in parentheses +$p < 0.10$, *$p < 0.05$.*
Condition 1 reflects the following question wording for each DV, relatively: China/China/Elites. Condition 2 reflects the following question wording for each DV, relatively: WHO/Foreign Government/Bill Gates. The baseline (excluded) categories are US Govt/US Military/Global Elites.

change. Thus, it is not an all-encompassing measure of protective behaviors such as those utilized by others (e.g., Imhoff and Lamberty, 2020; Kroke and Ruthig, 2021; Earnshaw et al., 2020). Given this limitation, we also employ two independent Likert-style measures, one asking frequency of wearing a facemask and the other asking frequency of staying six feet away from other people. When the survey was fielded, the CDC and WHO had yet to recommend consistent mask wearing if you are unable to be socially distant (Associated Press, 2020). Also, at the time of data collection, no vaccines had been approved for use in the United States, so we utilize a measure of the likelihood of getting vaccinated. While there are extensive batteries to assess vaccine likelihood or hesitancy (e.g., Quinn et al., 2019), other scholars have utilized a single-item measure in the context of COVID-19 vaccine likelihood (e.g., Chen and Farhart, 2020; Callaghan et al., 2021; Motta et al., 2021; Stoler et al., 2021). All Likert-style dependent variables are recoded to run from 0 (lowest likelihood) to 1 (highest likelihood).

Conspiracy Theory Index and Conspiratorial Thinking

To assess generalized conspiracy theory belief, we utilize a combined set of three additional conspiracy theories such as politicians inflating counts to hurt President Trump's re-election chances, whether individuals or groups are benefitting financially from the pandemic, and whether politicians are trying to destroy the economy to hurt President Trump[5]. These three conspiracy theories are combined into an additive index (alpha = 0.58). Multiple scholars have identified that conspiracy theory belief is not only target specific and dependent upon the media and political environment, but also associated with an individual's predisposition for conspiracy belief. Thus, we control for respondents' underlying conspiratorial thinking predisposition, so as to differentiate the effects of racialized attitudes and identities from a conspiratorial predisposition in predicting conspiracy theory endorsement. Further, as belief in specific conspiracy theories could be impacted by other motives, particularly tied to political motivated reasoning (e.g., Miller et al., 2016), we also control for a generalized predisposition measured through conspiratorial thinking which utilizes a four-item scale (see Uscinski and Parent, 2014; Uscinski et al., 2016). Respondents were presented with four statements (e.g., "Much of our lives are being controlled by plots hatched in secret places"), and were asked to indicate the extent to which they agree or disagree with each one on a five-point scale ranging from "strongly agree" to "strongly disagree." The four items were averaged together and the combined scale has high internal consistency (alpha = 0.80). While associated, these two indices are only moderately and positively correlated at 0.33 in the full sample and 0.39 among white respondents only, significant at $p < 0.01$.

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[5]This index does not include the three conspiracy theories used for our experimental analyses.

Racial Resentment and White Identity

Our main explanatory variables of interest include two measures of racial attitudes. First, we utilize a four-item measure of racial resentment as described by Kinder and Sanders (1996). This measure captures anti-black antipathy and is widely used (alpha = 0.77). We utilize Jardina (2019) measures of white identity, which were only administered to those who identified as white in our sample (alpha = 0.85). We also include a question designed to tap explicitly racialized attitudes about the pandemic. This question asks respondents to judge whether the term "Chinese Virus" is or is not racist. While not a general measure of anti-Asian attitudes, we utilized this measure as scholars have identified that anti-Asian attitudes were clearly activated and associated with COVID-19 attitudes and behaviors (Reny and Barreto, 2020). These measures are conceptually and methodologically distinct from one another, while only moderately and positively correlated with one another ($r = 0.35$ between white identity and racial resentment; $r = 0.12$ between white identity and the racialized COVID-19 question; $r = 0.45$ between racial resentment and the racialized COVID-19 question). Question wordings are located in **Supplementary Table 2**.

Demographic Controls

In addition to our variables of interest, we control for a number of socio-political variables. We include measures of party identification, ideology, sex, education, Hispanic, Spanish, or Latinx identification, income, region, age, and political knowledge.

RESULTS

Conspiracy Theory Endorsement (H1: Main Effects)

While there is good evidence that COVID-19 conspiracy theory belief systems are monological (Miller, 2020), we still anticipate that certain coronavirus conspiracy theories are likely to be more racialized and identity threatening than others. As noted in our hypotheses, while we expect those high in white identity to endorse conspiracy theories writ large as a psychological defense against identity threat, while we believe instances of racialization are likely to be conditional on the framing of the conspiracy theory.

As **Table 1** shows, for the three conspiracy theories tested, white identity predicts higher levels of conspiracy endorsement across the pooled conditions. For all three conspiracy theories, those higher in white identity are more likely to endorse the theory than those low in white identity. In contrast, the effects for racial resentment are mixed and statistically insignificant for two of the three conspiracy theories. These findings are above and beyond measures of conspiratorial thinking, which robustly predicts belief in our conspiracy theories, in addition to our measure of explicit racialized attitudes about whether the phrase "Chinese virus" is racist.

As expected, those who demonstrate greater attachment to their white identity appear to deal with the threat of the COVID-19 pandemic by leaning into conspiracy theory belief to explain

the uncertain and threatening context. The same cannot be said for racially resentful individuals. For these individuals, we do not see significant main effects for racial attitudes on conspiracy theory belief. This analysis, however, fails to consider the possibility that specific conspiracy frames may activate racial resentment for respondents. We examine this next.

Conspiracy Theory Endorsement (H2: Experimental Effects)

As noted above, while white identity appears to exert a fairly uniform influence on conspiracy endorsement, the effects for racial resentment appear far more mixed. To best understand these effects, **Table 1** also presents results from a set of interaction models examining experimental condition assignment and the effects of racial resentment and white identity[6].

To ease interpretation, we also present a figure depicting the conditional effects of white identity and racial resentment by condition assignment across the three conspiracy theories. Turning first to white identity, the bottom row of **Figure 1** shows strong support for our hypothesis that white identity will generally lead to higher conspiracy endorsement, regardless of condition assignment. Across eight of the nine conditions, white identity exhibits a strong, positive effect on conspiracy endorsement. Only for the conspiracy theory stating that China withheld information to downplay the severity of the pandemic do we see a null effect. In the case of this one conspiracy theory, however, the effect is not negative, but rather a consistently high level of endorsement among respondents, regardless of white identification.

In contrast, with racial resentment, we see clear evidence that conspiracy theory framing affects how racial attitudes structure conspiracy theory belief. For the first conspiracy theory, we see that racial attitudes are a strong, positive predictor of beliefs that China ($b = 0.24$, $p < 0.005$) or the WHO ($b = 0.27$, $p < 0.001$) withheld information about the pandemic, but that those same racial attitudes are a strong, *negative* predictor of beliefs that the U.S. Government withheld information ($b = -0.67$, $p < 0.001$). As the dependent variable is scaled to run from 0 to 1, these are substantively large effects. Across the range of racial resentment, endorsement of racially-framed conspiracy theories was nearly 25 percentage points higher for the most racially resentful as compared to the least racially resentful. Conversely, when the U.S. Government is cued, racial resentment decreases conspiracy theory endorsement by nearly 70 percentage points.

While not as strong of a relationship, a similar pattern emerges for beliefs that an entity released the coronavirus as a bioweapon. While there is no effect for racial resentment on beliefs that China did so ($b = 0.14$, $p < 0.12$), there is a positive relationship between racial resentment and belief that a foreign government did so ($b = 0.27$, $p < 0.004$). Again, this is a substantively large effect, with a nearly 27-point shift from the least to most racially resentful. In contrast, beliefs that the U.S. Military released it as a bioweapon were negatively related to racial resentment ($b = -0.18$, $p <$

0.04). Thus, when experimental conditions cue racialized theories (China, WHO), racial resentment exerts a positive influence on endorsement. When it cues an institution that is racially coded as white (U.S. Government, U.S. Military), the effect reverses and racial resentment leads to lower levels of endorsement.

By way of contrast, we also include a conspiracy theory without an explicitly racial frame, which is the third conspiracy theory (that Bill Gates, Elites, or Global Elites spread coronavirus *via* 5G). Here, while white identity is a strong predictor of support in all three conditions, racial resentment plays no role. Thus, racial resentment appears highly conditional on framing, while the effect of white identity is largely universal[7].

Protective Behaviors (H3a and H3b)

Lastly, we evaluated the effect of conspiracy theory endorsement, racial resentment, and white identity on protective, pro-social health behaviors. These results appear in **Table 2**. The results clearly indicate not only the influence of conspiracy theory endorsement and underlying conspiratorial thinking on protective behaviors, but also the extent to which these behaviors have become racialized (racial resentment, "Chinese Virus" question) and are salient for identity preservation (white identity).
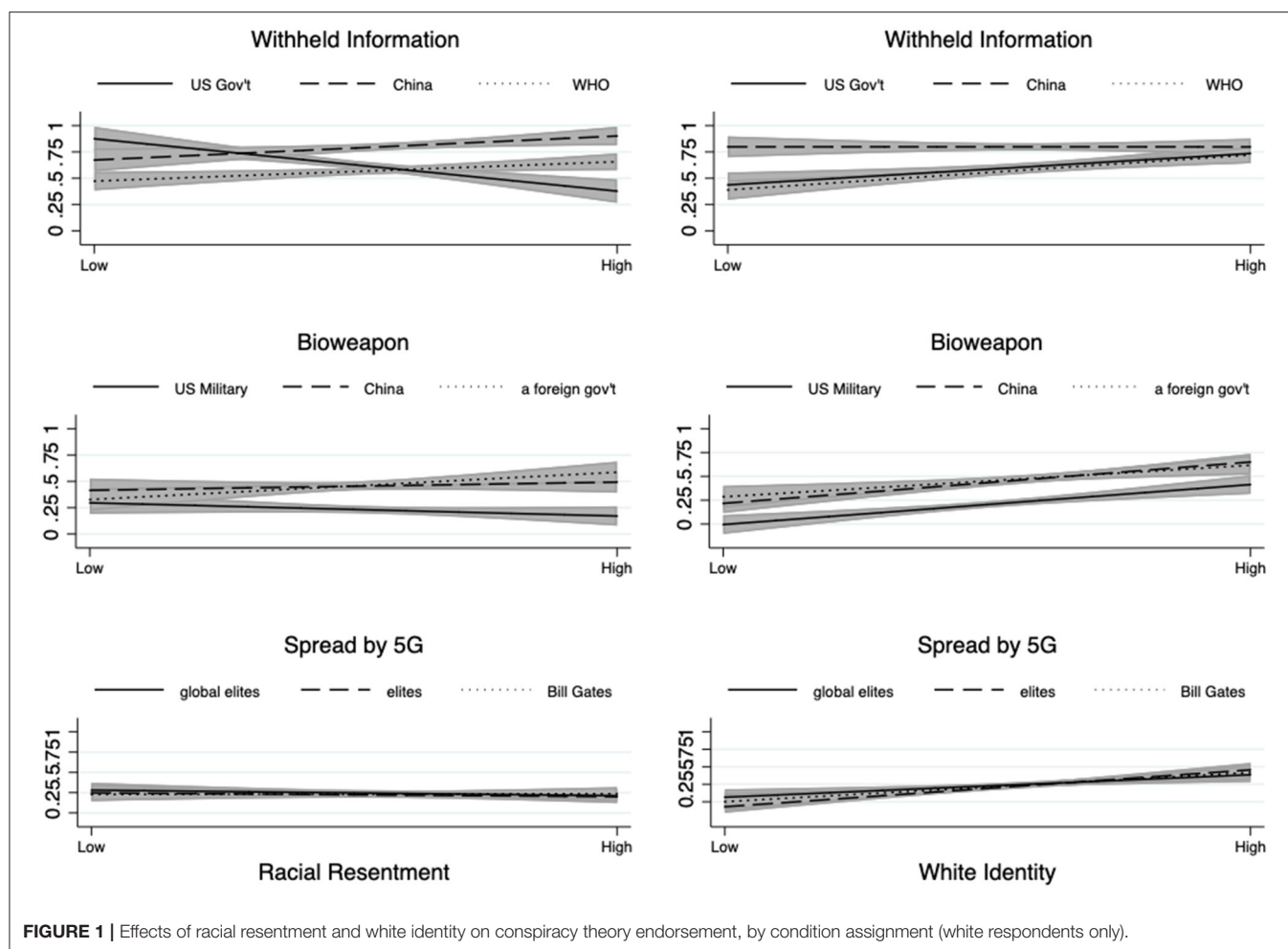
We see the clearest evidence in the first column looking at the protective behavior scale. We find that believing in all of the conspiracy theories (as opposed to none) leads an individual to engage in ~0.89 fewer social distancing activities on average. Similarly, those who do not believe the phrase "Chinese Virus" is racist engage in fewer social distancing activities than those who do believe this is racist. The racial resentment scale produces a similar negative pattern, with more racially resentful people engaging in significantly fewer social distancing activities ($b = -1.09$, $p < 0.05$).

Interestingly, the coefficient for white identity is positive ($b = 1.30$, $p < 0.05$). This accords well with our theory, which expects that identity-threatening events (such as a pandemic) are likely to be taken more seriously by those who are heavily invested in a social identity such as whiteness. Rather than serving as a proxy for racial attitudes, white identity acts as a distinct identity-protecting attitude, as Jardina (2019) notes.

Turning to our other measures of pro-social behaviors, we see a similar pattern for conspiracy endorsement, although the coefficients fail to reach conventional levels of statistical significance except for reducing the frequency with which respondents stayed at least six feet away from others. In all models, however, the coefficients are correctly (negatively) signed. Conspiratorial thinking only produces a slight reduction in the likelihood of eventual vaccination. Additionally, the measures of racial attitudes and white identity are significant and correctly signed in all three additional models. These results demonstrate clearly that COVID-19 protective behaviors can serve as

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[6]While the models include measures that covary, VIF tests for multicollinearity do not identify any values greater than 2, except among the partisanship dummy variables themselves.

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[7]Our **Supplementary Materials** also include analyses that break down the pattern of results by partisanship. While partisanship plays an important role, it is relatively minor in contrast to the effects for white identity and racial resentment for endorsement of the racialized conspiracy theories.

FIGURE 1 | Effects of racial resentment and white identity on conspiracy theory endorsement, by condition assignment (white respondents only).

an identity protecting action, are deeply racialized, and are linked to generalized endorsement of COVID-19 conspiracy theories[8].

In totality, these results present strong support for our hypotheses. To the extent that the COVID-19 pandemic is seen as a threat to an individual's identity, we see higher levels of conspiracy theory endorsement among those who highly value their whiteness as part of their identity. In contrast, racial resentment exerts an effect only when the conspiracy theory is racialized. If the conspiracy theory cues a racial out-group, racial resentment increases support for the theory. If the theory cues a racial in-group, racial resentment decreases support for the theory.

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[8] Interestingly, we find few effects for partisanship, once we introduce our measures of racial resentment and white identity. This suggests that, while much of the rhetoric surrounding the pandemic is polarized and partisan, the drivers of attitudes and behaviors appear more grounded in racial attitudes and white identity for white respondents, with only occasional instances of partisan identity playing a key role. This pattern repeats itself across our analyses.

DISCUSSION

Within this study, we sought to assess the ways in which in-group affinity (white identity) and out-group hostility (racial resentment) affected protective, pro-social health behaviors and conspiracy theory belief during the early racialized coronavirus pandemic. We expected that those high in white identity would endorse conspiracy theories writ large as a psychological defense against identity threat and that racialization would be conditional on the framing of the conspiracy theory. We also expected that racial resentment and white identity would exert countervailing effects on protective, pro-social health behaviors.

Our findings demonstrate how deeply intertwined race and identity are within American politics. Over and above alternative explanations for conspiracy theory belief such as conspiratorial thinking, we find that white identity is a strong predictor of COVID-19 conspiracy theory endorsement and compliance with protective health behaviors. This underscores the power of the coronavirus pandemic as an identity-threatening event, particularly for white individuals, who were more likely to benefit from the pre-pandemic societal status quo. For individuals who deeply value their whiteness as an identity, the coronavirus

TABLE 2 | Effect of conspiracy theory endorsement on COVID-19 preventative behaviors for white respondents only.

	Protective behavior scale	Wear facemask	Stay six feet apart	Likelihood of vaccination
Conspiratorial	−0.19	−0.02	0.04	−0.16*
Thinking	(0.32)	(0.06)	(0.04)	(0.06)
Conspiracy theory	−0.89*	−0.15*	−0.15*	−0.04
Index	(0.39)	(0.06)	(0.04)	(0.07)
"Chinese virus"	−0.46*	−0.11*	−0.05*	−0.13*
Is Racist	(0.19)	(0.04)	(0.02)	(0.04)
Racial	−1.09*	−0.17*	−0.07+	−0.24*
Resentment	(0.34)	(0.06)	(0.04)	(0.06)
White	1.30*	0.24*	0.17*	0.34*
Identity	(0.38)	(0.07)	(0.05)	(0.06)
Democrat	0.46	0.10+	0.05	0.07
	(0.29)	(0.05)	(0.04)	(0.05)
Republican	0.46	0.04	−0.00	0.05
	(0.29)	(0.05)	(0.04)	(0.05)
Ideology	−0.24	−0.05	0.00	−0.10+
	(0.29)	(0.05)	(0.04)	(0.05)
Sex (female)	0.19	0.03	0.03+	−0.06*
	(0.14)	(0.03)	(0.02)	(0.03)
Hispanic	0.40*	0.09*	−0.01	0.05
	(0.17)	(0.03)	(0.02)	(0.03)
Midwest	−0.41+	−0.18*	−0.08*	−0.03
	(0.21)	(0.03)	(0.03)	(0.04)
South	0.09	−0.13*	−0.03	0.00
	(0.17)	(0.03)	(0.02)	(0.03)
West	−0.00	−0.16*	−0.08*	−0.04
	(0.19)	(0.03)	(0.02)	(0.04)
Education	−0.10	−0.06	−0.01	0.03
	(0.38)	(0.06)	(0.05)	(0.07)
Income	1.37*	0.06	0.04	0.14*
	(0.26)	(0.04)	(0.03)	(0.04)
Age	−0.07	0.12*	0.22*	0.23*
	(0.35)	(0.06)	(0.05)	(0.06)
Political	0.20	−0.01	0.02	0.10*
Knowledge	(0.24)	(0.05)	(0.03)	(0.05)
Constant	5.87*	0.88*	0.76*	0.60*
	(0.45)	(0.08)	(0.06)	(0.08)
N	626	652	652	652
adj. R^2	0.160	0.155	0.155	0.193

Standard errors in parentheses +p < 0.10, *p < 0.05.

appears to have driven these individuals to comply with public health recommendations while at the same time embracing conspiracy theories about the pandemic to provide clarity to an uncertain, threatening context.

In contrast, racial animus functions very differently. Racially resentful individuals are much less likely to engage in protective behaviors. More interestingly, these racial attitudes can be activated and brought to bear on conspiracy theory endorsement, but only when the conspiracy theories are framed in a racialized manner. When the subject of the conspiracy theory is a foreign actor, racial resentment predicts higher levels of endorsement.

When the subject is coded white (the U.S. Government or Military), racial resentment exerts the opposite effect and decreases endorsement.

These results raise important questions about the spread of conspiracy theories and misinformation about COVID-19 and the consequences for public health. Interestingly, the story is not as consistent as some might believe, in particular with regard to white identity. While we find that COVID-19 conspiracy theory endorsement and conspiratorial thinking may correlate with reduced compliance with protective health behaviors, higher levels of white identity increase

compliance, potentially offsetting lower compliance that comes with conspiracy theory endorsement.

The findings around racial resentment, however, are more troubling. Not only does racial resentment have a direct effect on protective behavior (lowering the engagement with and the likelihood of compliance), but it also increases support for racialized conspiracy theories. Thus, it exerts both a direct and indirect effect on protective health behaviors, and in all cases, reduces compliance with public health recommendations.

While the effects of white identity were consistent across experimental conditions, we cannot rule out the possibility that the conditional effects for racial resentment are, in fact, a proxy for some other attitude (nationalism, ethnocentrism, collective narcissism, xenophobia). While we were unable to assess these constructs with our own data, nationalism, in particular, is a strong candidate for inclusion in future work examining conspiracy beliefs and COVID-19 conspiracy theories in particular. While we expect that other attitudinal constructs likely play a role, our results, particularly with regard to the 5G conspiracy theory, suggest that racial attitudes would likely still influence beliefs. Given that racial resentment is not cued by frames around "global elites", we suspect that nationalism's effects are likely to be additive, over and above the effects of racial attitudes. Nonetheless, we are left to speculate until future research examines this possibility.

In sum, we must continue to assess not only the nature of public health compliance but also endorsement of conspiracy theories around said public health emergency. Our results suggest that, at least in the American context, these two sets of beliefs are intimately tied together through the lens of race and whiteness. If we hope to understand how best to win the public opinion battle in pandemic responses, we would be wise to look not only at individual attitudes around race and identity, but also to the ways that misinformation and conspiracy theories are implicitly and explicitly racialized in the public discourse.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found on OSF. The DOI for these data is 10.17605/OSF.IO/HXDJA.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Boards at Carleton College and Beloit College. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpos.2022.648061/full#supplementary-material

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