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Individual differences in risk perception and misperception of COVID-19 in the context of political ideology

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Abstract

The COVID-19 pandemic has been characterized by misinformation, politicization of public health, and extreme differences in risk assessment. In two studies, we sought to understand factors that contribute to differences in people's understanding of the virus and associated risks. We found that conservative participants reported higher levels of acceptable risk, have lower risk estimates of activities, and endorsed more misinformation. Participants with personal health risk factors rated COVID-19 risks as higher, more reflective participants had lower acceptable risk levels, and impulsive participants endorsed more misinformation. In our second study, we also found that reflective participants were more likely to wear a mask, get vaccinated, and maintain social distancing, and that participants judged arguments about COVID-19 measures largely based on the claim rather than supporting reasons. By clarifying these individual differences, public health experts can more effectively create targeted interventions for at risk populations, and be better prepared for future outbreaks.

KEYWORDS
argumentation, individual differences, misinformation, pandemic, political ideology, risk assessment

1 | INTRODUCTION

One of the hallmarks of the COVID-19 pandemic has been the politicization of facts, with high levels of disagreement on the risks associated with COVID-19 between political parties and ideologies. This rejection of science along party lines is nothing new, as can be seen by the extensive research on how political ideology is associated with acceptance of climate change (Kahan et al., 2012). In part, the seeming dismissal of science during the COVID-19 pandemic is due to the conflicting information about the risks associated with the virus from different sources and widespread use of social media to further spread misinformation (Huynh, 2020a). For example, when cases started to rise and warnings were being issued by the Center for Disease Control and Prevention (CDC), President Trump downplayed the threat of the virus, saying it was under control and not as dangerous as the flu (Woodward, 2020).

In the wake of such extreme differences in risk assessment and spreading of misinformation between people, many researchers sought to characterize factors that can influence our understanding of the virus and its associated risk (Van Bavel, Baicker, et al., 2020). The importance of understanding these factors was further underlined by data collected from 10 countries, which found that COVID-19 risk perception correlated significantly with endorsement of preventative health behaviors (Dryhurst et al., 2020). Most studies aimed at understanding these individual differences factors have focused on political ideology, personality traits, and demographic information such as nationality or gender (Abdelrahman, 2020; Gerhold, 2020; Huynh, 2020b). Of note, a recent theoretical overview by Van Bavel, Baicker, et al. (2020) highlights much of the research on how social norms, inequality, political polarization, and other factors have influenced our response to the pandemic. However, there is a largely untapped body of literature on cognitive abilities that can influence risk assessment (e.g., Reyna, 2020; Reyna et al., 2009). Some researchers have found that cognitive sophistication, knowledge of the virus, current events, and medical training influenced preventative behaviors and a better understanding of the virus, and risk assessment (Motta Zanin et al., 2020; Pennycook

et al., 2020; Pennycook & Rand, 2020; Taghrir et al., 2020). However, others have disputed the importance of knowledge and cognitive ability on assessing risk and misinformation, showing that variables such as politics and religiosity play a larger role (Allum et al., 2008; Kahan et al., 2012; Lewandowsky & Oberauer, 2016).

Given the importance of understanding factors that can influence how people assess risk and misinformation, the lack of research on cognitive variables, and the mixed findings in literature, we endeavored to clarify the importance of key cognitive variables in how people understood the virus and its risks. Following Fuzzy-Trace Theory (Reyna, 2008) our conceptual model is that COVID-19 related behavioral intentions are informed by gist representations of risk (Reyna, 2012, 2021) and risk thresholds for specific actions. Individual differences in cognition and political affiliation are hypothesized to affect those representations. We selected subjective numeracy, cognitive reflectiveness, and impulsivity as our key cognitive variables. Each has been shown to influence our ability to assess medical risk or reject misinformation (Pennycook et al., 2015, 2020; Peters et al., 2006; Zimmermann, 2010). However, given the politicization of facts and the widespread misinformation coming from sources of authority, it is unclear how these variables would relate to COVID-19 specifically in the context of political ideology.

Numeracy (i.e., literacy for quantitative concepts) has been identified as contributing to individual differences health risk perception. Subjective numeracy (Fagerlin et al., 2007), which refers to an individual's perceptions of their own quantitative skills, appears to be an appropriate measure for risk perceptions about COVID-19 given its importance in medical judgment and decision making (Liberali et al., 2012; Peters et al., 2006). For example, participants with higher numeracy tend to be less influenced by presenting information in misleading ways and are generally better able to understand risk outcomes (Peters et al., 2006; Reyna et al., 2009). Numeracy clearly plays a role in health risk perception, yet numbers are surprisingly ambiguous, yielding the potential for large differences in interpreting the same risk-related data (Reyna, 2020).

Cognitive reflectiveness, as measured by the Cognitive Reflection Test (CRT; Toplak et al., 2014) refers to an individual's ability to avoid incorrect intuitive responses by being more thoughtful and reflective in their judgment and reasoning process. While related to cognitive ability and rational thinking styles, cognitive reflection scores seem to primarily indicate a level of cognitive miserliness, with higher scores reflecting a greater dedication of cognitive resources toward a task (Toplak et al., 2014). Higher CRT scores predict judgment and reasoning ability across a wide variety of tasks (Frederick, 2005; Hoppe & Kusterer, 2011), and lower endorsement of COVID-19 misperceptions (Pennycook et al., 2020), perhaps due to enhanced deliberation of the false statements (Van Bavel, Baicker, et al., 2020). Given the mathematical nature of the CRT, some have suggested that much of the power of the CRT in predicting decision making relies on numerical ability (Sinayev & Peters, 2015). However, other research indicates that cognitive reflectiveness contributes its own unique benefit to judgment and decision making tasks, above and beyond numeracy (Liberali et al., 2012). These findings suggest that in addition to

assessing numeracy, a measure cognitive reflectiveness may be beneficial for both assessing medical information and medical risk, though research on the importance of cognitive reflectiveness in medical judgment and reasoning is still in its infancy.

Another related individual difference under investigation is impulsivity. It is generally agreed upon that impulsivity is a construct that encompasses many executive functions including delayed discounting, reward evaluation, suppression of responses, and focusing of attention. More broad definitions of impulsivity tend to include behaviors that are unnecessarily risky, premature, or are poorly conceived (De Wit, 2009). Greater impulsivity has been specifically linked to higher risk-taking behavior as it concerns personal health, such as in the use of drugs and alcohol, unhealthy eating habits, or high-risk sexual activity (Braddock et al., 2011; Dawe & Loxton, 2004), and has recently been linked to lower perceptions of health-related risks for substance abuse (Zimmermann, 2010). As such, it presents a promising factor in an individual's ability to assess medical risk and misinformation during the COVID-19 pandemic.

Political ideology is hypothesized to influence risk assessment with respect to COVID-19 in three ways. First, beyond the scope of our investigation, ideology appears to determine sources of information about COVID-19 in the form of news, web sites, social media, etc. Second, political affection is hypothesized to affect participants' perceptions of the risks associated with the pandemic (Barrios & Hochberg, 2020; Calvillo et al., 2020). Finally, ideology is hypothesized to influence thresholds for acceptable risk. Thus, we predict that liberals will be more likely than conservatives to consider actions such as being in a crowded room risky and also have a lower threshold for acceptable risk.

2 | STUDY 1

We conducted two studies during the peak of the pandemic. To date, individual responses to the COVID-19 pandemic have mostly been investigated in the context of social constructs and personality traits. However, little is known about the importance of cognitive reflectiveness, subjective numeracy, and impulsivity in assessing COVID-19 risk or misinformation. In this study, we sought to expand upon previous findings on the importance of political ideology and cognitive reflectiveness in assessing misinformation and risks for COVID-19, and investigated the role subjective numeracy, impulsivity, and the presence of a risk factor for COVID-19 play in risk estimation, risk aversion, and their willingness to endorse common misperceptions related to COVID-19.

3 | METHOD

3.1 | Participants

A total of 422 undergraduate students participated in this study for class credit. Of these, 349 participants were from Miami University in

Ohio, and 73 were from Washington College in Maryland. Ages ranged between 18 and 23 years old, an age group least likely to be vaccinated against COVID-19 among adults (Baak et al., 2021). Out of the total participants, 74% identified as female, 24% identified as male, and less than 1% identified as non-binary or did not disclose their gender identity. Most participants were liberal or moderate with 18% identifying as strongly liberal, 26% as somewhat liberal, 28% as moderate, 19% as somewhat conservative, and 4% as strongly conservative. Strongly liberal and somewhat liberal were combined into one group for future analyses, as were strongly conservative and somewhat conservative. Approximately 19% claimed to have at least one health risk factor for developing more severe COVID-19 symptoms.

3.2 | Materials

3.2.1 | Risk factors

To more accurately assess individual risk for hospitalization, complications, and death due to COVID-19, each participant was asked to disclose if they had at least one risk factor for COVID-19. These risk factors were taken from the CDC's website, and consisted of the following diseases: asthma, chronic kidney disease, chronic lung disease, diabetes, hemoglobin disorders, immunocompromised, liver disease, serious heart conditions, severe obesity.

3.2.2 | Impulsivity

Participants competed the Barratt Impulsivity Scale (BIS) 11 (Barratt, 1994). This questionnaire consists of 30 self-report items ($\alpha = .82$) such as "I plan tasks very carefully" or "I am happy-go-lucky." Participants respond how much they agree to each item on a 1–4 Likert scale with higher values representing greater impulsivity. A meta-analysis by Vasconcelos et al. (2012) suggest high criterion validity and reliability. Of note, all reported Cronbach's alphas are for current samples.

3.2.3 | Cognitive reflectiveness

To assess cognitive reflectiveness, we used the 7-item ($\alpha = .69$) Cognitive Reflection Test (Frederick, 2005). Each question prompts an intuitive, but incorrect response that requires a more analytic and reflective process to reason through effectively. For example, in the question "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?" participants must ignore the intuitive answer of "10 cents" and instead select "5 cents." Total cognitive reflectiveness is assessed based on their accuracy for all seven questions. Performance on this test consistently predicts performance on similar tests such as bullshit receptivity and susceptibility to heuristics and biases, even in the face of repeated exposure, supporting its validity (Bialek & Pennycook, 2018).

TABLE 1 Mean (standard deviation) perceived risks associated with covid-19 by presence of risk factor(s) in Study 1

Perceived COVID-19 risk	Participants with risk factors	Participants without risk factors
General risk		
Infection	46.47 (27.65)	38.22 (24.95)*
Hospitalization	32.91 (29.52)	15.01 (17.02)***
Dying	19.47 (25.09)	6.50 (8.84)***
Serious long-term complications	28.29 (26.99)	17.13 (20.04)***
Spreading to friends or family members	55.63 (28.05)	51.26 (28.25)
Spreading to students, faculty, or staff	43.69 (30.22)	41.18 (30.22)
Killing someone else through spreading	27.66 (27.10)	22.36 (23.45)
Activity-related risk of infection		
Grocery shopping	34.75 (21.94)	26.84 (18.05)**
Getting a haircut	29.17 (21.05)	23.72 (18.53)*
Hanging out with fewer than 10 people	30.47 (20.10)	24.39 (17.82)**
Hanging out with more than 10 people	52.12 (23.86)	49.23 (25.15)
Going to the gym	42.50 (26.90)	36.54 (23.85)
Travel in the United States	48.83 (26.93)	45.35 (25.13)
International travel	54.57 (25.82)	49.37 (27.12)
Going to a restaurant	35.26 (22.52)	29.93 (20.12)*
Going to the Beach	33.97 (27.48)	27.32 (22.90)*

Note: *$p < .05$, **$p < .01$, ***$p < .001$.

3.2.4 | Subjective numeracy

We used the Subjective Numeracy Scale (SNS) as our measure of subjective numeracy (Fagerlin et al., 2007). This scale consists of eight self-report items ($\alpha = .82$) in which participants rate their preference for numerical information and their ability to use numbers on a 1–6 Likert scale. This scale is both reliable and valid, as evidence by a Cronbach's alpha consistently over .8, and positive correlations with other measures of numeracy such as the WRAT4 and S-TOFHLA (McNaughton et al., 2015; Zikmund-Fisher et al., 2007).

3.2.5 | Risk estimates

Participants estimated seven risks general associated with COVID-19 ($\alpha = .79$). Questions in this list included "What is your risk of being infected with COVID-19" or "What is your risk of dying from COVID-19" (see Table 1 for a complete list). For each question, participants rated their risk by moving a sliding scale between 0 and 100.

Participants also estimated activity-specific risk of infection for nine questions ($\alpha = .91$). These activities included grocery shopping, getting a haircut, going to a friend's house with fewer than 10 people,

Type	Question	Study 1	Study 2
Optimistic	The seasonal flu is just as dangerous as the coronavirus.	32.38	37.40
	You can only spread the coronavirus if you feel sick.	2.14	5.71
	The coronavirus does not survive on plastic or steel for longer than a few minutes.	22.62	24.42
	Coronavirus symptoms are short lived.	17.62	13.77
	Warm weather effectively stops the coronavirus from spreading.	8.33	14.03
	You can tell almost immediately (within a day) if you have contracted the coronavirus.	2.62	6.75
	The virus is relatively large, so any type of mask can filter it out.	7.86	11.17
	The coronavirus only stays alive on your hand for about 5–10 minutes.	16.67	15.32
	The coronavirus is not airborne.	14.29	10.13
	Mean	13.34	15.41
Pessimistic	Dogs and cats can contract and spread the coronavirus.	46.43	33.51
	The vast majority of people who contract the coronavirus will need to be hospitalized.	7.62	12.73
	The coronavirus will kill most people who contract it.	3.81	6.49
	Most people are very likely to contact the coronavirus simply from leaving their house and going for a walk.	7.86	10.91
	Mean	16.43	15.91
Magical	Vitamin C can cure the coronavirus.	3.81	5.71
	Holding your breath for 10 s without discomfort is an effective way to test if you have coronavirus.	12.14	9.61
	Eating garlic cures the coronavirus.	1.19	2.86
	If one gargles with warm water and salt or vinegar it eliminates the coronavirus.	0.71	5.19
	Mean	4.46	5.84
Conspiratorial	The coronavirus was created in a lab.	29.05	23.64
	Coronavirus was created to be a bio-weapon.	15.00	14.03
	A cure for the coronavirus has already been discovered but is being suppressed by people who want the pandemic to continue.	14.52	10.13
	The coronavirus is probably a hoax	6.19	4.16
	Mean	16.19	12.99

going to a friend's house with more than 10 people, going to the gym, traveling in the United States, traveling internationally, going to a restaurant, and going to the beach. Participants then rated their maximum acceptable risk of infection for engaging in each of these same activities on a scale of 0–100, with the understanding that a risk of 1% higher would be unacceptable ($\alpha = .93$).

3.2.6 | Misperceptions

To assess participants' misperceptions of COVID-19, they completed a 21-item true or false questionnaire ($\alpha = .72$) developed by Pennycook et al. (2020). Each item is a common misperception about

COVID-19, such as "The seasonal flu is just as dangerous as the coronavirus" or "You can only spread the coronavirus if you feel sick" (see Table 2 for a full list of misperceptions). Final scores on misperception represent the percentage of items participants deemed true.

3.3 | Procedure

Participants completed this experiment remotely through Qualtrics. After granting informed consent, participants answered demographic questions on their age, gender identity, and political ideology, and reported if they had a risk factor for COVID-19. They then estimated general risks associated with COVID-19, such as their general risk of

infection, as well as activity-specific risks such as the risk of infection while eating at a restaurant. Next, they reported their maximum acceptable risks for these same activities on a scale of 0–100. They then completed the three individual differences measures of SNS, CRT, and BIS-11 in a randomized order. In total, this experiment took approximately 15 min to complete. Upon completion, participants were given course credit and debriefed. Data for Study 1 were collected over the course of the fall semester (August to October) in 2020.

4 | RESULTS AND DISCUSSION

4.1 | Perceived risk

To assess the impact having a risk factor had on perceived risk, we compared risk estimates measured on a 0–100 scale between participants who had a COVID-19 risk factor and participants who did not for the seven types of general risk using independent samples t-tests (see Table 1). High risk participants had higher risk estimates for being infected with COVID-19, $t(414) = 2.59$, $p = .010$, $d = 0.32$, being hospitalized, $t(90.89) = 5.19$, $p < .001$, $d = 0.89$, dying from COVID-19, $t(79.53) = 4.44$, $p < .001$, $d = 0.96$, and developing serious complications, $t(97.42) = 3.41$, $p < .001$, $d = 0.52$. This suggests that people with specific risk factors for COVID-19 are appropriately taking those factors into account when estimating their own general risk. Having a risk factor did not significantly impact participants ratings of spreading the disease to friends or family members, $t(118.21) = 1.25$, $p = .216$, $d = 0.16$, spreading to other students, professors, or staff members, $t(393) = 0.65$, $p = .514$, $d = 0.08$, or killing someone by spreading the virus, $t(104.57) = 1.58$, $p = .116$, $d = 0.22$. Apparently, participants did not consider their own risk factors to have any bearing on the likelihood that they would spread COVID-19.

We also compared high risk participants with other participants on their perceived risk of being infected with COVID-19 while engaging in various activities using independent samples t-tests (see Table 1). High risk participants rated their risk of infection as significantly higher for going grocery shopping, $t(104.27) = 2.98$, $p = .004$, $d = 0.42$, getting a haircut, $t(405) = 2.27$, $p = .024$, $d = 0.29$, hanging out with fewer than 10 people, $t(410) = 2.63$, $p = .009$, $d = 0.33$, going to a restaurant, $t(408) = 2.05$, $p = .041$, $d = 0.26$, and going to the beach $t(403) = 2.21$, $p = .028$, $d = 0.28$, compared to participants without a risk factor.

Looking at our three individual differences measures, we found that cognitive reflectiveness and impulsivity were independent of each other $r(420) = −.07$, $p = .148$. However, subjective numeracy was negative correlated with impulsivity, $r(420) = −.27$, $p < .001$, and positive correlated with CRT scores, $r(420) = .35$, $p < .001$, indicating that more numerate participants are less impulsive and more reflective. To assess the impact these three measures had on risk perception, we averaged participants' responses to items in the top half of Table 1 into general perceived risk and items in the bottom half into activity-related perceived risk, resulting in each participant having two scores reflecting COVID-19 risk perception. We simultaneously regressed our three individual differences measures onto general
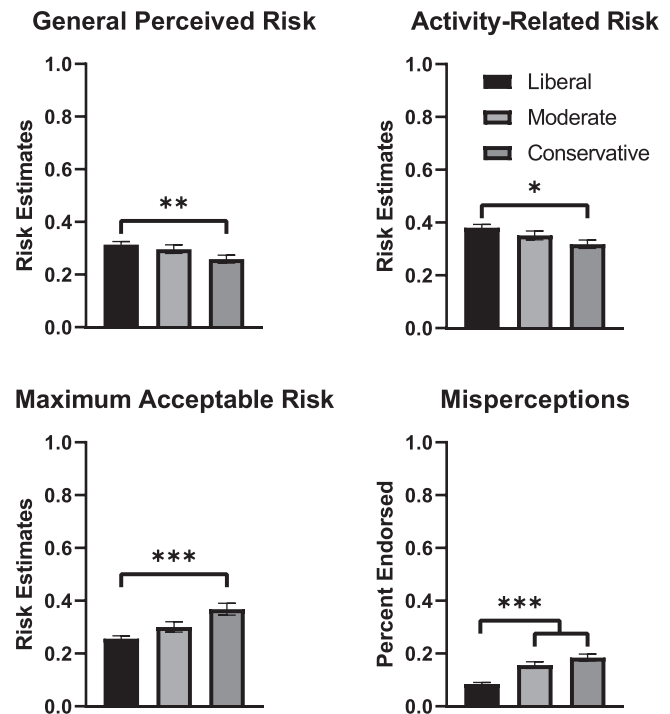

FIGURE 1 Differences in risk perception and endorsement of misperception by political ideology in Study 1. *$p < .05$, **$p < .01$, ***$p < .001$

perceived risk, $F(3, 421) = 1.06$, $p = .364$, $R^2 = .01$, which revealed that impulsivity, $\beta = −0.03$, $t = −0.65$, $p = .518$, cognitive reflectiveness, $\beta = −0.08$, $t = −1.45$, $p = .148$, and subjective numeracy, $\beta = −0.02$, $t = −0.40$, $p = .693$, did not significantly predict participants estimates of general perceived risk surrounding COVID-19. Our model for activity-related risk was similarly not significant, $F(3, 421) = .25$, $p = .862$, $R^2 = .002$. Impulsivity, $\beta = −0.02$, $t = −0.31$, $p = .758$, cognitive reflectiveness, $\beta = 0.03$, $t = 0.07$, $p = .948$, and subjective numeracy, $\beta = −0.05$, $t = −0.83$, $p = .408$, did not predict activity-related perceived risk. Thus, we did not find evidence that our three individual differences affect risk perception.

As can be seen in Figure 1, we also assessed the role political ideology had on participants' perceived risks. Using a one-way ANOVA, we found that both general perceived risk, $F(2, 416) = 4.57$, $p = .011$, $\eta^2 = .02$, and activity-related perceived risk, $F(2, 416) = 3.70$, $p = .026$, $\eta^2 = .02$, differed by political ideology. As predicted, Bonferroni corrected pairwise comparisons revealed that conservative participants rated general risks ($p = .009$). and activity-related risks ($p = .021$) as significantly lower than liberal participants. This suggests that ideology is a factor when estimating how dangerous activities such as going to a restaurant are with respect to getting COVID-19.

4.2 | Maximum acceptable risk

We next investigated participants' maximum acceptable risk, or the risk of infection that participants find acceptable to continue engaging in specific activities. As before, we averaged participants' responses to

the nine activities into a single score of maximum acceptable risk. Maximum acceptable risk was positively correlated with both general perceived risk, $r(420) = .21$, $p < .001$, and activity-related perceived risk, $r(420) = .23$, $p < .001$. Interestingly, high risk participants did not differ from other participants on their estimates of maximum acceptable risk, $t(415) = -.44$, $p = .659$, $d = -0.06$. This suggests that knowing they are more susceptible to complications with COVID-19 does not necessarily relate to being more risk-averse. When we regressed numeracy, impulsivity, and cognitive reflectiveness onto maximum acceptable risk we found that our model was significant, $F(3, 421) = 2.88$, $p = .036$, $R^2 = .02$. Subjective numeracy, $\beta = -0.22$, $t = -0.20$, $p = .845$, and impulsivity, $\beta = 3.20$, $t = 1.09$, $p = .278$, did not significantly predict maximum acceptable risk. However, cognitive reflectiveness was a significant negative predictor, $\beta = -1.17$, $t = -2.37$, $p = .018$, suggesting that more reflective participants are less willing to accept higher risks. Mirroring our findings with perceived risk, acceptable risk also differed by political ideology, $F(2, 416) = 11.85$, $p < .001$, $\eta^2 = .05$. Bonferroni pairwise comparisons revealed that conservative participants accepted significantly higher risks than liberal participants ($p < .001$).

4.3 | Misperceptions

Participants' endorsement of misperception was not correlated with their assessment of general risk, $r(420) = .01$, $p = .880$, or activity-related risk, $r(420) = -.03$, $p = .547$. However, there was a significant correlation between endorsement of misperception and maximum acceptable risk, $r(420) = .25$, $p < .001$. suggesting that participants who were more willing to endorse misinformation had higher levels of acceptable risk. After regressing misperception endorsement onto impulsivity, cognitive reflectiveness, and subjective numeracy, we found that our model was significant, $F(3, 421) = 8.59$, $p < .001$, $R^2 = .24$, and more specifically that cognitive reflectiveness negatively predicted endorsement, $\beta = -0.17$, $t = -3.41$, $p = .001$, and impulsivity positively predicted endorsement, $\beta = 0.13$, $t = 2.62$, $p = .009$. Subjective numeracy was not a significant predictor, $\beta = -0.04$, $t = -0.72$, $p = .474$. This suggests that participants who were more impulsive and less reflective were more likely to endorse factually incorrect statements surrounding COVID-19. Endorsement of misperceptions also differed significantly between political ideology, $F(2, 416) = 29.66$, $p < .001$, $\eta^2 = .13$. Bonferroni pairwise comparisons showed that liberal participants endorsed significantly fewer misperceptions than both moderate ($p < .001$), and conservative participants ($p < .001$).

5 | STUDY 2

Given the promising results of Study 1, the focus of Study 2 was to find the best predictors of healthy behavioral intentions, such as wearing a mask and getting vaccinated, and to test the relative persuasiveness of different arguments about COVID-19. Argumentation has been found to be effective in promoting healthy decisions and behaviors under some circumstances (e.g., Cedillos-Whynott et al., 2016) and are also sensitive to individual differences (Wolfe, 2012). An argument is, at minimum a claim supported by one or more reasons (Wolfe et al., 2009). Previous research suggests that when people agree with an argument, they are mostly agreeing with the claim, whereas when someone says that an argument is strong or weak, they are primarily weighing the supporting reasons (Wolfe et al., 2009). This suggests, contrary to notions of rational persuasion, that persuasion through written arguments is challenging because it is possible to admit that reasons supporting opposing beliefs are strong without changing one's level of agreement. This is especially challenging in partisan and ideological contexts where claims and reasons may be processed through differently weighted argumentation schema (Wolfe et al., 2009) and subject to different biases (Wolfe & Britt, 2008). Thus, argumentation has the potential to be a valuable tool in promoting health behaviors related to vaccination, but there are numerous challenges identified in the literature.

6 | METHOD

6.1 | Participants

A total of 365 undergraduate students participated for class credit, with 317 from Miami University in Ohio, and 48 from Washington College in Maryland. Ages ranged between 18 and 31 years old, with an average age of 19.53. Of these, 68% identified as female, 29% as male, and less than 1% identified as non-binary or did not disclose their gender identity. For political ideology, 43% identified as liberal, 33% as moderate, and 23% as conservative. Mirroring Study 1, 22% claimed to have at least one risk factor for developing more severe COVID-19 symptoms.

6.2 | Materials

6.2.1 | Arguments

Participants rated 32 single-sentence arguments on the strength of the argument and how strongly they agreed with the argument on a 1–7 Likert scale. Arguments dealt with eight issues related to the COVID-19 pandemic, with each issue represented in a set of four arguments, with argument blocks separated by other tasks. Each set contained two pro and two con claims, and two liberal and two conservative reasons (verified by pilot testing), as can be seen in the set below with Arguments 1 and 3 representing conservative reasons, and Arguments 2 and 4 representing liberal reasons.

> **Argument 1.** It is good that the Federal Government is making vaccines against COVID-19 available to Americans free of charge because that was the goal of President Trump's Operation Warp Speed.

Argument 2. It is good that the Federal Government is making vaccines against COVID-19 available to Americans free of charge because protecting the health of Americans is a basic function of government.

Argument 3. It is not good that the Federal Government is making vaccines against COVID-19 available to Americans free of charge because it represents creeping socialism.

Argument 4. It is not good that the Federal Government is making vaccines against COVID-19 available to Americans free of charge because it is really a giveaway to "big pharma" and multinational corporations.

One item from each set was presented in a block of eight arguments, for a total of four blocks, which were randomly presented between the individual differences measures.

6.2.2 | Behavioral intentions

We assessed participants' intentions to wear a mask, maintain social distancing, and get vaccinated by having them rate the likelihood of engaging in these three behaviors on a 1–5 (extremely unlikely-extremely likely) Likert scale.

6.3 | Procedure

Participants completed this experiment through Qualtrics. After granting informed consent, they provided information on their age, gender identity, political ideology, and reported if they had a risk factor for COVID-19. Participants then completed the first of eight blocks of arguments, where eight arguments focused on the pandemic were randomly presented, followed by three questions assessing their intention to wear masks, socially distance themselves, and get vaccinated. Next, participants complete the SNS, followed by the second block of arguments. They then completed the CRT, followed by the third block of arguments, then the Barratt Impulsivity Scale, finally followed by the fourth block of arguments. After completing the arguments and individual differences portion, participants completed the same measures of risk assessment and misperception as Study 1. In total, this experiment took approximately 30 min to complete. Upon completion, participants were given course credit and debriefed. Data for Study 2 were collected over the course of the spring semester (March to April) in 2021.

7 | RESULTS AND DISCUSSION

7.1 | Perceived risk

As seen in Study 1, high risk participants had higher risk estimates for being hospitalized with COVID-19, $t(87.00) = 3.82$, $p < .001$, $d = 0.63$, dying from COVID-19, $t(86.65) = 2.76$, $p = .001$, $d = 0.45$, and developing serious complications, $t(88.36) = 3.00$, $p = .003$, $d = 0.48$, as can be seen in Table 3. High risk participants were not significantly different in their risk estimates for being infected with COVID-19, $t(115.94) = -0.52$, $p = .603$, $d = -0.07$, spreading the disease to friends or family members, $t(349) = -0.31$, $p = .759$, $d = -0.04$, spreading to other students, professors, or staff members, $t(345) = -1.19$, $p = .236$, $d = -0.16$, or killing someone by spreading the virus, $t(342) = .69$, $p = .491$, $d = 0.09$. Unlike Study 1, having a risk factor did not impact participants' estimates for being infected with COVID-19 while engaged in specific activities such as going shopping or getting a haircut, $t(354) = -1.09$, $p = .272$, $d = -0.15$, perhaps due to this study taking place later in the pandemic when more people had a better understanding of the risks of infection.

Looking at the same cognitive individual differences measures as in Study 1, cognitive reflectiveness and impulsivity were independent of each other once again, $r(365) = -.03$, $p = .584$. Subjective numeracy was negative correlated with impulsivity, $r(365) = -.19$, $p < .001$, and positive correlated with CRT scores, $r(365) = .33$, $p < .001$. We simultaneously regressed our three individual differences measures onto general perceived risk, and found that our model was significant, $F(4,362) = 3.21$, $p = .023$, $R^2 = .03$. As before, impulsivity, $\beta = 0.08$, $t = 1.54$, $p = .125$ and subjective numeracy, $\beta = 1.31$, $t = 0.82$, $p = .414$, did not significantly predict participants estimates of general perceived risk surrounding COVID-19. However, CRT scores were a significant negative predictor of general perceived risk estimates, $\beta = -0.15$, $t = -2.72$, $p = .007$, suggesting that more reflective participants tended to have lower risk estimates. Looking at activity related risk, our model was also significant, $F(4,364) = 3.98$, $p = .008$, $R^2 = .03$. CRT scores, $\beta = -0.15$, $t = 2.75$, $p = .006$ but not impulsivity, $\beta = .09$, $t = 1.73$, $p = .084$, or subjective numeracy, $\beta = .001$, $t = 0.03$, $p = .980$, predicted lower activity-related risk perception. Together, these results suggest that cognitive reflectiveness may reflect a more appropriate perception of risk as the populace's understanding of the virus improved over time.

Using a one-way ANOVA, we also assessed the role political ideology had on participants' perceived risks, and found that activity-related perceived risk, $F(2, 360) = 8.79$, $p < .001$, $\eta^2 = .05$, but not general perceived risk, $F(2, 360) = 1.76$, $p = .173$, $\eta^2 = .01$, differed by political ideology (see Figure 2). Bonferroni corrected pairwise comparisons revealed that conservative participants rated risks as significantly lower than liberal ($p < .001$) and moderate ($p = .001$) participants, replicating our early finding.

7.2 | Maximum acceptable risk

Once again, high risk participants did not differ from other participants on their estimates of maximum acceptable risk, $t(354) = -1.21$, $p = .229$, $d = -0.16$. Regressing numeracy, impulsivity, and cognitive reflectiveness onto maximum acceptable risk revealed that our model was not significant, $F(4, 364) = 2.48$, $p = .061$, $R^2 = .02$. More specifically, we found that subjective numeracy, $\beta = -0.07$, $t = 1.16$, $p = .245$, and impulsivity, $\beta = 0.09$, $t = 1.76$, $p = .079$, did not

TABLE 3 Mean (standard deviation) perceived risks associated with Covid-19 by presence of risk factor(s) in Study 2

Perceived COVID-19 risk	Participants with risk factors	Participants without risk factors
General risk		
Infection	36.09 (23.71)	37.78 (26.57)
Hospitalization	27.4 (27.88)	13.88 (19.48)***
Dying	12.77 (16.29)	6.94 (12.10)***
Serious long-term complications	27.01 (25.68)	17.09 (19.20)**
Spreading to friends or family members	46.99 (29.45)	48.21 (29.68)
Spreading to students, faculty, or staff	40.07 (29.16)	44.93 (30.96)
Killing someone else through spreading	27.84 (27.89)	25.33 (26.89)
Activity-related risk of infection		
Grocery shopping	25.67 (22.11)	26.26 (22.25)
Getting a haircut	22.93 (22.00)	24.57 (21.70)
Hanging out with fewer than 10 people	24.34 (20.11)	27.64 (20.75)
Hanging out with more than 10 people	44.44 (26.09)	49.57 (24.35)
Going to the gym	34.43 (23.25)	36.20 (24.77)
Travel in the United States	40.61 (26.85)	45.10 (25.38)
International travel	47.53 (28.17)	49.97 (26.41)
Going to a restaurant	28.29 (21.66)	31.55 (22.64)
Going to the beach	26.80 (22.98)	29.33 (24.41)

Note: *p < .05, **p < .01, ***p < .001.

FIGURE 2 Differences in risk perception and endorsement of misperception by political ideology in Study 2. *p < .05, **p < .01, ***p < .001

significantly predict maximum acceptable risk, but cognitive reflectiveness did, $\beta = -2.14$, $t = -2.14$, $p = .033$, further supporting that more reflective participants are less willing to accept higher risks. We also replicated our previous findings on the role of political ideology on acceptable risk, $F(2, 362) = 7.77$, $p < .001$, $\eta^2 = .04$, with liberal participants reporting significantly lower levels of acceptable risk than conservative ($p = .001$) or moderate ($p = .012$) participants.

7.3 | Misperceptions

Mean endorsement of each misperception in Study 2 can be found in Table 2. As before, participants' endorsement of misperception was not correlated with their assessment of activity-related risk, $r(363) = .01$, $p = .839$, and was negatively correlated with maximum acceptable risk, $r(363) = -.13$, $p = .012$. In this study, there was also a significant negative correlation between misperception endorsement and general perceived risk, $r(363) = -.11$, $p = .032$, supporting the notion that participants who endorsed more misperception viewed general COVID-19 risks as lower. After regressing misperception endorsement onto impulsivity, cognitive reflectiveness, and subjective numeracy, our model was significant, $F(3,364) = 2.71$, $p = .045$, R^2
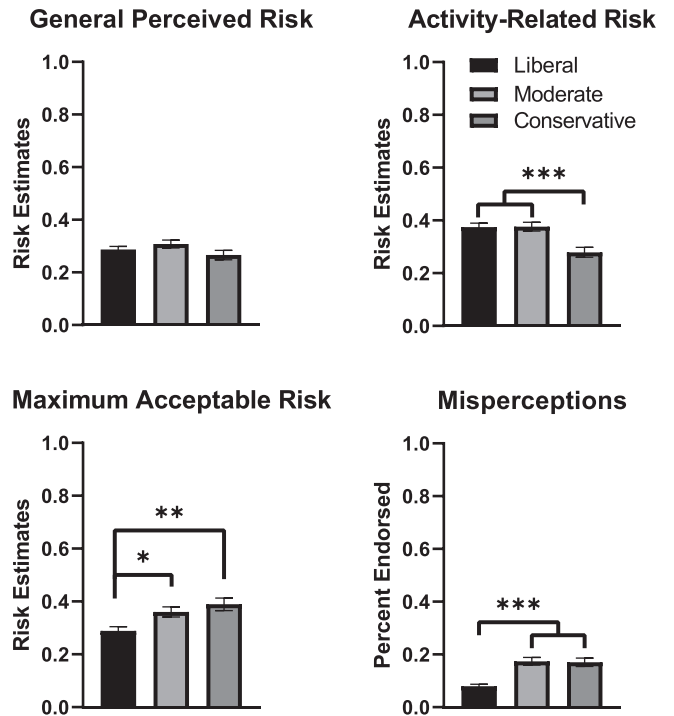
$= .02$. We once again found that impulsivity was a significant negative predictor, $\beta = -0.11$, $t = -2.05$, $p = .041$, and subjective numeracy was not significant, $\beta = 0.03$, $t = 0.51$, $p = .608$. However, unlike study 1, cognitive reflectiveness was also not a significant predictor, $\beta = 0.08$, $t = 1.41$, $p = .159$. As before, endorsement of misperceptions differed significantly between political ideology, $F(2, 362) = 21.70$, $p < .001$, $\eta^2 = .11$. Mirroring previous findings, Bonferroni pairwise comparisons showed that liberal participants endorsed significantly fewer misperceptions than both moderate ($p < .001$), and conservative participants ($p < .001$).

7.4 | COVID-19 arguments

We compared the relative importance of the arguments' claims (e.g., everyone should be required by law to wear masks in public to stop the spread of COVID-19) and reasons (e.g., because socially aware public health experts say that it helps prevent the spread of disease) on participants' agreement with the argument using a paired-samples t-test. These comparisons do not depend on the absolute level of agreement or quality ratings, but rather the absolute value of *differences* in weighting. As predicted, and consistent with earlier research, claims ($M = 5.19$, $SD = 1.58$) had a significantly higher impact on agreement than reasons ($M = 2.15$, $SD = 0.82$), $t(364) = 24.89$, $p < .001$, $d = 2.42$. We similarly compared the impact claims and reasons had on participants' assessment of the strength of arguments. Contrary to expectations, claims ($M = 3.29$, $SD = 1.44$)

had a significantly greater impact than reasons ($M = 2.91$, $SD = 1.32$), $t(364) = -4.72$, $p < .001$, $d = 0.28$. Breaking our results down by political ideology, we found that while conservative participants followed the above pattern of weighting claims more heavily than reasons for both agreement, $t(82) = 10.42$, $p < .001$, $d = 1.14$, and strength of an argument, $t(82) = -4.32$, $p < .001$, $d = 1.10$, liberal participants only weighed claims as more important when rating how strongly they agreed with the argument, $t(157) = 19.87$, $p < .001$, $d = 2.37$, but not for rating the strength of the argument, $t(157) = -1.11$, $p = .269$, $d = 1.72$. These findings indicate that all participants primarily rate their agreement with the arguments claim, but when assessing the strength of the argument, liberal participants tend to evenly weigh the claim and reason behind the claim whereas conservative participants related argument strength to claims without giving significant weight to supporting reasons.

7.5 | Behavioral intentions

Simultaneously regressing the three behavioral intentions onto our three individual differences revealed that our models for vaccination, $F(3, 362) = 3.51$, $p = .015$, $R^2 = .03$, and social distancing, $F(3, 364) = 3.75$, $p = .011$, $R^2 = .03$, were significant, but our model for wearing a mask was not, $F(3, 364) = 2.45$, $p = .064$, $R^2 = .02$. Cognitive reflectiveness significantly predicted greater likelihood for getting vaccinated, $\beta = 0.15$, $t = -2.73$, $p = .007$, wearing a mask, $\beta = 0.14$, $t = 2.52$, $p = .012$, and maintaining social distancing, $\beta = 0.18$, $t = 3.28$, $p = .001$. Impulsivity was not a significant predictor for getting vaccinated, $\beta = -0.06$, $t = -1.19$, $p = .234$, wearing a mask, $\beta = 0.002$, $t = 0.04$, $p = .965$, and maintaining social distancing, $\beta = -0.04$, $t = 0.82$, $p = .415$. Similarly, subjective numeracy did not predict getting vaccinated, $\beta = -.01$, $t = 0.18$, $p = .858$, wearing a mask, $\beta = -0.10$, $t = 1.73$, $p = .085$, and maintaining social distancing, $\beta = -0.06$, $t = -1.03$, $p = .304$. As can be seen in Figure 3, political ideology played a significant role in participants' intention to get vaccinated, $F(2, 360) = 32.72$, $p < .001$, $\eta^2 = .16$, to wear a mask, $F(2, 362) = 53.93$, $p < .001$, $\eta^2 = .23$, and to maintain social distancing, $F(2, 362) = 54.18$, $p < .001$, $\eta^2 = .23$. Bonferroni-corrected pairwise comparisons revealed that in all cases, liberal participants had the highest ratings, followed by moderate participants, and conservative participants, respectively. All pairwise comparisons were significant with an alpha of .05.

8 | GENERAL DISCUSSION

In this work, we aimed to better understand what leads people to engage in risky behaviors, inaccurately assess risk, and believe in common misperceptions surrounding COVID-19. We found that across both studies participants with at least one risk factor had higher risk estimates for hospitalization, complications, and death from COVID-19. Conservative participants rated COVID-19 risks as lower, were more willing to accept activity-related risk, and were more likely
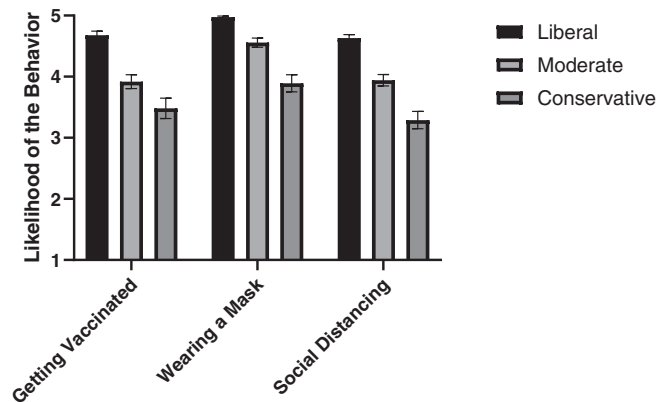

Behavioral Intentions by Political Ideology

FIGURE 3 The likelihood of participants to engage in healthy preventative behaviors reported on a 1–5 (extremely unlikely-extremely likely) Likert scale. All comparisons between groups are significant at an alpha level of .05

to believe misperceptions. In Study 2, conservative participants were less likely to wear a mask, socially distance, or get vaccinated. Impulsive participants tended to believe more misperceptions, whereas reflective individuals were more risk-averse and more likely to engage in preventative health behaviors. We also found that regardless of political ideology, and consistent with previous research (Wolfe et al., 2009), when agreeing with arguments, participants place more weight on an argument's claim than the reason behind that claim. However, our findings with respect to argument strength and supporting reasons differed from prior research. Overall, these findings present how multiple individual differences, including cognitive, political, and personal factors, can impact a person's response to the COVID-19 pandemic.

Across both studies, we found that having a COVID-19 risk factor is consistently associated with increased risk assessment of complications, hospitalization, and death, supporting the importance of personalizing and contextualizing facts and statistics on the virus. Indeed, research suggests that people give considerable weight to their own experiences over and above aggregate statistical information in assessing and making decisions about medical risk (Holmberg et al., 2015). The events themselves were secondary to the way people experienced those events and were given more weight than statistical information. Thus, the stories people tell themselves about their own risk factors are likely to strongly contribute to their own gist representations (Reyna, 2008) and play a significant role in risk perception.

Given the extreme politicization of COVID-19 in the United States, political attitudes seem to have a strong influence on perceptions of risk toward the pandemic. In general, political ideology can influence several cognitive processes related to risk perception including belief bias in causal reasoning (Gugerty & Shreeves, 2020). However, increasing political polarization in the United States has led to contrasting views and interpretations of events beyond what we might normally expect. In this study, we replicated previous findings on the influence political ideology

can have on participants' perception of risk for the pandemic, showing a clear negative relationship between risk perception and conservatism (Barrios & Hochberg, 2020; Calvillo et al., 2020). However, rather than assessing general worry or emotional responses, as most studies have done, we found that conservatives' actual risk estimations were lower while their estimates for acceptable maximum risk were higher. Taken in conjunction with other research, our results provide a more holistic understanding of how politics can influence risk perception and the acceptability of said risk.

Similarly, compared to liberal participants, both moderate and conservative participants believed more misinformation about the pandemic. Research has shown that people become susceptible to misinformation when the world does not make sense to them (Reyna, 2020). The pandemic has been the subject of several conspiracy theories directed at conservatives, often from popular news networks or the former president himself. Importantly, it is not necessary for people to "believe" conspiracy theories for them to influence risk assessment. Research on argumentation suggests that people are more likely to agree with claims supported by blatantly bogus reasons and warrants than unsupported claims (Wolfe et al., 2018). This effect holds true even when contradicting domain specific knowledge for relatively knowledgeable individuals (Wolfe et al., 2018). Because conspiracy theories provide reasons, they can serve to satisfy the cognitive constraints imposed by schema, they may influence risk perception without being judged true or credible. Research suggests that if a claim is neutral (or one a person is likely to support), even utterly ridiculous reasons increase agreement; most any reason is better than none (Wolfe et al., 2018).

One of the key findings of the present work was the role cognitive reflection played in assessing risk and misinformation. Our work replicated previous findings on the importance of cognitive reflection on not being swayed by misinformation (Pennycook et al., 2020; Pennycook & Rand, 2019). We also found that higher cognitive reflection predicted lower levels of maximum acceptable risk. The standard interpretation of these results is that participants who are more reflective and analytical are better able to navigate the current deluge of misinformation surrounding the pandemic and are more risk averse. However, performance on the CRT may have alternative explanations. For example, several studies, including ours, have found a significant relationship between cognitive reflectiveness and numeracy scores (Patel et al., 2019; Sinayev & Peters, 2015). This link between cognitive reflectiveness and numeracy is further supported by the fact that the items in the CRT all require some mathematical ability and knowledge. However, other work suggests that measures of numeracy and cognitive reflection are tapping overlapping but inherently different processes important for judgment and reasoning, (Liberali et al., 2012), a finding which can be partially supported by participants' similar performance on non-mathematical CRT versions (Campitelli & Labollita, 2010). Our findings support the latter conclusion, as numeracy and cognitive reflectiveness predicted different responses to COVID-19 risk and misinformation assessment. However, future work should continue to explore the specific roles reflective processes and numerical ability play in participants' responses to the pandemic.

In line with our findings of cognitive reflection, lower levels of impulsivity predicted fewer endorsements of misperception, but did not relate to risk assessment or risk acceptability. How impulsivity relates to risk-perception or acceptance seems to be domain-specific. For example, the relationship between impulsivity and risk perception is consistent in the context of drugs and alcohol, but less so in the context of high-risk sexual activity where risk perception can be more complex (Mehrotra et al., 2009). It is possible that the politicization and overabundance of misinformation on COVID-19 risks muddies the waters, making this a context where assessing risk is less straightforward, and thus less clearly related to impulsivity.

Numeracy has long been known to be associated with judgment and decision making related to health (Lipkus & Peters, 2009). However, our hypotheses about numeracy were not supported by the data. It may be that the politicized nature of COVID-19 overwhelms numeracy as a predictive individual difference. Citing Kahan et al. (2012), Lewandowsky and Oberauer (2016) report that with materials demonstrating the base rate fallacy that are problem isomorphs, numeracy was a good predictor of performance on a problem related to the effectiveness of a skin cream, but not for a numerically identical problem involving the politicized issue of gun control. In the case of gun control, political ideology predicted performance and numeracy did not. As Reyna (2020 p. 672) notes, "numeracy is not sufficient to understand risk. In fact, numbers are ambiguous in the way that words are ambiguous, perhaps more so."

Looking at our individual differences measures as a whole, these studies suggest that judgments about the level of risk for behaviors, such as going shopping, are distinct from personal thresholds for what constitutes too much risk. While it appears that political ideology affects both judgments on risk perception and acceptability, other variable such as reflectiveness predict lower thresholds for acceptable risk and, at least in Study 2, lower risk perception. While initially counterintuitive, this may simply show that, despite a lower perception of risk, reflective participants are still more risk-averse. However, the joint influence of thresholds and risk perception should be studied in future research.

With respect to argumentation, typically when people agree with an argument they are primarily agreeing with the claim, whereas when they assess the strength or quality of an argument, they are more heavily weighing the supporting reasons (Wolfe et al., 2009). However, in the present research there were ideological differences for judgments of argument strength. While liberal participants weighed claims and reasons evenly, conservatives weighed the claim more heavily. In other words, conservative participants were more likely to base judgments about the strength or quality of arguments on claims such as "It is good that the Federal Government is making vaccines against COVID-19 available to Americans free of charge" rather than on supporting reasons, be they those that pilot testing suggests are relatively conservative, such as "because that was the goal of President Trump's Operation Warp Speed" or relatively liberal such as "because protecting the health of Americans is a basic function of government." Unfortunately, these findings highlight the difficulty in developing effective argument-based interventions to promote healthy decisions and behaviors. It appears that in this partisan environment, the argumentation schemata of conservatives and liberals

weigh theme and side above warrants and reasons (Wolfe et al., 2009). Instead, there are reasons to believe that a more fruitful approach is to give people the information and conceptual tools they need to understand the qualitative, contextualized meaning of risk information (Reyna, 2020).

Finally, looking at participants' intent to engage in healthy preventative behaviors, we saw that participants who were liberal and more reflective were more likely to engage in all three behaviors. These findings could be useful in helping address vaccine hesitancy. Despite the fact that adults over the age of 16 have been able to get vaccinated for several months, young adults are still plagued by vaccine hesitancy, citing concerns for the vaccine's safety and efficacy as their main reason to avoid it (Baak et al., 2021). Many of these concerns can be linked to widespread misinformation, largely associated with conservative circles. This may explain why reflective participants, who can better ascertain what information is valuable, and liberal participants may be more willing to get vaccinated. We may able to help more of these young adults overcome their vaccine hesitancy by directly targeting our efforts on conservatives who are confronted with more misinformation, and providing more consistent, bipartisan messaging that appeals to a sense of national identity (Van Bavel, Cichocka, et al., 2020).

9 | CONCLUSIONS

Here, we have taken preliminary steps towards understanding the cognitive individual differences that may cause people to inaccurately assess risks of COVID-19, engage in risky behaviors, and endorse misperceptions. Our findings support the importance of cognitive ability in avoiding misinformation during the current pandemic, and the effect political polarization can have on an individual's perception of medical risk, willingness to accept risk, tendency to believe misinformation, and intention to engage in healthy behaviors. By clarifying these individual differences, we can further understand health behaviors, and more effectively create interventions targeted at populations that need them most. One limitation of the current work is that represents a "snapshot" in time. However, some social and political influences on risk perception may be dynamic. Additionally, we asked about behavioral intentions and hypothetical actions, but did not assess potentially risky behaviors directly. Thus, it is not clear whether estimates for statements about the risk associated with getting a haircut correspond with the frequency of actually visiting a hair salon. A third limitation is that only about 4% of our sample self-identified as "strong conservative." These studies lacked the statistical power to make fine-grained distinctions based on ideology, or separate "social conservatives" from "fiscal conservatives" etc.

One policy implication of these studies is that public health interventions designed to reduce the spread of COVID-19 should take ideology into account during development and testing. Future work should continue to expand upon our current knowledge of COVID-19 risk perception. The role of argumentation in influencing risk perception warrants further research, particularly in the context of political

ideology and personal risk factors. Now that sufficient time has passed, there is a wealth of knowledge to be gleaned on how individuals differed in their actual behaviors, acceptance of health-related mandates, and willingness to be educated on the pandemic, to name a few key questions. Furthermore, understanding the processes and abilities that shaped the response to the current pandemic can ideally help us prepare for the next one.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT
The data from the present work are available from the corresponding author upon request.

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