

# Political ideology shapes risk and benefit judgments of COVID-19 vaccines

Enrico Rubaltelli<sup>1</sup>  | Stephan Dickert<sup>2</sup> | David M. Markowitz<sup>3</sup> | Paul Slovic<sup>3,4</sup> 

<sup>1</sup>Department of Developmental Psychology and Socialization, University of Padova, Padova, Veneto, Italy

<sup>2</sup>School of Business and Management, Queen Mary University, London, UK

<sup>3</sup>School of Journalism and Communication, University of Oregon, Eugene, Oregon, USA

<sup>4</sup>Decision Research, Eugene, Oregon, USA

## Correspondence

Enrico Rubaltelli, Department of Developmental Psychology and Socialization, University of Padova, Via Venezia, 8, 35131 Padova, Italy.  
Email: [enrico.rubaltelli@unipd.it](mailto:enrico.rubaltelli@unipd.it)

## Abstract

In April 2021, the use of the Johnson & Johnson COVID-19 vaccine was paused to investigate whether it had caused serious blood clots to a small number of women (six out of 6.8 million Americans who had been administered that vaccine). As these events were unfolding, we surveyed a sample of Americans ( $N = 625$ ) to assess their reactions to this news, whether they supported the pausing of the vaccine, and potential psychological factors underlying their decision. In addition, we employed automated text analyses as a supporting method to more classical quantitative measures. Results showed that political ideology influenced the support for the pausing of the vaccine; liberals were more likely to oppose it than conservatives. In addition, the effect of political ideology was mediated by the difference between perceived benefit and risk and the language style used to produce reasons in support (or against) the decision to pause the vaccine. Liberals perceived the benefit of vaccines higher than the risk, used a more analytic language style when stating their reasons, and had a more positive attitude toward the vaccine. We discuss the implications of our findings considering vaccine hesitancy and risk perception during the COVID-19 pandemic.

## KEYWORDS

benefit, political ideology, risk, thinking style, vaccine

## 1 | INTRODUCTION

On April 23, 2021, both the Federal Drug Administration (FDA) and the Centers for Disease Control (CDC) lifted the temporary stop in the use of the Johnson & Johnson (J&J) vaccine and reassured the public stating their confidence in its effectiveness (U.S. Food & Drug Administration, 2021). The pausing was decided 10 days earlier, on April 13, 2021, to investigate potential severe side effects, when six women had experienced serious blood clots after receiving the shot. Up to the time of the pausing, 6.8 million doses of the J&J vaccine had been administered to U.S. citizens.

The news of these side effects reinforced the doubts that some people already had about the COVID-19 vaccines. Even without believing in any elaborated conspiracy theories, some people questioned whether the vaccines were rushed into production or if they received enough testing (Pew Research

Center, 2020). The blood clots suffered by the women who received the J&J vaccine, like those experienced by people in Europe who received the AstraZeneca vaccine (Robbins & Erdbrink, 2021), seemed to suggest that the vaccines were not safe and created additional uncertainty among the public.

After more than a year fighting the COVID-19 pandemic, the debate over whether the J&J vaccine should be paused to investigate possible serious side effects became emotionally charged. At the time of the pausing, we administered a survey on a sample of U.S. citizens to investigate the variables that could predict their attitude toward the vaccine. We were mainly interested in attitudes toward the vaccine as a function of one's political ideology, perception of the risks and benefits associated with vaccines, and the reasons underlying (lack of) support for pausing the vaccine. The timing of our study allowed us to gather the actual reactions people were experiencing at a time of high uncertainty in which the vaccine's safety was questioned. As a result, our data are

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2023 The Authors. *Risk Analysis* published by Wiley Periodicals LLC on behalf of Society for Risk Analysis.

especially informative of how a disruptive event can influence people's perceptions of a vaccine that, despite these issues, was contributing to efforts designed to save the lives of many.

## 1.1 | Perception of risk and benefit of vaccines

Since the start of the COVID-19 vaccination program at the end of 2020, a high level of scrutiny was directed toward possible side effects of the vaccines. The rapid global spread of the virus increased both the speed at which vaccines were developed and the process by which the safety of the vaccines had to be ensured. However, the high level of scrutiny has fed into the existing negative attitudes some people already had toward vaccines (Hornsey et al., 2018). Inevitably, the news that attracted more attention in the media was the catastrophic side effects (like blood clots) instead of the more frequent but relatively benign minor side effects. As a result, the most severe side effects, such as those that emerged in relation to the J&J vaccine, have sparked strong reactions by the public. Some people felt the vaccine was too dangerous and should have been discarded altogether, whereas others pointed out to the low incidence of side effects compared to the large number of people who had received the shot, suggesting that the vaccine was safe enough to be used.

These reactions can be caused by many factors but, ultimately, are rooted in the perception that people have of the risk and benefit of a specific hazard (Alhakami & Slovic, 1994; Slovic et al., 2002). Previous work showed that the perception of risk and benefit is driven by the affective reactions people experience toward a stimulus. People tend to perceive a negative correlation between the risk and the benefit, even when this inference is not warranted by the available data. For instance, when judging whether to take an anti-COVID-19 vaccine shot, some people may think that the vaccine is a useful and important tool to protect from the virus. In doing so, they are also likely to end up concluding that the risk of the vaccine is quite small. Others, however, may think that the vaccine was rushed into production without enough testing. As a result, these people perceive a high risk and conclude that the benefit of taking the vaccine shot is rather low. Indeed, vaccines are somehow conducive to this negative correlation in the perception of their risk and benefit (Alhakami & Slovic, 1994). Since side effects are possible and minor reactions are common, people can easily overestimate the risk. Not surprisingly, vaccine hesitancy has been a growing issue in many countries (Eskola et al., 2015). Although many vaccines have been deployed to great effect, basically eradicating many serious diseases, vaccine hesitancy has sometimes played a significant role in compromising or greatly reducing herd immunization (Dubè et al., 2013; Salmon et al., 2015).

The way the anti-COVID-19 vaccines were developed can be perceived as a scientific success story, one in which public funding and private enterprise cooperated to achieve a solution in record time. Yet, the lack of testing caused concern for

many people, which was exacerbated by the news that serious side effects could, and in fact did, occur. In line with previous work, we expect to find that people's opinion on the pausing of the J&J vaccine depends on their perception of the risk and benefit of vaccines. Those perceiving the benefit of the vaccine higher than its risk should be against pausing the vaccine since that would halt the positive contribution it makes to saving lives. Instead, people who perceive the benefit of the vaccine lower than its risk should be in favor of pausing the vaccine since the serious side effects would confirm their own intuition that it is unsafe.

## 1.2 | Political ideology and vaccine hesitancy

The pandemic, and the way it was tackled in the United States, has been met by a strong political divide. Democrats were more likely to support stricter measures such as lockdowns and mask wearing, whereas republicans were more skeptical and perceived a lower risk (Stroebe et al., 2021).

Similarly, political ideology has been a consistent factor associated with vaccine hesitancy (Aw et al., 2021; Dubè et al., 2013). For instance, during the N1H1 outbreak, Americans supporting the Affordable Care Act were more likely to get vaccinated (Mesch & Schwirian, 2015). In the early stages of the pandemic, one of the most visible differences in attitudes emerged in reaction to the anti-COVID-19 vaccines. Data collected before the start of the vaccine campaign showed that conservatives were less likely than liberals to say that they would take the vaccine once available (Fridman et al., 2021; Khubchandani et al., 2021). This translated to lower actual vaccination rates among conservatives. A survey run in February 2022 revealed that only 27% of conservatives had been fully vaccinated (including the booster shot) versus 72% of liberals (and a national average of 47%; KFF, 2022). Similarly, conservatives were less likely to support employers' decision to mandate vaccines for their employees (27% vs. 70% of liberals; KFF, 2021).

One of the reasons that produces high levels of political polarization is people's tendency to gather information from media, social media, and acquaintances who are likely to share their opinions. By doing so, they can get isolated in echochambers where it is difficult to hear messages that contradict one's own views (Cinelli et al., 2021; Di Marco et al., 2021; Sharma et al., 2021). This process exacerbates confirmation bias and opinions on a specific subject end up diverging beyond a level where they are easily reconcilable. This dynamic is likely even more pronounced when people judge events that are characterized by uncertainty and could be framed in ways that are contradictory but still plausible. As a case in point, once the vaccination campaign started, the difference in the number of deaths recorded in counties that voted Trump (vs. Biden) in 2020 has increased over time (Leonhardt, 2021).

In our study, we expect that political ideology influences how people perceive the risk and the benefit associated with vaccines. People with a more conservative ideology should

be more likely to rate the benefit of vaccines as lower than its risk, whereas people leaning to the left of the political spectrum should perceive the benefit as higher than the risk. In other words, we expect that people who have a different political ideology will have a different perception of the vaccines. This prediction is supported by previous work showing that political ideology influences people's risk perception in the context of the COVID-19 pandemic (Ju & You, 2021; Kyung et al., 2022). Thus:

Hypothesis 1 :Political ideology should predict the difference between the perceived risk and benefit of the vaccines.

### 1.3 | Analytic versus intuitive thinking

Another factor that can influence one's support or opposition toward pausing the J&J vaccine is the type of reasons that are used to explain the decision and how information regarding the vaccine is processed. Based on extensive research in this area, we know that the reasons people produce in support to their views are not necessarily objective representations on a subject (e.g., they are not based on statistics and logical reasoning). Rather, on many occasions people's reasoning produces justifications that go along with their intuitive assessment of a situation (Kahan, 2013). Therefore, it is important to understand how political ideology and perceived risk and benefit shape the reasons people produce in support to their decision whether to pause the J&J vaccine or not.

In our study, we used automated text analyses to examine the reasons for supporting or opposing a J&J pause. In most psychology of language studies, people evaluate content words (e.g., nouns, verbs) and style words (e.g., articles, prepositions, and pronouns) to understand *what* people were communicating about and *how* they were communicating, respectively (Pennebaker, 2011). This research tradition uses words as markers of one's attention (Boyd & Schwartz, 2021). For example, people who use high rates of self-references (e.g., *I, me, my*) tend to focus more on the self and attend to their personal worldviews compared to those who use low rates of self-references. Based on this foundation, we examined how much people attended to emotions in their responses, and their general thinking style via an indicator called analytic thinking.

Emotion patterns in language have revealed a range of social and psychological dynamics in the field. For example, prior work suggests by counting negative emotion terms such as *hate, bad, awful, and disgust*, one can understand how people psychologically manage trauma and emotional upheavals (Cohn et al. 2004; Markowitz, 2022) and personality dimensions (Ireland & Mehl, 2014). People who use high rates of emotion tend to reveal how they are thinking, feeling, and experiencing the world psychologically at a particular time (Pennebaker, 2011). Another language dimension critical to the current study is analytic thinking. Analytic thinking is a proxy for Kahneman's (2011) System 2 mode of thinking, where people who score high on this language

index tend to be more reasoned, rational, and categorical in their thinking style compared to those who score low on this index. At the language level, analytic thinking is comprised of seven style word categories (see Jordan et al., 2019; Pennebaker et al., 2014): high rates of articles and prepositions, but low rates of storytelling words such as pronouns, auxiliary verbs, negations, conjunctions, and adverbs. Analytic thinking has been connected to a range of social and psychological processes, including persuasion (Markowitz, 2020), psychological distress (Seraj et al., 2021), and cultural trends in politics (Jordan et al., 2019), to indicate those who think in categorical/hierarchical terms (high on analytic thinking) or more in narrative terms (low on analytic thinking).

We employed automated text analysis to measure how much the perception of risk and benefit was related to a tendency to focus on emotion or engage in analytic thinking. Research on analytical thinking has provided conflicting evidence on its effectiveness in leading people to rely more on objective information (Pennycook et al., 2020). Some work has pointed out that controlled reasoning can override potentially incorrect intuitive responses. For instance, a disposition toward analytic thinking reduced the likelihood of believing in fake news, irrespective of this news being consistent with one's political views or not (Pennycook & Rand, 2019). Similarly, people who engage more in analytical thinking are less likely to hold paranormal or religious beliefs (Pennycook et al., 2012; Shenhav et al., 2012), to fall for conspiracy theories (Swami et al., 2014), or to have antiscience beliefs (Gervais, 2015). Finally, people who rely more on intuition have been shown to have a stronger belief in traditional moral values (Pennycook et al., 2014; Royzman et al., 2014) and to be conservatives (Jost, 2017).

However, analytic thinking is sometimes applied not to achieve better judgment but to protect one's own identity (Kahn, 2013) or to be more convincing (Mercier, 2016). In this view, reasoning can undermine judgment and make people even more convinced of what they already believe (Kunda, 1990). Examples of such processes are studies in which reasoning led to dismissing information inconsistent with one's political ideology (Strickland et al., 2011) or to confirmation bias and selective information search (Knobloch-Westerwick et al., 2017).

Based on this work and the literature on text analysis, we can advance some hypothesis on how analytic thinking can influence people's reactions to the J&J side effects issue, as well explain their decision to support or oppose the pausing of the vaccine. Analytic thinking may exacerbate polarization by way of confirming and justifying prior beliefs. Hence, we should find that both conservatives and liberals engage in it to maintain, uncritically, their original opinion of vaccines. However, another possibility is that analytic thinking serves to overcome a challenge to one's beliefs because this is the right thing to do. In the specific case investigated here, we should find that people who see the benefit of the vaccine higher than the risk are more likely to engage in this type of thinking. The reports of severe side effects may challenge their beliefs about the usefulness of the vaccines thus eliciting negative feelings and doubts. People who perceive the benefit

of the vaccines lower than the risk are not challenged by the news of the severe side effects, rather their prior beliefs seem to be supported by the events. As a result, they can stick to their gut feelings and intuitions and should be less motivated to engage in analytic reasoning. This line of reasoning is also consistent with the literature showing that affective reactions are quick and can come first while analytic reasoning is usually slower and influenced by the intuitive conclusions reached by System 1 (Evans, 2008; Kahneman, 2011). It is likely that the motivation to engage in analytic thinking depends on the intuitive perception of the mismatch between the current state of things (e.g., vaccine can be harmful) and one's previous beliefs (e.g., the benefit of vaccines is higher than their risk).

Thus, we hypothesized that:

- Hypothesis 2a :People who perceived the benefit higher than the risk should be more likely to oppose the decision to pause the use of the J&J vaccine and to do so by using analytical thinking.
- Hypothesis 2b :People who perceived the benefit lower than the risk should be more likely to support the decision to pause the use of the J&J vaccine and to do so by relying on their affective reactions.

Finally, since we hypothesized that political ideology should predict whether people perceived the benefit of vaccines higher than their risk (or vice versa) and that the difference between these two dimensions should influence whether people engage in analytical or intuitive thinking, we also expect that:

- Hypothesis 3a :The effect of political ideology on the decision to pause the use of the vaccine is mediated by the difference in the perception of risk and benefit.
- Hypothesis 3b :The effect of political ideology on the decision to pause the use of the vaccine should be mediated by both the difference in the perception of risk and benefit and by the extent in which people engage in analytical thinking (Figure 1).

In addition to evaluating the prior language patterns and their connection to vaccine risk and attitudes, we performed exploratory content analyses to identify themes within participant rationales. The purpose of this content analysis was twofold. First, we were interested in identifying *what* participants were mentioning when they provided rationales to pause the J&J vaccine. Independent of one's thinking style, it is unclear what people might communicate during this rationale procurement process and we used this opportunity to understand content patterns through an automated approach. Second, among the themes that emerged from the content analysis, we were interested in the degree to which they associated with risk perceptions compared to analytic thinking or emotion. Comparing these linguistic effects will determine

the psychological pathways that link the most to vaccine attitudes and drive how people feel about a consequential decision such as pausing the J&J vaccine.

## 2 | METHOD

### 2.1 | Participants

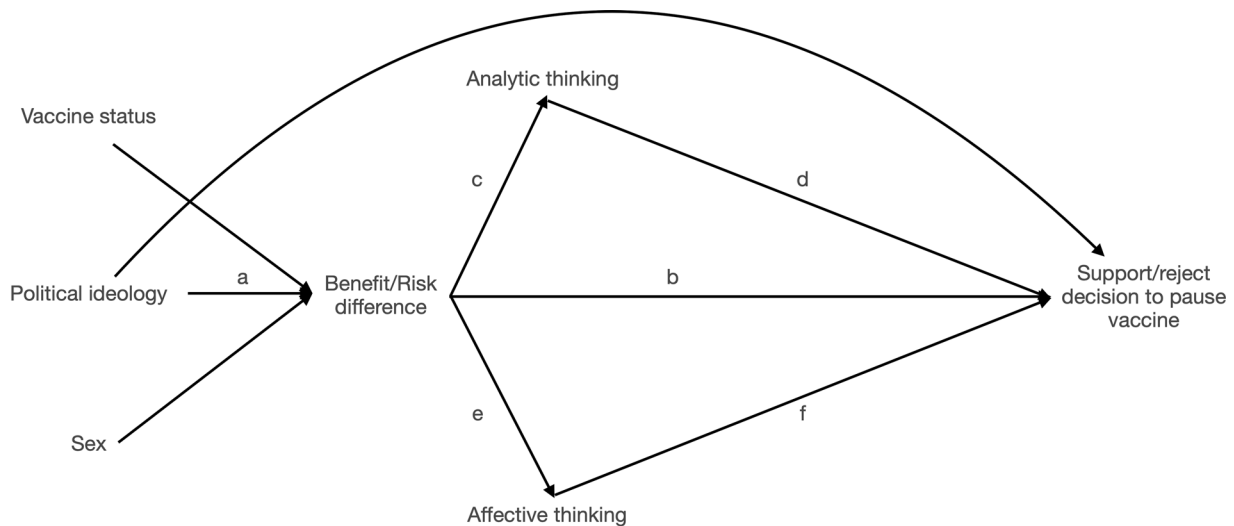
A total of 625 people (58% female, mean age = 34.79, SD = 12.58, ranging from 18 to 79 years) was contacted on Prolific and asked to complete a 5-min-long survey, receiving a compensation corresponding to an hourly payment of about \$10 (\$.80 for 5 min). For further details on the sample, see Table 1. Data were collected on April 26 and 27, 2021, thus only a few days after the public were notified of the blood clots on April 23, 2021.

### 2.2 | Materials

After giving their consent to take part in the study, participants were presented with a scenario describing the recent news related to the severe side effects, in the form of blood clots, that a few women had suffered after receiving the J&J vaccine. The text did not focus exclusively on the reported severe side effects of the vaccine but aimed to give a complete picture of the situation. Participants were informed of the number of women who suffered the blood clots, the overall number of people who received that specific vaccine to that point, as well as the number of people who contracted the coronavirus and the number of people who died because of it.

After reading the text, participants were asked whether they supported or opposed pausing the vaccine and were asked to report up to three reasons for their decision. These reasons were the texts used in the automated text analyses and were combined into a single unit of analysis per participant because we were interested in rationales overall, not individual rank-ordered rationales. Participants were also asked to state their agreement with nine statements related to people's attitudes toward the vaccine (nine-point scale ranging from -4, "strongly disagree," to 4, "strongly agree," with 0, "neither agree nor disagree" as the midpoint). Eight of these statements presented possible reasons people could report to avoid the J&J vaccine, whereas one statement was more supportive of not pausing the vaccine (see Table S1 in the [supplementary online materials](#)).

Afterward, participants rated the perceived benefit and risk of vaccines on two separate six-point scales (from 1, "No risk/benefit," to 6, "Very high risk/benefit"). The order of presentation of these two questions was randomized across participants. Next, participants were asked to answer four questions measuring their feelings toward: the overall number of people who received the J&J vaccine; the women who suffered the blood clots; the overall number of people who died because of the coronavirus since the start of the pandemic; the overall number of people who contracted the coronavirus



**Hyp. 1:** Path a; **Hyp. 2a:** Paths c + d; **Hyp. 2b:** Paths e + f; **Hyp. 3a:** Paths a + b; **Hyp. 3b:** Paths a + c + d

**FIGURE 1** Full path model with details of the paths tested in each hypothesis.

since the start of the pandemic (nine-point scales ranging from  $-4$ , “Very bad,” to  $4$ , “Very good,” with  $0$  “neither bad nor good” as the midpoint).

Finally, participants were asked to report on their vaccine status, by choosing one of three alternatives: fully vaccinated; partially vaccinated; not vaccinated yet. For participants who reported not being vaccinated yet, a further question asked whether they intended to get the shot once it would be available to them. Participants also answered an attention check in which they had to identify among four alternatives which statistics they saw reported in the scenario. Afterward, participants reported their political ideology (five-point scale ranging from  $1$ , “Extremely liberal,” to  $5$ , “Extremely conservative,” with  $3$ , “Neither liberal nor conservative,” as the midpoint). At the end of the survey, participants were asked to report their age and sex. All participants responded to these questions in the same order as reported here and were not aware beforehand that the survey was about COVID-19 or about vaccines.

### 2.2.1 | Automated text analysis

Recall that the rationales offered to pause the J&J vaccine were combined into a single unit of analysis (one text per participant) and all language data were analyzed with Linguistic Inquiry and Word Count (LIWC; Pennebaker et al., 2015). LIWC counts words as percentage of the total word count per text and contains dictionaries of social (e.g., words related to friends, family), psychological (e.g., words related to emotion, cognitive processes), and part of speech dimensions (e.g., pronouns, articles). For example, the phrase “I think it is unsafe” contains five words and LIWC would identify words within the following dictionary categories, including but not limited to: self-references ( $I$ ; 20% of the total word count) and

negative emotion terms (*unsafe*; 20%). All dimensions were drawn from the standard LIWC2015 dictionary.

#### Emotion

The emotion category contains positive emotion words (e.g., *agree, favor, kind*) and negative emotion words (e.g., *hate, awful*). Therefore, with this language dimension, we evaluated the degree to which people focused on overall emotion or had an affective response when providing reasons for supporting or opposing the stop of the J&J vaccine. This variable is calculated as a percent of the total word count.<sup>1</sup>

#### Analytic thinking

Analytic thinking is an index of style words that evaluates the thinking patterns of communicators when writing their rationales for supporting or opposing the stop of the J&J vaccine. It is measured on a scale of  $0$  (low analytic thinking) to  $100$  (high analytic thinking). High scores on this index suggest reasoned and rational thinking compared to low scores. This variable is normalized because it is an index of seven style word categories (Jordan et al., 2019; Pennebaker et al., 2014) and does not represent a percentage of the total word count.<sup>2</sup>

#### Content patterns

We used the Meaning Extraction Method (Chung & Pennebaker, 2008; Markowitz, 2021) to automatically extract

<sup>1</sup> An example of a response with high emotion includes “*Low* percentage of people *suffering* from side effects *Benefits* outweigh the negatives” (25% emotion; italic words are emotion terms) and an example of a response with low emotion includes “Possibility that blood clots could appear after in the long term The possibility of the company getting sued Less people would want this particular vaccine due to the blood clot news” (0% emotion).

<sup>2</sup> A response high on analytic thinking includes “The causing of blood clots The two deaths Prevention of any more injury or fatality” (normalized score = 99) and a response low on analytic thinking includes “It could kill someone It’s was made to fast Because there is no such thing as COVI-19” (normalized score = 1.23).

**TABLE 1** Sample characteristics split by participants' decision on whether to pause the use of the J&J vaccine or not

Variable	Decision	
	Do not pause vaccine	Pause vaccine
Sex, <i>n</i> (%)		
Man	124 (47.51)	137 (52.49)
Woman	115 (33.24)	231 (66.76)
Nonbinary	6 (40.00)	9 (60.00)
Prefer not to say	0 (0.0)	3 (100.00)
Age, <i>n</i> (%)		
18–25	61 (35.47)	111 (64.53)
25–30	97 (47.55)	107 (52.45)
31–50	59 (35.33)	108 (64.67)
>50	28 (34.15)	54 (65.85)
Ideology, <i>n</i> (%)		
Liberal	173 (44.13)	219 (55.87)
Conservative	72 (30.90)	161 (69.10)
Vaccine status, <i>n</i> (%)		
Fully vaccinated	113 (51.13)	108 (48.87)
One shot	54 (35.29)	99 (64.79)
Not vaccinated yet	78 (31.08)	173 (68.92)
Thinking style <i>M</i> ( <i>SD</i> )		
Analytic	82.5 (21.4)	71.6 (29.0)
Affect (%)	8.21 (8.96)	8.83 (10.67)
Likelihood of being infected, <i>M</i> ( <i>SD</i> )	54.6 (24.9)	52.6 (23.4)
Benefit/Risk difference, <i>M</i> ( <i>SD</i> )	3.09 (1.47)	0.98 (2.36)

Note: The difference between benefit and risk ranged from -5 to 5, with negative values indicating that the perceived risk of the vaccines is higher than the perceived benefit and positive values indicating that the perceived benefit is higher than the perceived risk. Affect represents the percentage of the total word count per text that contained positive or negative emotion term from LIWC. Analytic thinking is a composite variable (not a percentage) also calculated by LIWC.

content words (e.g., nouns, verbs) from participant rationales, which are then submitted to a principal component analysis (PCA) to form themes. In this process, the Meaning Extraction Method removes style words and low base-rate words to retain content, resulting in a binary output for each content-related term (1 = a content word is present in the corpus, 0 = a content word is absent from the corpus). Then, using a PCA with varimax rotation, themes are created after considering scree plot evidence, variance explained, and the interpretability of the themes. Consistent with best practices for the Meaning Extraction Method (Chung & Pennebaker, 2008; Markowitz, 2021), words were retained if they appeared in at least 5% of all responses and item loadings for each component were retained if they were  $> |0.20|$ .

### 3 | RESULTS

#### 3.1 | Descriptive statistics

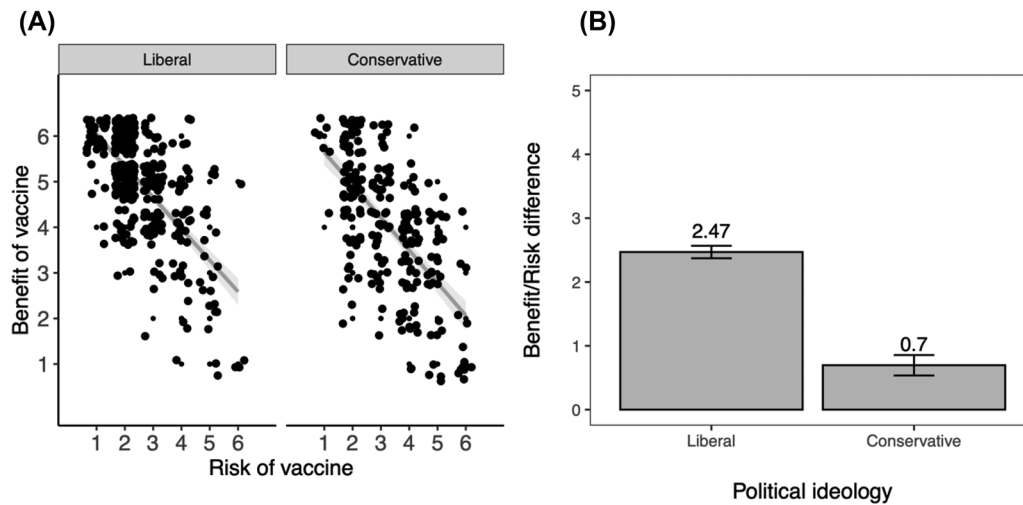
As shown in Table 1, women were more likely to support the pausing of the vaccine than men. This is consistent with the evidence that all the cases of blood clots involved women who

received the J&J vaccine. Liberals were less likely to support the pausing of the vaccine compared to conservatives<sup>3</sup> and fully vaccinated respondents were less likely to support it than people who either had only one shot of vaccine or were not vaccinated at all. Finally, people who did not support the pausing of the vaccine perceived a larger difference between the benefit and the risk of vaccines.

#### 3.2 | Correlations

First, we checked if perceived benefit and risk were negatively correlated, consistent with previous research (e.g., Alhakami & Slovic, 1994; Slovic et al., 2002). Results showed that this was the case ( $r = -0.69$ ,  $p < 0.001$ ). A negative correlation emerged for both liberals ( $r = -0.65$ ,  $p <$

<sup>3</sup> In Table 1, as well as in some of the figures, we reported political ideology as a categorical variable with two levels: liberal (values 1 and 2) versus conservative (values 3–5). This was done for easy of presentation although in all the analyses political ideology was entered as a continuous variable. The coding depended on respondents who selected value 3 (neither liberal nor independent) being statistically not different from those who chose values 4 and 5 (conservatives) on the variables relevant to the study (e.g., difference between benefit and risk, analytic thinking, affective thinking, and decision to support the pausing of the vaccine).



**FIGURE 2** Panel A: Negative correlation between risk and benefit of the vaccines for liberal and conservative participants, respectively. Panel B: Benefit minus risk score for liberals and conservatives.

**TABLE 2** Correlations among the study variables

	Benefit/risk difference	Political ideology	Analytic thinking	Affective thinking	Decision on pausing vaccine
Benefit/risk difference	—				
Political ideology	-0.38***	—			
Analytic thinking	0.10**	-0.07	—		
Affective thinking	-0.02	-0.05	0.10**	—	
Decision on pausing vaccine	-0.48***	0.15***	-0.19***	0.01	—

Note: \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ . Political ideology was included as a continuous measure ranging from 1 (“Extremely liberal”) to 5 (“Extremely conservative”) with 3 (“Neither liberal nor conservative”) as the midpoint; Decision was coded as 0 (oppose to pausing the J&J vaccine) and 1 (support pausing the J&J vaccine). For the decision to pause the vaccine, we computed Spearman rank correlations.

0.001) and conservatives ( $r = -0.66$ ,  $p < 0.001$ ), although the distribution of their responses was quite different (Figure 2, Panel A). While liberals were mostly clustered around high benefit and low risk scores, conservatives showed a more variable pattern of responses.

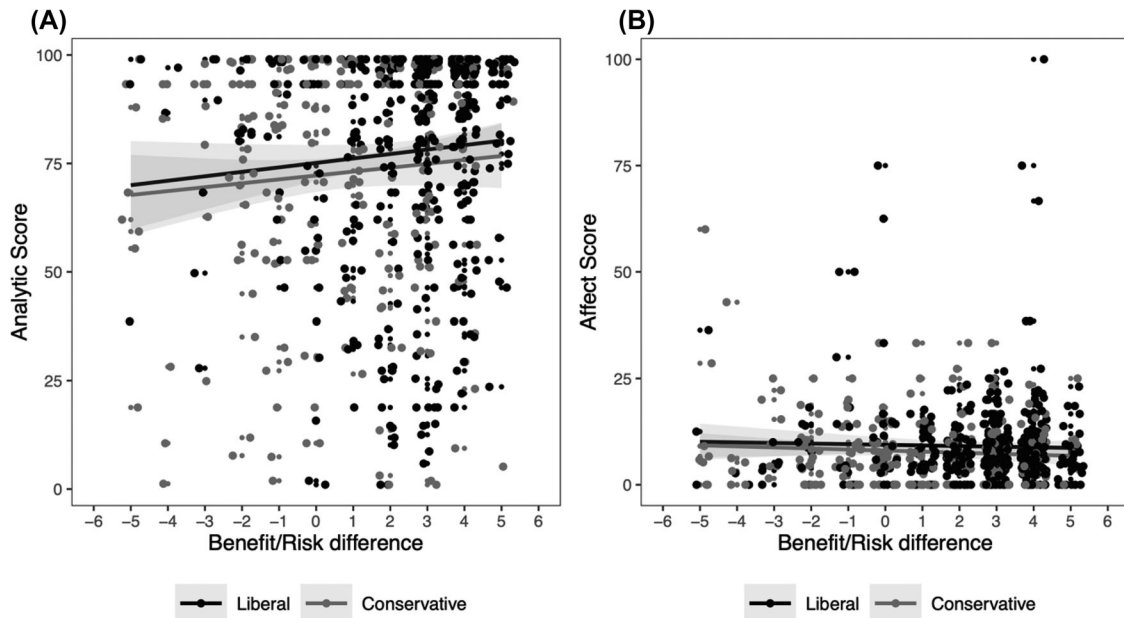
We then computed the difference between perceived benefit and risk of the vaccines, so that positive values indicated a higher benefit (than risk), and negative values indicated a lower benefit (than risk) perception. We assessed whether the difference between benefit and risk was correlated with political ideology and the use of an analytic or affective thinking style when writing reasons to support/oppose the pausing of the J&J vaccine (Table 2). Both groups perceived the benefit of the vaccine higher than the risk, although this difference was larger for liberals than conservatives (Figure 2, Panel B). This finding is in support of Hypothesis 1.

In addition, respondents who perceived the benefit higher than the risk were also more likely to provide reasons in support of their decision using an analytical thinking style, whereas no association was found between the benefit/risk difference and the affective thinking (Figure 3).

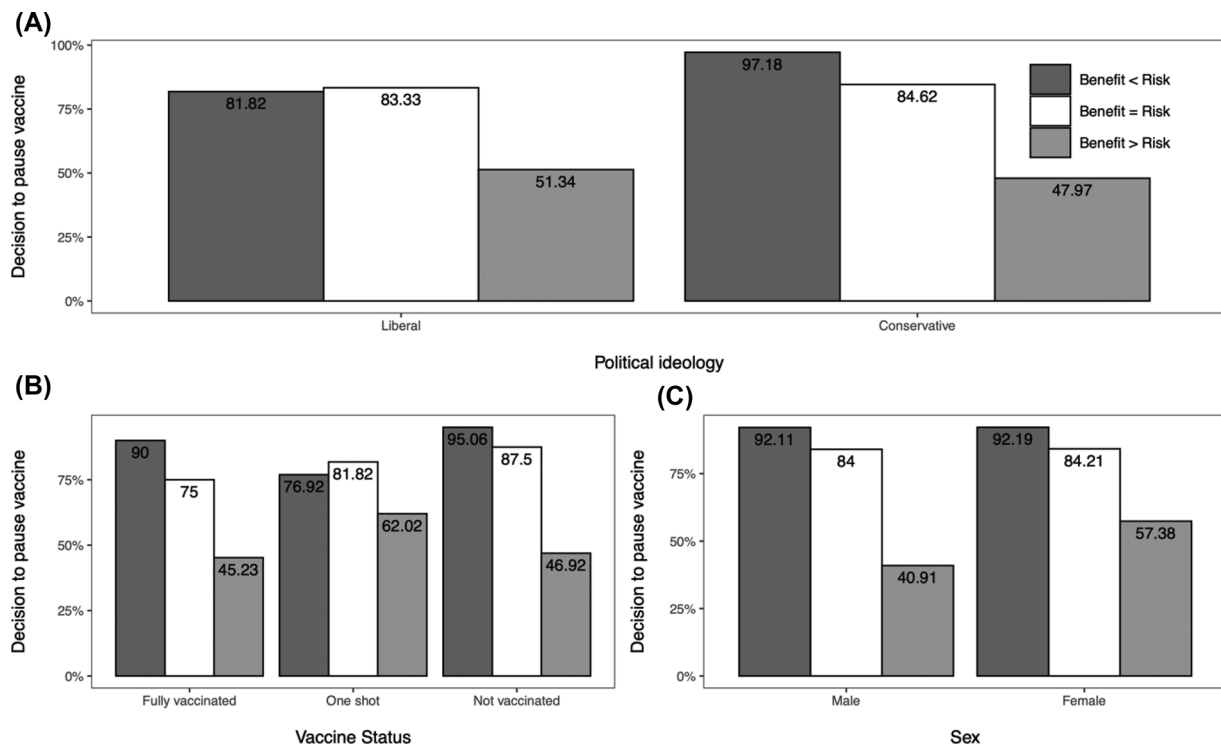
Finally, respondents who perceived the benefit higher than the risk were more likely to oppose the pausing of the J&J vaccine. Political ideology did not correlate with either of the two thinking styles but correlated with the decision: conservatives were more likely than liberals to support the decision to pause the use of the vaccine (Figure 4). These correlations are consistent with our hypotheses because it seems that, unlike the measures of thinking style (analytic and affective), the difference between the perceived benefit and risk of the vaccines was associated with respondents’ political ideology.

### 3.3 | Regression analyses

We first conducted a regression analysis to assess whether political ideology predicted the decision to support or oppose the pausing of the vaccine while controlling for vaccine status and sex. These covariates were added to the model because people who had already been vaccinated should feel less impacted by the side effects and likely perceive the benefit higher than the risk; further, it is possible that vaccine status



**FIGURE 3** Correlation between the benefit/risk difference and analytic thinking (Panel A) and affective thinking (Panel B).



**FIGURE 4** Decision to support the pausing of the J&J vaccine split by benefit/risk difference and political ideology (Panel A), vaccine status (Panel B), and sex of the respondents (Panel C). For clarity, the benefit/risk difference was computed as three categories based on the following values: -5 to -1 (benefit < risk); 0 (benefit = risk); 1 to 5 (benefit > risk) but is used as a continuous measure in the analyses.

is related to political ideology because of the high polarization on this issue. In addition, men should feel less threatened since it was only women who experienced the severe blood clots. Results showed a significant effect of political ideology, indicating that conservatives were more willing to support

pausing the use of the vaccine (Table 3). People who were partially immunized and those who were not vaccinated were more supportive of pausing the vaccine than those who were already fully immunized. Finally, women were more likely to support the pausing of the J&J vaccine.



**TABLE 3** Logistic regression models predicting the decision to support/oppose the pausing of the J&J vaccine

	(1)		(2)		(3)	
	<i>B</i> ( <i>SE</i> )	<i>Z</i>	<i>B</i> ( <i>SE</i> )	<i>z</i>	<i>B</i> ( <i>SE</i> )	<i>Z</i>
Intercept	-.09 (.19)	-.44	4.59 (.58)	7.97***	5.57 (.68)	8.26***
Political ideology	1.21 (.36)	3.38***	-.36 (.42)	-.86	-.42 (.43)	-.99
Full immunization versus partial	.67 (.23)	2.96**	.45 (.24)	1.85 <sup>+</sup>	.52 (.25)	2.08*
Full immunization versus no vaccine	.78 (.20)	3.86***	-.17 (.24)	-.73	-.15 (.26)	-.60
Sex	.71 (.18)	4.05***	.41 (.19)	2.13*	.44 (.20)	2.19*
Benefit/risk difference			-5.87 (.66)	-8.92***	-5.80 (.67)	-8.72***
Analytic thinking					-1.47 (.39)	-3.80***
Affective thinking					1.55 (1.02)	1.51
McFadden/Cox–Snell	.06/.07		.20/.24		.22/.26	
AIC	778.39		662.37		648.57	

Note: <sup>+</sup>  $p < 0.10$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

Subsequently, we ran a second regression model in which we added the difference between benefit and risk as one of the predictors of the decision to support/oppose the pausing of the vaccine (see Table 4 to compare each model Akaike Information Criterion (AIC) value). This second model revealed a significant effect of the benefit/risk difference, indicating that people who perceived the benefit higher than the risk were more likely to oppose the decision to pause the vaccine. In addition, we found a significant effect of sex. Importantly, the effect of political ideology was not significant in this second model, suggesting the presence of the hypothesized mediation effect; the effect of vaccine status was also not significant.

Finally, we ran a third model in which we added the analytic and affective thinking styles extracted from the text analysis. This model revealed significant effects of the difference between the benefit and the risk of vaccines, analytic thinking, and sex. People who perceived the benefit of the vaccines higher than the risk, those who engaged in more analytic thinking, and men were more likely to oppose the pausing of the J&J vaccine. There was also a difference between fully vaccinated respondents and partially vaccinated ones but no difference between fully vaccinated respondents and nonvaccinated ones. The effects of political ideology and affective thinking were not significant.

### 3.4 | Mediation analyses

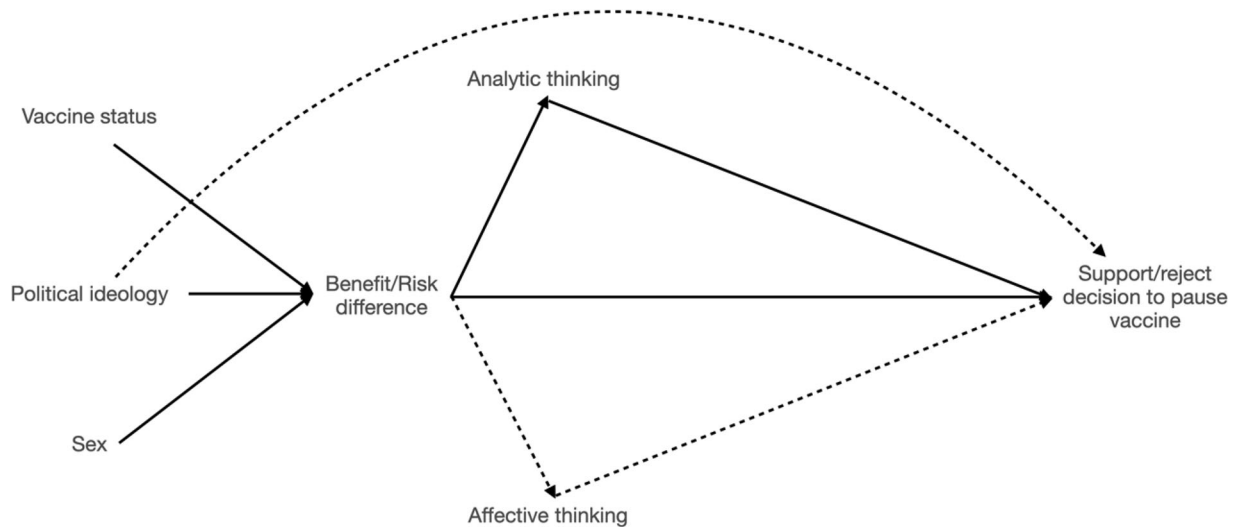
#### 3.4.1 | Mediating role of the benefit/risk difference

Based on the correlations and the regression models reported in the previous sections, we tested a model in which the difference between the benefit and the risk mediates the effect of political ideology on the decision to support/oppose the pausing of the J&J vaccine. We ran the analyses using R 4.1.0 (R Core Team, 2020) and the lavaan package version 0.6-8

(Rosell, 2021). Results showed a significant indirect effect ( $B = 0.08$ ,  $SE = 0.01$ ,  $z = 7.84$ ,  $p < 0.001$ ). Consistent with the earlier regression analysis, this indicates that the difference between the benefit and the risk of vaccines mediates the effect of political ideology on people's decision to support/oppose the pausing of the J&J vaccine. This mediation effect supports Hypothesis 3a.

#### 3.4.2 | Mediating role of analytic thinking or emotion

We then investigated whether analytic thinking or affect mediated the effect of the difference between the benefit and the risk of vaccines on people's decision to support/oppose the pausing of the J&J vaccine. Results showed that the benefit/risk difference predicted the use of an analytic thinking style when providing written reasons in support of one's decision ( $B = 0.13$ ,  $SE = 0.05$ ,  $z = 2.68$ ,  $p = 0.007$ ). This result supports Hypothesis 2a and indicates that respondents who perceived the benefit of vaccines higher than the risk were more likely to think in a rational and categorical manner as indicated by their language patterns. Hypothesis 2b was not supported since the difference between the benefit and the risk of vaccine did not predict the level of affect used by respondents ( $B = -0.01$ ,  $SE = 0.02$ ,  $z = -0.32$ ,  $p = 0.746$ ). In turn, respondents who adopted a more analytical thinking style were more likely to oppose the decision to pause the J&J vaccine than respondents who relied less on an analytic style ( $B = -0.26$ ,  $SE = 0.07$ ,  $z = -3.99$ ,  $p < 0.001$ ). The degree to which people focused on affect did not predict their support/opposition to the decision to pause the vaccine. Despite this, the effect of the difference between the benefit and the risk of vaccines remained significant ( $B = -0.92$ ,  $SE = 0.08$ ,  $z = -12.09$ ,  $p < 0.001$ ) even when the two language dimensions were added to the model, thus indicating a partial mediation. The indirect effect through the analytic style was significant ( $B = -0.03$ ,  $SE = 0.02$ ,  $z = -2.23$ ,  $p = 0.026$ ).



**FIGURE 5** Path model explaining the effect of political ideology on respondents' decision to support/oppose the decision to pause the J&J vaccine including the mediating role of the benefit/cost difference and of respondents thinking style (dashed lines indicate nonsignificant paths).

This mediation effect supports Hypothesis 3b.

### 3.4.3 | Full path model with language patterns

Based on the results of the analyses presented so far, we then assessed a full model in which the effect of political ideology on the decision to support/oppose the pausing of the vaccine is explained by the mediation effect of the difference between the benefit and the risk of vaccines as well as respondents' use of an analytic thinking style when provide reasons for their decision (Figure 5). Results showed a significant, overall indirect effect ( $B = 0.32$ ,  $SE = 0.04$ ,  $z = 7.54$ ,  $p < 0.01$ ). Specifically, there was a significant mediation of the benefit/risk difference ( $B = 0.30$ ,  $SE = 0.04$ ,  $z = 7.61$ ,  $p < 0.001$ ) as well as a significant indirect effect through both the benefit/risk difference and the use of analytic thinking ( $B = 0.02$ ,  $SE = 0.01$ ,  $z = 2.16$ ,  $p = 0.031$ ). The indirect effect through both the benefit/risk difference and the use of emotional language was not significant ( $B = -0.01$ ,  $SE = 0.01$ ,  $z = -0.84$ ,  $p = 0.401$ ). Liberals were more likely than conservatives to perceive the benefit of vaccines as higher than the risk and to use analytic thinking when reporting reasons in favor of their decision to support/oppose the pausing of the vaccine and these variables mediated their higher likelihood to oppose the pausing of the vaccine.

### 3.5 | Exploratory content patterns

Five reliable themes were extracted. The themes focused on side effects of the J&J vaccine (Components 1, 2), risk assessment of the vaccine (Component 4), and vaccine public safety (Components 3, 5). These data suggest *what* people wrote about was not only relevant to the current study of interest (e.g., assessing risk associated with pausing a vaccine), but

such themes are also psychologically revealing because they indicate the dominant themes that people focused on during their judgments and decision making about the vaccine and its risk (Table 4).

We also saved component scores as regression weights and associated these data with the self-report measures (see Table 5). We found that the decision to support the pausing of the vaccine correlated with the scores on all five components, although some of these correlations were quite small. Among the highest correlations, we found that people who supported the pausing of the vaccine had lower scores in the risk assessment component, which indicated reasons suggesting that COVID had a higher risk than the vaccine. Similarly, these people had higher scores in the public safety component, indicating that public safety should be considered in the decision, and in the vaccines component, indicating that there are other alternatives available. Importantly, all the main variables in our study correlated with the risk assessment component. Specifically, people who perceived the benefit of the vaccines higher than their risk had a higher score than those who perceived the benefit as lower than the risk, whereas liberals had higher scores on this component than conservatives.

## 4 | GENERAL DISCUSSION

In April 2021, the emergence of potential severe blood clots caused by the J&J vaccine sparked an intense debate on its safety. Ultimately, this news led to the pausing of the J&J vaccine to assess its side effects. We investigated how people reacted to this news and whether they supported or opposed the decision to pause the use of the vaccine. A first finding was that people's decision was associated with their political ideology. This result is consistent with evidence that in the United States, the perception of the pandemic, the protective measures, and the vaccines is quite polarized across the

**TABLE 4** Results from the meaning extraction method

Component 1: Side effects		Component 2: Blood clots		Component 3: Vaccines		Component 4: Risk assessment		Component 5: Public safety	
$\lambda = 2.14$	6.89%	$\lambda = 1.93$	6.21%	$\lambda = 1.56$	5.02%	$\lambda = 1.52$	4.89%	$\lambda = 1.37$	4.42%
Word	Loading	Word	Loading	Word	Loading	Word	Loading	Word	Loading
side	0.942	blood	0.919	vaccines	0.816	higher	0.717	public	0.752
effects	0.829	clots	0.846	available	0.808	risk	0.698	safety	0.615
effect	0.514				0.569	covid	0.646		

Note: Lambda values are eigenvalues and percentages represent the amount of variance explained.

**TABLE 5** Correlations between content components, political ideology, benefit/risk difference, and decision to pause the vaccine

	Benefit/risk difference	Political ideology	Decision on pausing vaccine
Side effects	-0.06	0.06	0.08*
Blood clots	0.04	0.00	-0.08*
Vaccines	0.03	-0.07	0.16***
Risk assessment	0.17***	-0.16***	-0.31***
Public safety	0.02	-0.01	0.18***

Note: \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; Political ideology was included as a continuous measure ranging from 1 ("Extremely liberal") to 5 ("Extremely conservative") with 3 ("Neither liberal nor conservative") as the midpoint; Choice was coded as 0 (oppose to pausing the J&J vaccine) and 1 (support pausing the J&J vaccine).

political spectrum (Stroebe et al., 2021). Indeed, high levels of polarization in relation to the pandemic were found even in other countries (Flores et al., 2022). The reason for this polarization could depend on the specific echochambers in which people with different ideology form their views on topics like the vaccination against COVID-19 (Sharma et al., 2021). However, it might also be that conservatives are skeptical about the degree to which the pandemic is dangerous because the proposed solutions go against their beliefs and ideologic motives (Campbell & Kay, 2014; Jost, 2006). For instance, the mandatory use of masks and the advice that everyone should vaccinate may feel like taking away the freedom of choice, thus prompting the conservatives' opposition.

A second finding was the link between political ideology and people's perception of the benefit and the risk of vaccines. Liberals were more likely than conservatives to perceive the benefit of the vaccine higher than its risk. This result is in line with the predicted and actual data on vaccine coverage showing that liberals are more likely than conservatives to get vaccinated (Fridman et al., 2021; KFF, 2021; Khubchandani et al., 2021). Furthermore, these results confirm the underlying affective nature of people's attitudes toward vaccines (Gavaruzzi et al., 2021) and replicate findings showing that the affect heuristic leads people to perceive a negative correlation between risk and benefit (Alhakami & Slovic, 1994; Slovic et al., 2002). Importantly, when we computed the difference between the perceived benefit and the perceived risk of vaccines, this score mediated the effect of political ideology on people's support/opposition for the pausing of the J&J

vaccine. Liberals were more likely to indicate that the benefit was higher than the risk, and this predicted opposition to pausing the vaccine.

A third result pertains to the thinking style displayed by people when reporting the reasons in favor of their decision. We found that respondents who perceived the benefit of vaccines higher than the risk were more likely to produce reasons with a text structure associated to an analytical thinking style (Jordan et al., 2019). In turn, they were also more likely to oppose the decision to pause the use of the vaccine. Based on the literature on how analytic reasoning impacts decision making (Pennycook et al., 2020), a possible interpretation of these findings is that people who perceived higher benefit than risk gave more weight to the positive information that a very large amount of people who received the J&J vaccine did not experience severe side effects. To do so, however, they may have had to engage in analytical thinking to counteract the news of severe side effects that could have elicited intuitive, negative feelings and led to cast doubts on the effectiveness of the vaccine. In contrast, people who perceived the benefit lower than the risk did not experience the situation as a challenge to their prior beliefs. Rather, they must have felt as if their opinion (vaccines are risky) was supported by facts. We had a chance to test this interpretation by analyzing people's affective reactions toward the overall amount of people who received the J&J vaccine as well as their affective reactions toward the women who experienced the severe blood clots. We performed a within-subject ANOVA with political ideology (liberals vs. conservative), the two affect questions, and their interaction as predictors and affective reactions as the dependent variable, while controlling for the random effect of the participant. We found that liberals experienced more positive affective reactions than conservatives toward the overall number of people who received the J&J vaccine.<sup>4</sup> In contrast, liberals and conservatives did not show differences in the level of negative affect experienced toward the women who suffered the severe blood clots.

<sup>4</sup> We found a significant interaction effect ( $X^2 = 50.14$ ,  $df = 1$ ,  $p < 0.001$ ). Pairwise  $t$ -tests with Bonferroni correction showed that liberals ( $M = 1.74$ ,  $SD = 2.05$ ) experienced more positive affective reactions than conservatives ( $M = 0.36$ ,  $SD = 2.22$ ) toward the overall number of people who received the J&J vaccine ( $t = -20.35$ ,  $p < 0.001$ ). In contrast, liberals ( $M = -2.81$ ,  $SD = 1.47$ ) and conservatives ( $M = -2.68$ ,  $SD = 1.82$ ) did not differ in the level of negative affect experienced toward the women who suffered from the severe blood clots ( $t = -0.82$ ,  $p = 0.41$ ). For both groups of respondents, the difference between these two affective reactions was significant, although the effect was larger for liberals ( $t = 34.88$ ,  $p < 0.001$ ) than conservatives ( $t = 17.95$ ,  $p < 0.001$ ).

For both groups of respondents, the difference between these two affective reactions was significant, although the effect was significantly larger for liberals than conservatives. Thus, liberals experience a more intense positive reaction than conservatives toward the information showing that the vaccine is helping saving millions of lives and may use this insight to overcome the negative feelings induced by the news of the blood clots.

The process of overcoming one's doubts and defend one's prior beliefs by engaging in analytical thinking has been associated with the confirmation bias (Knobloch-Westerwick et al., 2017). The confirmation bias, in turn, has been described as a bias that people exhibit because of an inability to be flexible or update their views (e.g., believing fake news only when they support their prior beliefs). However, that does not mean that the confirmation bias is always harmful since it may help people to stick with correct opinions when doubts arise. For instance, people may engage in probability neglect when experiencing intense affective reactions (Dickert et al., 2015; Sunstein, 2002). When this happens, judgments are exclusively based on the affective reactions rather than considering the actual, very low likelihood of an event (e.g., the severe side effects of a vaccine). A way to overcome these affective reactions, and the doubts they might produce, could be by confirming one's prior beliefs. Consistently, it should be noted that the CDC reported that the J&J vaccine has been effective in preventing thousands of U.S. COVID-19 hospitalizations compared to a small number of blood clots (3–12 cases depending on the source; CDC, 2021). This information supports our conclusion that, at least on a theoretical level, perceiving the benefit higher than the risk and opposing the pausing of the vaccine was a reasonable position based on the data, although an investigation on its side effects was the safest option especially considering that vaccines from other manufacturers were also available. In fact, since alternatives are available, the CDC suggested to avoid the J&J vaccine when possible (CDC, 2021).

In addition, we ran an exploratory content pattern analysis and extracted five content components. Three of them were associated with concepts related to side effects of the vaccines, blood clots, and death. The other two were related to risk assessment and pausing of the vaccine. Political ideology, the differences between the benefit and the risk of vaccines, and the decision to pause the J&J vaccine were all correlated with the risk assessment and the pausing of the vaccine, whereas the correlation with the other three components were not particularly strong. Conservatives had lower scores than liberals on the risk assessment component, which indicated that they were less likely to state that the risk assessment was still in favor of using the vaccine. Unsurprisingly, these respondents perceive the differences between the perceived benefit and the perceived risk as lower than those who reported reasons suggesting that the risk assessment was still in favor of the use of the vaccine. As a result, this difference was also reflected on the decision to pause the vaccine. These data are consistent and support the findings relative to the thinking style used to report the reasons in favor of or against

the pausing of the vaccine. Liberals who perceived the benefit of the vaccines higher than the risks seem to have been more prone to rely on conscious thoughts on the safety of vaccines to overcome their negative feelings about the serious side effects.

#### 4.1 | Limitations and Future Directions

Despite the findings described above, this work has some limitations. The biggest limitation is likely the use of a correlational design. In part, this was a forced choice (e.g., people cannot be randomly assigned to a particular political group; information about the side effects of the vaccine was widely available in the media) but allowed us to use real stimuli and investigate a real-world issue while it was unfolding. Still, this design does not provide any definitive information regarding the causal effects that drive the decision to support or oppose the pausing of the vaccine. However, based on the literature and the correlations that emerged in the present study, we are confident that our interpretation of the data is reasonable. In fact, it is more likely that political ideology has an impact on the difference between the perceived benefit and risk of vaccines rather than the other way around. It would be rather surprising to discover that people's political ideology changes depending on how they feel about a specific risk topic (e.g., vaccines). Indeed, there is ample evidence that political ideology predicts people's feelings, opinions, and support for a wide range of issues in our society (Cohen, 2003; Van Boven & Sherman, 2021). In addition, we did not find a correlation between political ideology and thinking style, thus a model in which we invert the position of the two mediators does not work. Of course, this is an interpretation based on our findings, but further work is needed. To expand on the present work and have a better understanding of the underlying causal relations, an option would be to manipulate the format used to report the statistics (e.g., frequentist vs. probabilistic). Previous work suggest that this could impact risk perception (Monahan et al., 2002; Slovic et al., 2000) and could also impact people's choices about the pausing of the J&J vaccine. Finally, focusing the attention on the number of people saved by the vaccine versus those who suffered serious side effects (or died because of the coronavirus; Vacondio et al., 2021) could assess the impact of information that is inconsistent with previous beliefs and whether it is incorporated into people's motivations and decisions.

Another limitation is that we do not know the percentage of respondents who were already vaccinated with the J&J vaccine. People who had received that vaccine and did not experience any serious side effects might have had a more positive opinion of the J&J vaccine than if they had received another one instead. Consistent with such reasoning, men who were not impacted by the blood clots were more likely than women to perceive the benefit of the vaccines as much higher than the risk.

Finally, when it comes to measures to prevent the spread of COVID-19, the issue of people's trust is certainly a central

one (Cohen et al., 2022; Siegrist, 2021). We did not measure this variable, but it is very likely to play a role and should be included in future studies testing our proposed model. In the specific case on COVID-19 vaccines, trust might correlate with political ideology because of the intense polarization that characterized people's opinions on the measures to contain the spread of the virus. More importantly, we should expect that people with higher trust in the institutions and private companies should perceive the benefit of the vaccines higher than the risk and, potentially, to rely more on analytical thinking. Similarly, we provided respondents with several numerical pieces of information (number of people who died because of COVID-19, number of infected, number of people who received the J&J vaccine, and how many of them experienced serious side effects). We should therefore expect respondents with higher numeracy to be more able to extract meaning from the statistical information about the use of the vaccines and their effects, and to better assess the risk of the vaccines compared to respondents with lower numeracy.

This study contributes at multiple levels to the literature on vaccine hesitancy and risk perception. By studying a real-world issue as it was unfolding, we were able to assess how individual differences in political ideology and risk perception intertwined in shaping people's decisions. We also mixed different methodologies to achieve a more complex and complete understanding of the psychological dynamics underlining the decision to support or oppose the pausing of the J&J vaccine. We employed automated text analyses as a supporting method to more classical quantitative measures. By analyzing reasons that were directly produced by the respondents, we were able to provide a more direct measure of their thinking processes rather than inferring them indirectly. Finally, the analyses of the attitude statements rated by the respondents allowed us to gauge how multifaceted people's reactions to the J&J side effects issue were. It would be a mistake to reduce these issues to a mere political ideology contrast; clearly, political ideology has an impact on one's opinion of vaccines but the perception of information underlying people's decision making can vary significantly.

Our findings are also providing new insights on how people perceive risk, and future studies should deepen our understanding of these dynamics. For instance, there might be domains in which conservatives perceive the benefit higher than the risk, while liberals may perceive the benefit lower than the risk (e.g., guns). Therefore, a direction for future work could be to test the model described here in relation to a series of risks to understand when one group seems to underestimate risk compared to the other or vice versa. If there is variability among different risks in how conservatives and liberals react then a further question would pertain the analytical and affective strategies they employ to support or oppose action. This could allow to better understand the role of analytical thinking in relation to risk perception. If it is driven by the confirmation bias (e.g., motivated reasoning), we should find that both liberals and conservatives engage in more analytical thinking when their opinions are challenged by facts, and they need to overcome this information to stick to their

prior beliefs. Alternatively, we may find that analytic thinking is more likely to be used by liberals independently from whether their prior beliefs have been challenged or not.

After several years, the pandemic is still having a serious global impact and people's lives may never go back to what they were before the spread of coronavirus. Vaccines seem to be among the best tools to counteract the virus spread. However, science cannot guarantee that vaccines will never produce any side effects. This gives way to uncertainty and fear that can reduce people's willingness to vaccinate and our collective protection against viruses. Thus, the way people react to the news of severe side effects and how these events are managed is critical to maintain faith in the effectiveness of vaccines and to overcome the pandemic.

## ACKNOWLEDGMENTS

Open Access Funding provided by Università degli Studi di Padova within the CRUI-CARE Agreement.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

## ORCID

Enrico Rubaltelli  <https://orcid.org/0000-0002-7521-755X>

Paul Slovic  <https://orcid.org/0000-0002-7473-6403>

## REFERENCES

- Alhakami, A., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis*, *14*, 1085–1096. <https://doi.org/10.1111/j.1539-6924.1994.tb00080.x>
- Aw, J., Seng, J. J. B., Seah, S. S. Y., & Low, L. L. (2021). COVID-19 vaccine hesitancy—A scoping review of literature in high-income countries. *Vaccines*, *9*, 900. <https://doi.org/10.3390/vaccines9080900>
- Boyd, R. L., & Schwartz, H. A. (2021). Natural language analysis and the psychology of verbal behavior: The past, present, and future states of the field. *Journal of Language and Social Psychology*, *40*, 21–41. <https://doi.org/10.1177/0261927x20967028>
- Campbell, T. H., & Kay, A. C. (2014). Solution aversion: On the relation between ideology and motivated disbelief. *Journal of Personality and Social Psychology*, *107*, 809–824. <https://doi.org/10.1037/a0037963>
- Center for Disease Control (CDC). (2021). *Updates to the benefit/risk assessment for Janssen COVID-19 vaccines: Applying the evidence to recommendation framework*. [https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2021-12-16/04\\_COVID\\_Oliver\\_2021-12-16.pdf](https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2021-12-16/04_COVID_Oliver_2021-12-16.pdf)
- Chung, C. K., & Pennebaker, J. W. (2008). Revealing dimensions of thinking in open-ended self-descriptions: An automated meaning extraction method for natural language. *Journal of Research in Personality*, *42*, 96–132. <https://doi.org/10.1016/j.jrp.2007.04.006>
- Cinelli, M., De Francisci Morales, G., Galeazzi, A., Quattrociocchi, W., & Starnini, M. (2021). The echo-chamber effect of social media. *PNAS*, *118*, e2023301118. <https://doi.org/10.1073/pnas.2023301118>
- Cohen, A. S., Lutzke, L., Otten, C. D., & Arvai, J. (2022). I think, therefore I act: The influence of critical reasoning ability on trust and behavior during the COVID-19 pandemic. *Risk Analysis*, *42*, 1073–1085. <https://doi.org/10.1111/risa.13833>
- Cohen, G. L. (2003). Party over policy: The dominating impact of group influence on political beliefs. *Journal of Personality and Social Psychology*, *85*, 808–822. <https://psycnet.apa.org/doi/10.1037/0022-3514.85.5.808>
- Cohn, M. A., Mehl, M. R., & Pennebaker, J. W. (2004). Linguistic markers of psychological change surrounding September 11, 2001. *Psychological Science*, *15*, 687–693. <https://doi.org/10.1111/j.0956-7976.2004.00741.x>

- Di Marco, N., Cinelli, M., & Quattrociochi, W. (2021). Infodemics on YouTube: Reliability of content and echo-chambers on COVID-19. *arXiv preprint*. <https://arxiv.org/pdf/2106.08684.pdf>
- Dickert, S., Västfjäll, D., Mauro, R., & Slovic, P. (2015). *The feeling of risk: Implications for risk perception and communication*. In H. Cho, T. Reimer, & K. A. T. McComas (Eds.), *The SAGE handbook of risk communication* (pp. 41–54). Sage.
- Dubè, E., Laberge, C., Bramadat, P., Roy, R., & Bettinger, J. A. (2013). Vaccine hesitancy. *Human Vaccines & Immunotherapeutics*, 9, 1763–1773. <https://doi.org/10.4161/hv.24657>
- Eskola, J., Duclos, P., Schuster, M., & MacDonald, N. E. (2015). The SAGE Working Group on vaccine hesitancy. How to deal with vaccine hesitancy? *Vaccine*, 33, 4215–4217. <https://doi.org/10.1016/j.vaccine.2015.04.043>
- Evans, J. S. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, 59, 255–278. <http://doi.org/10.1146/annurev.psych.59.103006.093629>
- Flores, A., Cole, J. C., Dickert, S., Eom, K., Jiga-Boy, G. M., Kogut, T., Loria, R., Mayorga, M., Pedersen, E. J., Pereira, B., Rubaltelli, E., Sherman, D. K., Slovic, P., Västfjäll, D., & Van Boven, L. (2022). Politicians polarize and experts depolarize public support for COVID-19 management policies across countries. *PNAS*, 119, e2117543119. <https://doi.org/10.1073/pnas.2117543119>
- Fridman, A., Gershon, R., & Gneezy, A. (2021). COVID-19 and vaccine hesitancy: A longitudinal study. *PLoS ONE*, 16, e0250123. <https://doi.org/10.1371/journal.pone.0250123>
- Gavaruzzi, T., Caserotti, M., Leo, I., Tasso, A., Speri, L., Ferro, A., Fretti, E., Sannino, A., Rubaltelli, E., & Lotto, L. (2021). The role of emotional competencies in parents' vaccine hesitancy. *Vaccines*, 9, 298. <https://doi.org/10.3390/vaccines9030298>
- Gervais, W. M. (2015). Override the controversy: Analytic thinking predicts endorsement of evolution. *Cognition*, 142, 312–321. <https://doi.org/10.1016/j.cognition.2015.05.011>
- Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). The psychological roots of anti-vaccination attitudes: A 24-nation investigation. *Health Psychology*, 37, 307–315. <https://doi.org/10.1037/hea0000586>
- Ireland, M. E., & Mehl, M. R. (2014). Natural language use as a marker of personality. In T. M. Holtgraves (Ed.), *The Oxford handbook of language and social psychology* (pp. 201–218). Oxford University Press.
- Jordan, K. N., Sterling, J., Pennebaker, J. W., & Boyd, R. L. (2019). Examining long-term trends in politics and culture through language of political leaders and cultural institutions. *PNAS*, 116, 3476–3481. <https://doi.org/10.1073/pnas.1811987116>
- Jost, J. T. (2006). The end of the end of ideology. *American Psychologist*, 61, 651–670. <https://doi.org/10.1037/0003-066X.61.7.651>
- Jost, J. T. (2017). Ideological asymmetries and the essence of political psychology. *Political Psychology*, 38, 167–208. <https://doi.org/10.1111/pops.12407>
- Ju, Y., & You, M. (2021). It's politics, isn't it? Investigating direct and indirect influences of political orientation on risk perception of COVID-19. *Risk Analysis*, 42, 56–68. <https://doi.org/10.1111/risa.13801>
- Kahan, D. M. (2013). Ideology, motivated reasoning, and cognitive reflection. *Judgment and Decision Making*, 8, 407–424.
- Kahneman, D. (2011). *Thinking, fast and slow*. Macmillan.
- KFF. (2021). *KFF COVID-19 vaccine monitor: March 2021*. <https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-march-2021/>
- KFF. (2022). *KFF COVID-19 vaccine monitor: February 2022*. <https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-february-2022/>
- Khubchandani, J., Sharma, S., Price, J. H., Wiblehauser, M. J., Sharma, M., & Webb, F. J. (2021). COVID-19 vaccination hesitancy in the United States: A rapid national assessment. *Journal of Community Health*, 46, 270–277. <https://doi.org/10.1007/s10900-020-00958-x>
- Knobloch-Westerwick, S., Mothes, C., & Polavin, N. (2017). Confirmation bias, ingroup bias, and negativity bias in selective exposure to political information. *Communication Research*, 47, 104–124. <https://doi.org/10.1177/0093650217719596>
- Kunda, Z. (1990). The case for motivated reasoning. *Psychological Bulletin*, 108, 480–498. <https://doi.org/10.1037/0033-2909.108.3.480>
- Kyung, E., Manoj, T., & Aradhna, K. (2022). How political identity influences COVID-19 risk perception: A model of identity-based risk perception. *Journal of the Association for Consumer Research*, 7, 316–324.
- Leonhardt, D. (2021). US Covid deaths get even redder. *The New York Times*, November 24. <https://www.nytimes.com/2021/11/08/briefing/covid-death-toll-red-america.html>
- Markowitz, D. M. (2020). Putting your best pet forward: Language patterns of persuasion in online pet advertisements. *Journal of Applied Social Psychology*, 50, 160–173. <https://doi.org/10.1111/jasp.12647>
- Markowitz, D. M. (2021). The meaning extraction method: An approach to evaluate content patterns from large-scale language data. *Frontiers in Communication*, 6, 588823. <https://doi.org/10.3389/fcomm.2021.588823>
- Markowitz, D. M. (2022). Psychological trauma and emotional upheaval as revealed in academic writing: The case of COVID-19. *Cognition & Emotion*, 36, 9–22. <https://doi.org/10.1080/02699931.2021.2022602>
- Mercier, H. (2016). The argumentative theory: Predictions and empirical evidence. *Trends in Cognitive Sciences*, 20, 689–700. <https://doi.org/10.1016/j.tics.2016.07.001>
- Monahan, J., Heilbrun, K., Silver, E., Nabors, E., Bone, J., & Slovic, P. (2002). Communicating violence risk: Frequency formats, vivid outcomes, and forensic settings. *International Journal of Forensic Mental Health*, 1, 121–126. <https://doi.org/10.1080/14999013.2002.10471167>
- Mesch, G. S., & Schwirian, K. P. (2015). Social and political determinants of vaccine hesitancy: Lessons learned from the N1H1 pandemic of 2009–2010. *American Journal of Infection Control*, 43, 1161–1165. <https://doi.org/10.1016/j.ajic.2015.06.031>
- Pennebaker, J. W. (2011). *The secret life of pronouns: What our words say about us*. Bloomsbury Press.
- Pennebaker, J. W., Booth, R. J., Boyd, R. L., & Francis, M. E. (2015). Linguistic inquiry and word count: LIWC2015. Pennebaker Conglomerates.
- Pennebaker, J. W., Chung, C. K., Frazee, J., Lavergne, G. M., & Beaver, D. I. (2014). When small words foretell academic success: The case of collage admission essays. *PlosOne*, 9, e115844. <https://doi.org/10.1371/journal.pone.0115844>
- Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. A. (2014). The role of analytic thinking in moral judgements and values. *Thinking & Reasoning*, 20, 188–214. <https://doi.org/10.1080/13546783.2013.865000>
- Pennycook, G., Cheyne, J. A., Koehler, D. K., & Fugelsang, J. A. (2020). On the belief that beliefs should change according to evidence: Implications for conspiratorial, moral, political, religious, and science beliefs. *Judgment and Decision Making*, 15, 476–498.
- Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, 123, 335–346. <https://doi.org/10.1016/j.cognition.2012.03.003>
- Pennycook, G., & Rand, D. G. (2019). Lazy, not biased: Susceptibility to partisan fake news is better explained by lack of reasoning than by motivated reasoning. *Cognition*, 188, 39–50. <https://doi.org/10.1016/j.cognition.2018.06.011>
- Pew Research Center. (2020). *U.S. public now divided over whether to get COVID-19 vaccine*. <https://www.pewresearch.org/science/2020/09/17/u-s-public-now-divided-over-whether-to-get-covid-19-vaccine/>
- R Core Team. (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. <https://www.r-project.org>
- Robbins, R., & Erdbrink, T. (2021). European countries suspend use of AstraZeneca shots over worries about blood clots. *The New York Times*, March 11. <https://www.nytimes.com/2021/03/11/business/astrazeneca-vaccine-denmark-blood-clots.html?searchResultPosition=13>
- Rossell, Y. (2021). Package “lavaan.” <https://cran.r-project.org/web/packages/lavaan/lavaan.pdf>
- Royzman, E. B., Landy, J. F., & Goodwin, G. P. (2014). Are good reasoners more incest-friendly? Trait cognitive reflection predicts selective

- moralization in a sample of American adults. *Judgment and Decision Making*, 9, 176–190.
- Salmon, D. A., Dudley, M. Z., Glanz, J. M., & Omer, S. B. (2015). Vaccine hesitancy. *American Journal of Preventive Medicine*, 49, S391–S398. <https://doi.org/10.1016/j.amepre.2015.06.009>
- Seraj, S., Blackburn, K. G., & Pennebaker, J. W. (2021). Language left behind on social media exposes the emotional and cognitive cost of a romantic breakup. *PNAS*, 118, e2017154118. <https://doi.org/10.1073/pnas.2017154118>
- Sharma, K., Zhang, Y., & Liu, Y. (2021). Covid-19 vaccines: Characterizing misinformation campaigns and vaccine hesitancy on Twitter. arXiv preprint. <https://arxiv.org/pdf/2106.08423.pdf>
- Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: Cognitive style influences belief in God. *Journal of Experimental Psychology: General*, 141, 423–428. <https://doi.org/10.1037/a0025391>
- Siegrist, M. (2021). Trust and risk perception: A critical review of the literature. *Risk Analysis*, 41, 480–490. <https://doi.org/10.1111/risa.13325>
- Slovic, P., Finucane, M., Peters, E., & MacGregor, D. G. (2002). Rational actors or rational fools: Implications of the affect heuristic for behavioral economics. *Journal of Socio-Economics*, 31, 329–342. [https://doi.org/10.1016/S1053-5357\(02\)00174-9](https://doi.org/10.1016/S1053-5357(02)00174-9)
- Slovic, P., Monahan, J., & MacGregor, D. G. (2000). Violence risk assessment and risk communication: The effect of using actual cases, providing instruction, and employing probability versus frequency formats. *Law and Human Behavior*, 24, 271–296. <https://doi.org/10.1023/A:1005595519944>
- Strickland, A. A., Taber, C. S., & Lodge, M. (2011). Motivated reasoning and public opinion. *Journal of Health Politics, Policy and Law*, 36, 89–122. <https://doi.org/10.1215/03616878-1460524>
- Stroebe, W., vanDellen, M. R., Abakoumkin, G., Lemay, E. P., Jr., Schiavone, W. M., Agostini, M., Bélanger, J. J., Gützkw, B., Kreienkamp, J., Reitsema, A. M., Abdul Khaiyom, J. H., Ahmed, V., Akkas, H., Almenara, C. A., Atta, M., Bagci, S. C., Basel, S., Berisha Kida, E., Bernardo, A. B. I., ... & Leander, N. P. (2021). Politicization of Covid-19 health-protective behaviors in the United States: Longitudinal and cross-national evidence. *PLoSOne*, 16, e0256740. <https://doi.org/10.1371/journal.pone.0256740>
- Sunstein, C. R. (2002). Probability neglect: Emotions, worst cases, and law. *Yale Law Journal*, 112, 61–107.
- Swami, V., Voracek, M., Stieger, S., Tran, U. S., & Furnham, A. (2014). Analytic thinking reduces belief in conspiracy theories. *Cognition*, 133, 572–585. <https://doi.org/10.1016/j.cognition.2014.08.006>
- U.S. Food & Drug Administration. (2021). FDA and CDC lift recommended pause on Johnson & Johnson (Janssen) COVID-19 vaccine use following thorough safety review. FDA News Release. <https://www.fda.gov/news-events/press-announcements/fda-and-cdc-lift-recommended-pause-johnson-johnson-janssen-covid-19-vaccine-use-following-thorough>
- Vacondio, M., Priolo, G., Dickert, S., & Bonini, N. (2021). Worry, perceived threat and media communication as predictors of self-protective behaviors during the COVID-19 outbreak in Europe. *Frontiers in Psychology*, 12, 577992. <https://doi.org/10.3389/fpsyg.2021.577992>
- Van Boven, L., & Sherman, D. K. (2021). Elite influence on public attitudes about climate policy. *Current Opinions in Behavioral Science*, 42, 83–88. <https://doi.org/10.1016/j.cobeha.2021.03.023>

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Rubaltelli, E., Dickert, S., Markowitz, D. M., & Slovic, P. (2023). Political ideology shapes risk and benefit judgments of COVID-19 vaccines. *Risk Analysis*, 1–15. <https://doi.org/10.1111/risa.14150>