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Exploring vaccine hesitancy: the twofold role of critical thinking

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Abstract
With the progress of the vaccination campaign against the SARS-COV-2, we are ever closer to reaching that part of the population that refuses or is hesitant about vaccination. This study investigated the association between critical thinking motivation factors (i.e., intrinsic value of critical thinking and expectancy of one's critical thinking ability), conspiracy mentality, intolerance of uncertainty and hesitancy toward vaccination. A sample of 390 participants completed an online survey during April 2021. Across participants, results indicate that conspiracy mentality and expectancy about personal ability as a critical thinker positively predict vaccine hesitancy. On the contrary, the intrinsic value attributed to critical thinking, intolerance of uncertainty, and education are negatively associated with hesitancy. While the findings confirm existing evidence, particularly on the detrimental role of conspiracy mentality on vaccine acceptance, they also shed light on the double-faced role exercised by critical thinking. Practical implications and future directions are discussed.

Keywords Critical thinking · Conspiracy mentality · Intolerance of uncertainty · Vaccine hesitancy · COVID-19

Introduction

From the first clinical trial for a COVID-19 vaccine in March 2020, we have witnessed a growing development of different vaccine solutions and a simultaneous diffusion of the vaccine among the population in the last few months. While during the first pandemic phase, as vaccine availability was limited, much attention has been paid to investigate possible solutions to manage COVID-19 vaccine allocation priority (e.g. Ceccato, Di Crosta, et al., 2021; Ceccato, Palumbo, et al., 2021), nowadays national governments are concentrating their efforts on accelerating the vaccination campaign, as clinical and socio-economic benefits are linked to a high vaccination coverage. However, a portion of the population reports to be skeptics and/or shows hesitancy toward the vaccination. Vaccine hesitancy refers to "delay in acceptance or refusal of vaccines despite availability of vaccination services" (MacDonald, 2015). For example, related to the COVID-19 vaccination, in a recent survey across European countries 27% of Europeans were found to be vaccine hesitant (Ahrendt et al., 2021). As the vaccination campaign progresses, this could be a crucial point as we are getting closer and closer to this resistant part of the population (Feleszko et al., 2021).

To date, several psychological factors and processes have been explored in relation to vaccine hesitancy. For example, the lack of trust in authorized members of society (e.g., scientists, pharmaceutical companies, or governments in general) have been associated with negative attitudes towards vaccines (e.g. Kennedy, 2019; Mesch & Schwirian, 2015). More recently, regarding the COVID-19 pandemic, conspiracy-related variables (both generic conspiracy beliefs and specific COVID-19 related conspiracy beliefs) have been largely confirmed as negative predictor of compliance with preventive measures (e.g. Pavela Banai et al., 2021) and as a positive predictors of vaccine hesitancy across different populations and during different stages of the pandemic (Allington et al., 2021; Bertin et al., 2020; Murphy et al.,

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2021). It should be noted that conspiracy beliefs have been sometimes related to intolerance of uncertainty, as their formation is supposed to be due to an individual's perceived necessity to find a causal explanation to a situation with a high level of uncertainty (Douglas et al., 2019). Given the social and epidemiological relevance of the hesitancy phenomenon, researchers are urged to identify which variables may reduce or modulate the hesitancy toward vaccination. For example, critical/analytical thinking skills have been suggested as "protective" factors against general vaccine hesitancy (Arede et al., 2019). Some studies also reported that analytic thinking is associated with reduced endorsement of conspiracy theories (Pytlik et al., 2020). It should be noted that, as critical/analytical thinking is cognitively demanding and usually produces longer processing of information, some scholars argued that when assessing this ability, motivation towards this ability "activation" should be considered as well (Valenzuela et al., 2011).

Overall, the current study adopted an integrative approach to fill previous gaps in the literature by analyzing at once conspiracy mentality, intolerance of uncertainty, and critical thinking motivation, examining their separate role on people's hesitancy toward COVID-19 vaccination. Furthermore, for the first time, critical thinking was analyzed not as a cognitive skill, but as an attitudinal and motivational factor able to orient decisions and health behaviors.

Theorical background

Conspiracy mentality and intolerance of uncertainty

In the last few years, a topic that has increasingly caught scholars' attention is the investigation of psychological drivers and consequences of individuals' tendency to believe in conspiracy theories (Douglas et al., 2017). According to the most recent literature, the expression "conspiracy theories" identifies the "attempts to explain the ultimate causes of significant social and political events and circumstances with claims of secret plots by two or more powerful actors" (Douglas et al., 2019). Another widely shared definition was proposed by Swami and colleagues (Swami et al., 2014), who suggested that conspiracy theories can be defined as "a subset of false beliefs in which the ultimate cause of an event is believed to be due to a plot by multiple actors working together with a clear goal in mind, often unlawfully and in secret" (Swami et al., 2014; Swami & Furnham, 2014). One of the first psychological contributions on this topic supported the hypothesis that conspiracy beliefs are defined by a "monological functioning", as believing in one conspiracy theory is associated with believing in all conspiracy theories (Goertzel, 1994). While more recent evidence suggested that sometimes conspiracy beliefs can also be associated with a singular topic (Sutton & Douglas, 2014), some studies highlighted that a person who believes in a specific conspiracy theory is more likely to trust all other conspiracy theories even if not related to the first one (Swami et al., 2010; Wood et al., 2012). This evidence led to the conceptualization of a more general thinking style, usually referred to as "conspiracy mentality" or "conspiracy mindset" (Dagnall et al., 2015). According to the available literature, this "style" may arise from different factors. For example, schizotypy, a personality style associated with magical thinking and distorted odds beliefs, has been systematically found to be a strong predictor of beliefs in conspiracy theories (Barron et al., 2018; Barron et al., 2014). Moreover, conspiracy mentality has been associated with greater proneness to specific cognitive biases, such as the Bias Against Disconfirmatory Evidence (Buchy et al., 2007; Georgiou et al., 2021). Also, other factors, such as low level of education (Georgiou et al., 2019; Van Prooijen & Jostmann, 2013) and extreme political orientation (Van Prooijen & Acker, 2015), have been identified as positive predictors of conspiracy beliefs. Taken together, available evidence suggests a role of three possible unmet psychological needs in people's proneness to believe in conspiracy theories (Douglas et al., 2019; Stojanov et al., 2021). First, on a social level, when people feel that their need to maintain a positive self-image (Fairfield et al., 2015; Lantian et al., 2017) or a positive image of their ingroup (Cichocka et al., 2016) is threatened, they are more likely to adopt conspiracy beliefs. Second, conspiracy beliefs may arise when existential needs are activated and people need to feel safe and in control, such as when feeling powerless (Abalakina-Paap et al., 1999; Zebrowitz et al., 2015); this explanation was further supported by evidence of a reduction in conspiracy beliefs when the individual regained control (Van Prooijen & Acker, 2015). At last, as conspiracy beliefs may be seen as hypothesized causal explanations of the relationship between different events that might satisfy unsolved epistemic needs. Specifically, conspiracy beliefs can reduce uncertainty by engaging in mental sense-making processes that make the world understandable and predictable. This enhanced cognitive activity works as a coping strategy to restore a feeling of control (Park, 2010). Intolerance of uncertainty can be defined as "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016). Results on the relationship between intolerance of uncertainty and conspiracy theories' endorsement are mixed, with some findings suggesting no relationship (Maftei & Holman 2022; Moulding et al., 2016) and others reporting a positive association between the two variables

(Mari et al., 2022). By the way, for what concerns the direct influence of intolerance of uncertainty on COVID-19 vaccine hesitancy, more recent evidence suggests no significant role of this variable (Nazlı et al., 2021).

Regardless of the origin of a conspiracy mindset and its relationship with intolerance of uncertainty, several studies have reported an influence of this variable on the propensity to vaccinate. For example, in a cross-country study, Hornsey and colleagues reported conspirative thinking as the strongest predictor of anti-vaccine attitudes in general (Hornsey et al., 2018). The relationship between conspiracy beliefs and vaccine hesitancy has also been reported as related to specific diseases such as Polio (Murakami et al., 2014) or a particular type of vaccination such as MMR (McHale et al., 2016). Based on the available literature, we hypothesized that conspiracy mentality and intolerance of uncertainty positively predict vaccine hesitancy.

Critical thinking motivation and conspiracy mentality

Thinking style preferences, particularly for critical/analytical thinking, have been investigated as a possible protective factor against the endorsement of conspiracy theories (Pytlik et al., 2020). For instance, analytic thinking is associated with reduced beliefs in conspiracy theories and, in line with that, experimentally eliciting analytic thinking produces a reduction in conspiracies ideation (Swami et al., 2014). Generally speaking, out of the different measures and constructs used in literature to assess this variable, a more intuitive vs. deliberative thinking style has been consistently reported as a predictor of conspiracy mentality (Denovan et al., 2020). As related to the COVID-19 pandemic and related behaviors, Stanley and colleagues recently showed that lower engagement in analytic thinking is a predictor of both the tendency to believe that the pandemic is a hoax and the lack of respect for social distancing measures (Stanley et al., 2021). For what strictly regards vaccine hesitancy and refusal, an influence of parents' analytical thinking has been proposed as a relevant variable in children's vaccine uptake (Bertoncello et al., 2020; Tomljenovic et al., 2020). It should be noted that most of the contributions investigating the relationship between thinking style and vaccine-related behaviors have focused on analytic/critical thinking in its skill-based component. Nevertheless, no evidence is available for what concerns analytic/critical thinking motivation. Theoreticians of critical thinking, indeed, argued in favor of a bifactorial structure in the development of this style of thinking: on the one hand, the skill factor as a cognitive component, and on the other hand the disposition/motivation to put this style of thinking into practice (Elder & Paul, 2020). According to this approach, both components are required for critical thinking to be exercised. Moreover, critical thinking is a deliberative process, it is not automatically activated and presents activation costs. Therefore, the disposition/motivation component has been proposed as a prerequisite for activating and executing critical thinking skills (Faccione et al., 2000; Di Domenico et al., 2016). Thus, the literature investigating disposition/motivation toward critical thinking, by representing critical thinking as a task that requires resources to be performed, suggested that this variable depends on two different elements: first, the value that the individual assigns to critical thinking; and second, the expectation of a positive outcome as a consequence of the application of critical thinking (Eccles & Wigfield, 2002). Valenzuela and colleagues followed this line of reasoning and proposed a model and an associated measurement instrument for critical thinking motivation based on the value/expectation dichotomy. In this model, the value dimension reflects the positive intrinsic merit attributed to the critical thinking activity. In contrast, the dimension of expectation is defined as the individual self-evaluation of being a good critical thinker (Valenzuela et al., 2011). According to this model, both value and expectancy dimensions are required to be motivated to use one's critical thinking skills. Therefore, this motivational component led to the activation of critical thinking skills (the cognitive component).

For the current work, given that critical thinking motivation is expected to be positively associated with critical thinking skill itself and that this skill has been proposed as a protective factor against vaccine hesitancy and refusal (Anderson, 2015), we hypothesized that both expectancy and value dimensions of critical thinking motivation negatively predicts vaccine hesitancy.

Methods

Sample

A total of 400 participants (39% male; mean age = 39.2 ± 13, mean years of education 14.2 ± 3.8) were recruited for this study using a snowball method. Students were recruited during faculty classes. When they completed the survey, they were invited to share the link to the survey with friends. Therefore, the final sample included both college students and adults from the general population (age range: 21–64). Participants provided written informed consent in accordance with the Declaration of Helsinki's ethical standards. Data were collected via Qualtrics online platform (qualtrics.com) in three days during April 2021, when the national vaccine campaign in Italy had already started for a portion

of the population and the first vaccination wave was just started. All participants were Italian speakers who physically resided in Italy during the pandemic. The research protocol was approved by the Institutional Review Board of Psychology (IRBP).

Measures

To ensure that participants had no previous history of psychiatric disorders or mental health conditions in general, as this can represent an influencing factor for study variables, the survey included a screening question on mental health. As based on this question, 10 participants were excluded from the dataset. Therefore, we obtained a final sample of 390 participants (38% male; mean age = 41 ± 13 years, mean years of education = 13.9 ± 3.7). The survey also included demographic questions about age, gender, years of education, political orientation, and a screening question to exclude potential respondents that had already received the vaccine because belonging to one of the groups that have accessed vaccination before the rest of the population in Italy at the moment of data collection (i.e., over 80 years old, some professionals and people with specific medical conditions). No participant was excluded after this question. Further, participants answered the vaccine hesitancy question "When it becomes available to you, how likely or unlikely is it that you will decide to get the vaccine?" by using a 0 to 100 rating scale (from 0 = very likely to 100 = very unlikely). Thus, we obtain a score for which the higher the value, the higher respondent's hesitancy. The survey also included the Italian version of the Intolerance of Uncertainty Scale (IUS-12) (Bottesi et al., 2015; Lauriola et al., 2016), the Italian adaptation of the Conspiracy Mentality Scale (Stojanov & Halberstadt, 2019) and the Italian adaptation of the Critical Thinking Motivational Scale (Valenzuela et al., 2011).

Intolerance of uncertainty (IUS-12)

The short form of the Intolerance of uncertainty scale (IUS-12) (Lauriola et al., 2016) was administered to assess this factor. The scale includes 12 items measuring two independent scores, prospective and inhibitory intolerance, and a general score (example item: "Unforeseen events upset me greatly"). Participants are required to answer using a 5-points Likert scale (from 1 = not at all characteristic of me to 5 = entirely characteristic of me). For the current study, we computed the general score for which the higher the score, the more the respondent feels intolerant toward uncertainty. The scale showed excellent reliability in the current sample, Cronbach's α = 0.90.

Conspiracy mentality scale (CMS)

This scale includes 11 items measuring conspiracy mentality by asking participants to express their agreement with each item statement (example item: "Events throughout history are carefully planned and orchestrated by individuals for their betterment") using a 7 points Likert scale (from 1 = completely disagree to 7 = completely agree) (Stojanov & Halberstadt, 2019). The original scale allows computing two scores (skepticism and conspiracy theories) and a total composite score reflecting conspiracy mentality. Higher scores are associated with a more conspiratorial mindset. Given our interest in measuring a conspiracy mentality in its whole and the lack of a priori hypothesis on the role of each subfactor, for the subsequent analyses we focused on the total composite score, including all 11 items (in the present study Cronbach's α = 0.91) as suggested by previous literature (Stojanov & Halberstadt, 2019). It should be noted that none of the items in the CMS refers to specific conspiracy beliefs/theories about COVID-19 (more details on the Italian adaptation of the scale are provided in the Supplementary Material).

Critical thinking motivational scale (CTMS)

The critical thinking motivation scale (CTMS) (Valenzuela et al., 2011) contains 19 items measuring two factors: the intrinsic value of critical thinking (Value) and the expectations about one's skills as a critical thinker (Expectancy) through a Likert scale (from 1 = completely agree to 6 = completely disagree). The Value factor of critical thinking is assessed via items such as: "Critical thinking will be useful for my future" (in the present study Cronbach's α = 0.90). An example for the Expectancy factor is: "Concerning reasoning correctly, I am better than most of my peers" (in the present study Cronbach's α = 0.75). To the aim of the current study, the independent influence of Value and Expectancy factors of critical thinking on vaccine hesitancy was assessed (see the Supplementary Material for details on the Italian adaptation of the scale).

Results

Distribution of vaccine hesitancy

Across participants, vaccine hesitancy ranging from 0 (very likely to get the vaccine) to 100 (very unlikely to get the vaccine), was found to be moderate (M = 45.9, SD = 38.8). Mean vaccine hesitancy scores for each considered demographic variable are reported in Table 1.

Table 1 Participants' vaccine hesitancy on a scale from 0 (very likely to get the vaccine) to 100 (very unlikely to get the vaccine)

		M (SD)
Gender	Female	45.6 (37.8)
	Male	46.3 (40.5)
Educational Level	Elementary School	63 (40.3)
	Middle School	56.3 (36.9)
	High School	44.9 (40.1)
	College/University (1st level)	44.0 (36.6)
	College/University (2nd level)	38.1 (40.9)
	PhD or more	40.2 (43.3)
Political Orientation	Extreme right	0 (0)
	Right	60.9 (42.7)
	Center-Right	40.9 (43.3)
	Center	53.8 (45.0)
	Center-Left	38.6 (40.0)
	Left	39.3 (38.0)
	Extreme Left	78.6 (35.9)
	Prefer not to answer	47.3 (36.2)

Note. For descriptive purposes, years of education were converted into six educational levels.

Pearson correlation coefficients were computed to assess the relationships between intolerance of uncertainty, conspiracy mentality, and the two dimensions of critical thinking (i.e., expectancy and value) (Table 2). Intolerance of uncertainty was positively correlated with conspiracy mentality, $p < .001$. On the contrary, there was a negative correlation between conspiracy mentality and both value of critical thinking, $p = .002$, and expectancy of critical thinking, $p < .001$. Moreover, a negative correlation between intolerance of uncertainty and expectancy of critical thinking was found, $p < .001$.

At last, a hierarchical multiple regression model was carried out to investigate whether conspiracy mentality, intolerance of uncertainty, value, and expectancy scores from the CTMS could significantly predict participants' vaccine hesitancy while controlling for the potential role of demographic characteristics (gender, age, and years of education). Therefore, in the first step, we entered gender, age, and education. In the second step, conspiracy mentality, intolerance of uncertainty, value, and expectancy of CTMS were added. All the assumptions were met. The result indicated that the overall model explained a significant variance of vaccine hesitancy, 53%, $F(4, 382) = 104.2$, $p < .001$. Results revealed that education was the only significant demographic predictor, while age and gender did not exhibit significant relationship with hesitancy. Specifically, higher levels of education intolerance of uncertainty and value of CTMS, predicted lower levels of vaccine hesitancy. On the contrary, conspiracy mentality and expectancy of CTMS were found to be positive predictors of hesitancy. Therefore, vaccine hesitancy increases by about 3% for each unit increase in conspiracy mentality and 4.4% for each unit increase critical thinking expectancy. On the contrary, vaccine hesitancy decreases by about 5% for each unit increase in critical thinking value, about 1.5% for each increase in intolerance of uncertainty unit, and about 3.7% for education. Therefore, results revealed that, while conspiracy mentality and one's expectation as a critical thinker positively predict vaccine hesitancy, education, intolerance of uncertainty and value attributed to critical thinking were negative predictors of vaccine hesitancy (see Table 3).

The described analysis did not include political orientation as a predictor because about half of the participants answered "Prefer not to answer" on this question. Therefore, we replicated the same regression analysis described above by admitting only those participants who had reported their political orientation, adding political orientation into the first step. No significant association between vaccine hesitancy and political orientation was detected. For model 2 an $R^2 = 0.62$, $F(4, 186) = 74.13$, $p < .001$ was obtained. Detailed results are reported in Table 4.

Discussion

Going forward with vaccinations, nations are increasingly clashing with that portion of the population that has avoided vaccinating up to now. As current predictions suggest that we will need to continue vaccinating, it is helpful to understand which individual factors influence vaccine hesitancy we may have to continue to struggle with during the vaccination campaigns.

Our results highlighted a significant negative influence of education on vaccine hesitancy, similarly to what was reported by other studies (Bertoncello et al., 2020; Reno et al., 2021). On the other side, we found no relationship between political orientation and vaccine hesitancy, contrary to what was described in previous contributions (Fridman et

Table 2 Means (*M*), Standard Deviations (*SD*) and Pearson correlations (*r*) between variables

Variable	*M*	*SD*	1	2	3	4
1. Intolerance of Uncertainty	20.7	17.7	-			
2. Conspiracy Mentality	4.05	1.0	0.231**	-		
3. Value CTMS	5.1	0.64	−0.062	−0.146*	-	
4. Expectancy CTMS	4.3	0.98	−0.312**	−0.172**	0.497**	-
5. Vaccine Hesitancy	45.9	38.8	−0.709**	−0.064	−0.009	0.264**

Note. CTMS = Critical thinking motivational scale. *$p < .01$. **$p < .001$.

Table 3 Results for the hierarchical regression predicting vaccine hesitancy

	Predictor	*B*	*SE*	β	*t*	*p*	95%*CI* LL	95%*CI* UL
Model 1	Intercept	73.93	14.34		5.15	0.000	45.74	102.13
$F(3,386) = 2.38$	Gender	−0.25	4.24	−0.00	−0.05	0.953	-8.60	8.09
$p > .05$	Age	−0.20	0.16	−0.07	-1.21	0.225	−0.53	0.12
	Years of Education	-5.57	2.07	−0.14	-2.68	0.007	-9.65	-1.49
Model 2	Intercept	81.34	16.95		4.79	0.000	48.01	114.68
$F(7,382) = 61.63$	Gender	2.50	2.96	0.03	0.84	0.399	-3.31	8.33
$p < .001$	Age	−0.04	0.11	−0.01	−0.33	0.73	−0.27	0.19
	Years of Education	-3.68	1.50	−0.09	-2.45	0.015	-6.64	−0.73
	Intolerance of Uncertainty	-1.52	0.08	−0.69	-18.22	0.000	-1.68	-1.35
	Conspiracy Mentality	3.01	1.47	0.08	2.07	0.038	0.17	5.96
	Expectancy CTMS	4.41	1.69	0.11	2.60	0.010	1.08	7.75
	Value CTMS	-4.99	2.48	−0.08	-2.00	0.045	-9.88	−0.10

Note. SE = Standard Error. 95% CI = Confidence Interval at 95% for the estimated coefficient, LL = lower level, and UP = upper level. N = 390.

Table 4 Results for the hierarchical regression predicting vaccine hesitancy (including political orientation)

	Predictor	*B*	*SE*	β	*t*	*p*	95%*CI* LL	95%*CI* UL
Model 1	Intercept	83.86	22.70		3.69	0.000	39.07	128.65
$F(4,190) = 1.55$	Gender	0.42	6.45	0.00	0.06	0.947	-12.29	13.15
$p > .05$	Age	−0.19	0.24	−0.06	−0.78	0.433	−0.68	0.29
	Years of Education	-7.23	3.09	−0.18	-2.33	0.020	-13.33	-1.13
	Political Orientation	-1.37	2.01	−0.05	−0.68	0.494	-5.34	2.58
Model 2	Intercept	101.96	24.94		4.08	0.000	52.75	151.16
$F(8,186) = 39.04$	Gender	2.91	4.09	0.03	0.71	0.478	-5.16	10.98
$p < .001$	Age	−0.09	0.15	−0.03	−0.59	0.556	−0.404	0.21
	Years of Education	-3.67	2.01	−0.09	-1.82	0.070	-7.66	0.30
	Political Orientation	−0.77	1.27	−0.02	−0.60	0.544	-3.30	1.74
	Intolerance of Uncertainty	-1.69	0.11	−0.73	-14.87	0.000	-1.91	-1.46
	Conspiracy Mentality	4.68	1.97	0.11	2.37	0.019	0.79	8.58
	Expectancy CTMS	5.54	2.32	0.13	2.38	0.018	0.96	10.12
	Value CTMS	-9.57	3.78	−0.13	-2.52	0.012	-17.04	-2.10

Note. SE = Standard Error. 95% CI = Confidence Interval at 95% for the estimated coefficient, LL = lower level, and UP = upper level. N = 195.

al., 2021), possibly due to differences in the nationality of the involved participants. Regarding gender, we found no statistical differences contrary to some previous evidence which suggested more vaccine hesitancy in the female sample (Liu, 2021). Similarly, not significant role of age was detected in the present sample, while, for example, other evidence supported a higher hesitancy in the 35–54 years sample (Reno et al., 2021).

Results contribute to the investigation of this topic in two ways. First, from a theoretical point of view, present findings help clarify the association between intolerance of uncertainty and conspiracy beliefs. While a positive correlation between the two was detected, they intriguingly exerted an opposite influence of vaccine hesitancy. Indeed, while conspiracy mentality was found to positively predict hesitancy, as expected based on the literature, intolerance of uncertainty was a negative predictor of hesitancy. Overall, these findings supported the hypothesis of an association between intolerance towards uncertainty and a conspiratorial mentality and the influence of both factors on the propensity to receive the vaccination. Importantly, our results align with a recent study in the context of COVID-19 (Maftei & Holman, 2022), reporting a similar pattern of findings. Other authors investigated the predictors of compliance with the lockdown rules and found a small positive correlation between intolerance of uncertainty and conspiracy mentality and an opposite influence exerted by the two on the dependent variable (Maftei & Holman, 2022). A possible interpretation for our results stems from the hypothetical comparison of potential consequences to get (or not) vaccinated made by the individuals. Indeed, participants with high intolerance of uncertainty may have evaluated the effects of being vaccinated as less uncertain (more tolerable) than the consequences of not being vaccinated.

Second, our results suggest a dual role of critical thinking motivation in influencing hesitation about the vaccine.

While, on the one hand, beliefs about oneself as a good critical thinker seem to promote hesitation, beliefs about the positive intrinsic value of critical thinking itself seem to work as a protective factor against hesitation. In other words, people who believe to be very able to reason systematically and rationally (i.e., expectancy) were also less prone to get vaccinated. On the contrary, people who believe that thinking in a critical and analytical way is a relevant skill and an important personal goal were less hesitant toward the vaccination. From a more practical point of view, this result is particularly interesting for what concerns policy-making efforts to promote vaccination among the hesitant population. In this regard, our results confirm the relevant role played by critical thinking as they suggest that attributing a high value to critical thinking is associated with less vaccine hesitancy, thus supporting those accounts that sustain the need for specific health and media literacy training (Dib et al., 2021; Pisl et al., 2021). It is important to acknowledge that the supplementary analysis on the construct validity of the CTMS questionnaire suggested substantial room for improvement. However, to date, this is the only instrument available in the literature to measure critical thinking motivation. Future studies are needed to confirm present findings and to delve into the topic, examining additional aspects and operationalizations of critical thinking attitude.

Following the line of reasoning delineated so far, promoting a culture of critical thinking and attention toward accuracy (Pennycook et el., 2021) would help the population navigate a world full of information that every day requires the ability to distinguish the truth from fake information (Arede et al., 2019; Mammarella et al., 2012). On the other side, our findings indicate that perceiving oneself as a good critical thinker increases the hesitation towards the vaccine, suggests being cautious of those training programs, social initiatives, or intervention protocols that aim to increase (or that cause an increase as an indirect consequence of other programs) critical thinking, without taking into account the possible negative consequences or without equipping individuals of any instrument to manage this effect.

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Author contribution LC conceived the experiment. AB, ADC, and PLM prepared tasks and conducted the experiment. LC and IC performed the statistical analyses. LC, IC, ROP, ADD, and RIP prepared the draft manuscript. All authors discussed, reviewed, and approved the final manuscript.

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Data Availability The datasets generated during and/or analyzed the current study are available in the Open Science Framework repository: [https://osf.io/83mzb/?view_only=d6763991d8df45aba49cbd93860c85a1]

Declarations

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

References

Abalakina-Paap, M., Stephan, W. G., Craig, T., & Gregory, W. L. (1999). Beliefs in conspiracies. *Political Psychology*, *20*(3), 637–647. https://doi.org/10.1111/0162-895X.00160

Ahrendt, D., Mascherini, M., Nivakoski, S., & Sándor, E. (2021). Living, working and COVID-19 (Update April 2021): Mental health and trust decline across EU as pandemic enters another year. Eurofound.

Allington, D., McAndrew, S., Moxham-Hall, V., & Duffy, B. (2021). Coronavirus conspiracy suspicions, general vaccine attitudes, trust and coronavirus information source as predictors of vaccine hesitancy among UK residents during the COVID-19 pandemic. *Psychological medicine*, 1–12. https://doi.org/10.1017/S0033291721001434

Anderson, D. A. (2015). Analytic thinking predicts vaccine endorsement: linking cognitive style and affective orientation toward childhood vaccination. *University Honors Theses Paper*, *215*, https://doi.org/10.15760/honors.220

Arede, M., Bravo-Araya, M., Bouchard, É., Singh Gill, G., Plajer, V., Shehraj, A., & Shuaib, A., Y (2019). Combating vaccine hesitancy: teaching the next generation to navigate through the post truth era. *Frontiers in public health*, 381. https://doi.org/10.3389/fpubh.2018.00381

Barron, D., Furnham, A., Weis, L., Morgan, K. D., Towell, T., & Swami, V. (2018). The relationship between schizotypal facets and conspiracist beliefs via cognitive processes. *Psychiatry research*, *259*, 15–20. https://doi.org/10.1016/j.psychres.2017.10.001

Barron, D., Morgan, K., Towell, T., Altemeyer, B., & Swami, V. (2014). Associations between schizotypy and belief in conspiracist ideation. *Personality and individual differences*, *70*, 156–159. https://doi.org/10.1016/j.paid.2014.06.040

Bertin, P., Nera, K., & Delouvée, S. (2020). Conspiracy Beliefs, Rejection of Vaccination, and Support for hydroxychloroquine: A Conceptual Replication-Extension in the COVID-19 Pandemic Context. Frontiers in psychology,2471. https://doi.org/10.3389/fpsyg.2020.565128

Bertoncello, C., Ferro, A., Fonzo, M., Zanovello, S., Napoletano, G., Russo, F., Baldo, V., & Cocchio, S. (2020). Socioeconomic determinants in Vaccine Hesitancy and Vaccine Refusal in Italy. *Vaccines*, *8*(2), 276. https://doi.org/10.3390/vaccines8020276

Bottesi, G., Ghisi, M., Novara, C., Bertocchi, J., Boido, M., De Dominicis, I., & Freeston, M. H. (2015). Intolerance of uncertainty scale (IUS-27 e IUS-12): due studi preliminari. *Psicoterapia Cognitiva e Comportamentale*, *21*(3), 345–365.

Buchy, L., Woodward, T. S., & Liotti, M. (2007). A cognitive bias against disconfirmatory evidence (BADE) is associated with schizotypy. *Schizophrenia research*, *90*(1–3), 334–337. https://doi.org/10.1016/j.schres.2006.11.012

Carleton, R. N. (2016). Into the unknown: a review and synthesis of contemporary models involving uncertainty. *Journal of anxiety disorders*, *39*, 30–43. https://doi.org/10.1016/j.janxdis.2016.02.007

Ceccato, I., Di Crosta, A., La Malva, P., Cannito, L., Mammarella, N., Palumbo, R., & Di Domenico, A. (2021). Public opinion in

vaccine allocation priority: who comes first. *? Psychology & health*, 1–21. https://doi.org/10.1080/08870446.2021.2007914

Ceccato, I., Palumbo, R., Di Crosta, A., Marchetti, D., La Malva, P., Maiella, R., & Di Domenico, A. (2021). "What's next?" Individual differences in expected repercussions of the COVID-19 pandemic. *Personality and Individual Differences*, 174. https://doi.org/10.1016/j.paid.2021.110674

Cichocka, A., Marchlewska, M., Golec de Zavala, A., & Olechowski, M. (2016). 'They will not control us': Ingroup positivity and belief in intergroup conspiracies. *British Journal of Psychology*, *107*(3), 556–576. https://doi.org/10.1111/bjop.12158

Dagnall, N., Drinkwater, K., Parker, A., Denovan, A., & Parton, M. (2015). Conspiracy theory and cognitive style: a worldview. *Frontiers in psychology*, *6*, 206. https://doi.org/10.3389/fpsyg.2015.00206

Denovan, A., Dagnall, N., Drinkwater, K., Parker, A., & Neave, N. (2020). Conspiracist beliefs, intuitive thinking, and schizotypal facets: a further evaluation. *Applied Cognitive Psychology*, *34*(6), 1394–1405. https://doi.org/10.1002/acp.3716

Di Domenico, A., Palumbo, R., Fairfield, B., & Mammarella, N. (2016). Fighting apathy in alzheimer's dementia: a brief emotional-based intervention. *Psychiatry Research*, *242*, 331–335. https://doi.org/10.1016/j.psychres.2016.06.009

Dib, F., Mayaud, P., Chauvin, P., & Launay, O. (2021). Online mis/disinformation and vaccine hesitancy in the era of COVID-19: why we need an eHealth literacy revolution. *Human vaccines & immunotherapeutics*, 1–3. https://doi.org/10.1080/21645515.2021.1874218

Douglas, K. M., Sutton, R. M., & Cichocka, A. (2017). The psychology of conspiracy theories. *Current Directions in Psychological Science*, *26*(6), 538–542. https://doi.org/10.1177/0963721417718261

Douglas, K. M., Uscinski, J. E., Sutton, R. M., Cichocka, A., Nefes, T., Ang, C. S., & Deravi, F. (2019). Understanding conspiracy theories. *Political Psychology*, *40*, 3–35. https://doi.org/10.1111/pops.12568

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual review of psychology*, *53*(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Elder, L., & Paul, R. (2020). *Critical thinking: tools for taking charge of your learning and your life*. Foundation for Critical Thinking.

Faccione, P., Faccione, N., & Giancarlo, C. (2000). The disposition toward critical thinking: its character, measurement, and relationship to critical thinking skill. *Informal Logic*, *20*(1), 61–84. https://doi.org/10.22329/il.v20i1.2254

Fairfield, B., Mammarella, N., Palumbo, R., & Di Domenico, A. (2015). Emotional meta-memories: a review. *Brain Sciences*, *5*(4), 509–520. https://doi.org/10.3390/brainsci5040509

Feleszko, W., Lewulis, P., Czarnecki, A., & Waszkiewicz, P. (2021). Flattening the curve of COVID-19 vaccine Rejection-An International Overview. *Vaccines*, *9*(1), 44. https://doi.org/10.3390/vaccines9010044

Fridman, A., Gershon, R., & Gneezy, A. (2021). COVID-19 and vaccine hesitancy: a longitudinal study. *PloS one*, *16*(4), e0250123. https://doi.org/10.1371/journal.pone.0250123

Georgiou, N., Delfabbro, P., & Balzan, R. (2019). Conspiracy beliefs in the general population: the importance of psychopathology, cognitive style and educational attainment. *Personality and Individual Differences*, *151*, 109521. https://doi.org/10.1016/j.paid.2019.109521

Georgiou, N., Delfabbro, P., & Balzan, R. (2021). Conspiracy-beliefs and receptivity to Disconfirmatory Information: a study using the BADE Task. *SAGE Open*, *11*(1), 21582440211006131. https://doi.org/10.1177/21582440211006131

Goertzel, T. (1994). Belief in conspiracy theories. *Political psychology*, *15*(4), 731–742. https://doi.org/10.2307/3791630

Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). The psychological roots of anti-vaccination attitudes: a 24-nation investigation. *Health psychology*, *37*(4), 307–315. https://doi.org/10.1037/hea0000586

Kennedy, J. (2019). Populist politics and vaccine hesitancy in Western Europe: an analysis of national-level data. *European journal of public health*, *29*(3), 512–516. https://doi.org/10.1093/eurpub/ckz004

Lantian, A., Muller, D., Nurra, C., & Douglas, K. M. (2017). "I know things they don't know!": the role of need for uniqueness in belief in conspiracy theories. *Social Psychology*, *48*(3), 160–173. https://doi.org/10.1027/1864-9335/a000306

Lauriola, M., Mosca, O., & Carleton, R. N. (2016). Hierarchical factor structure of the intolerance of uncertainty scale short form (IUS-12) in the italian version. *TPM: Testing Psychometrics Methodology in Applied Psychology*, *23*(3), https://doi.org/10.4473/TPM23.3.8

Liu, R., & Li, G. M. (2021). Hesitancy in the time of coronavirus: temporal, spatial, and sociodemographic variations in COVID-19 vaccine hesitancy. *SSM-population health*, *15*, 100896. https://doi.org/10.1016/j.ssmph.2021.100896

MacDonald, N. E. (2015). Vaccine hesitancy: definition, scope and determinants. *Vaccine*, *33*(34), 4161–4164. https://doi.org/10.1016/j.vaccine.2015.04.036

Maftei, A., & Holman, A. C. (2022). Beliefs in conspiracy theories, intolerance of uncertainty, and moral disengagement during the coronavirus crisis. *Ethics & Behavior*, *32*(1), 1–11. https://doi.org/10.1080/10508422.2020.1843171

Mammarella, N., Fairfield, B., & Di Domenico, A. (2012). Comparing different types of source memory attributes in dementia of alzheimer's type. *International Psychogeriatrics*, *24*(4), 666–673. https://doi.org/10.1017/S1041610211002274

Mari, S., Gil de Zúñiga, H., Suerdem, A., Hanke, K., Brown, G., Vilar, R., & Bilewicz, M. (2022). Conspiracy theories and institutional trust: examining the role of uncertainty avoidance and active social media use. *Political Psychology*, *43*(2), 277–296. https://doi.org/10.1111/pops.12754

McHale, P., Keenan, A., & Ghebrehewet, S. (2016). Reasons for measles cases not being vaccinated with MMR: investigation into parents' and carers' views following a large measles outbreak. *Epidemiology & Infection*, *144*(4), 870–875. https://doi.org/10.1017/S0950268815001909

Mesch, G. S., & Schwirian, K. P. (2015). Social and political determinants of vaccine hesitancy: Lessons learned from the H1N1 pandemic of 2009–2010. *American journal of infection control*, *43*(11), 1161–1165. https://doi.org/10.1016/j.ajic.2015.06.031

Moulding, R., Nix-Carnell, S., Schnabel, A., Nedeljkovic, M., Burnside, E. E., Lentini, A. F., & Mehzabin, N. (2016). Better the devil you know than a world you don't? Intolerance of uncertainty and worldview explanations for belief in conspiracy theories. *Personality and individual differences*, *98*, 345–354. https://doi.org/10.1016/j.paid.2016.04.060

Murakami, H., Kobayashi, M., Hachiya, M., Khan, Z. S., Hassan, S. Q., & Sakurada, S. (2014). Refusal of oral polio vaccine in northwestern Pakistan: a qualitative and quantitative study. *Vaccine*, *32*(12), 1382–1387. https://doi.org/10.1016/j.vaccine.2014.01.018

Murphy, J., Vallières, F., Bentall, R. P., Shevlin, M., McBride, O., Hartman, T. K., & Hyland, P. (2021). Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nature communications*, *12*(1), 1–15. https://doi.org/10.1038/s41467-020-20226-9

Nazlı, Ş. B., Yığman, F., Sevindik, M., & Deniz Özturan, D. (2021). Psychological factors affecting COVID-19 vaccine hesitancy. *Irish Journal of Medical Science (1971-)*, 1–10. https://doi.org/10.1007/s11845-021-02640-0

Park, C. L. (2010). Making sense of the meaning literature: an integrative review of meaning making and its effects on adjustment to stressful life events. *Psychological bulletin*, *136*(2), 257. https://doi.org/10.1037/a0018301

Pavela Banai, I., Banai, B., & Mikloušić, I. (2021). Beliefs in COVID-19 conspiracy theories, compliance with the preventive measures, and trust in government medical officials. *Current Psychology*, *41*(10), 7448–7458. https://doi.org/10.1007/s12144-021-01898-y

Pennycook, G., Epstein, Z., Mosleh, M., Arechar, A. A., Eckles, D., & Rand, D. G. (2021). Shifting attention to accuracy can reduce misinformation online. *Nature*, *592*(7855), 590–595. https://doi.org/10.1038/s41586-021-03344-2

Pisl, V., Volavka, J., Chvojkova, E., Cechova, K., Kavalirova, G., & Vevera, J. (2021). Dissociation, cognitive reflection and health literacy have a modest effect on belief in conspiracy theories about Covid-19. *International Journal of Environmental Research and Public Health*, *18*(10), 5065. https://doi.org/10.3390/ijerph18105065

Pytlik, N., Soll, D., & Mehl, S. (2020). Thinking preferences and conspiracy belief: intuitive thinking and the jumping to conclusions-bias as a basis for the belief in conspiracy theories. *Frontiers in psychiatry*, 987. https://doi.org/10.3389/fpsyt.2020.568942

Reno, C., Maietti, E., Fantini, M. P., Savoia, E., Manzoli, L., Montalti, M., & Gori, D. (2021). Enhancing COVID-19 vaccines acceptance: results from a survey on vaccine hesitancy in northern Italy. *Vaccines*, *9*(4), 378. https://doi.org/10.3390/vaccines9040378

Stanley, M. L., Barr, N., Peters, K., & Seli, P. (2021). Analytic-thinking predicts hoax beliefs and helping behaviors in response to the COVID-19 pandemic. *Thinking & Reasoning*, *27*(3), 464–477. https://doi.org/10.1080/13546783.2020.1813806

Stojanov, A., & Halberstadt, J. (2019). The conspiracy mentality scale. *Social Psychology*, *50*, 215–232. https://doi.org/10.1027/1864-9335/a000381

Stojanov, A., Halberstadt, J., Bering, J. M., & Kenig, N. (2021). Examining a domain-specific link between perceived control and conspiracy beliefs: a brief report in the context of COVID-19. *Current Psychology*, 1–10. https://doi.org/10.1007/s12144-021-01977-0

Sutton, R. M., & Douglas, K. M. (2014). Examining the monological nature of conspiracy theories in Van Prooijen JW & Van Lange P (Eds.), *Power, politics, and paranoia: Why people are suspicious of their leaders* (pp. 254–272). https://doi.org/10.1017/CBO9781139565417.018

Swami, V., & Furnham, A. (2014). Political paranoia and conspiracy theories in Van Prooijen JW & Van Lange P (Eds.). *Power, politics, and paranoia: Why people are suspicious of their leaders* (pp. 218–236). https://doi.org/10.1017/CBO9781139565417.016

Swami, V., Chamorro-Premuzic, T., & Furnham, A. (2010). Unanswered questions: a preliminary investigation of personality and individual difference predictors of 9/11 conspiracist beliefs. *Applied Cognitive Psychology*, *24*(6), 749–761. https://doi.org/10.1002/acp.1583

Swami, V., Voracek, M., Stieger, S., Tran, U. S., & Furnham, A. (2014). Analytic thinking reduces belief in conspiracy theories. *Cognition*, *133*(3), 572–585. https://doi.org/10.1016/j.cognition.2014.08.006

Tomljenovic, H., Bubic, A., & Erceg, N. (2020). It just doesn't feel right–the relevance of emotions and intuition for parental vaccine conspiracy beliefs and vaccination uptake. *Psychology & health*, *35*(5), 538–554. https://doi.org/10.1080/08870446.2019.1673894

Valenzuela, J., Nieto, A. M., & Saiz, C. (2011). Critical thinking motivational scale (CTMS): una aportación para el estudio de la relación entre el pensamiento crítico y la motivación. *Electronic Journal of Research in Educational Psychology*, *9*(2), 823–848. https://doi.org/10.25115/ejrep.v9i24.1475

Van Prooijen, J. W., & Acker, M. (2015). The influence of control on belief in conspiracy theories: conceptual and applied extensions. *Applied Cognitive Psychology*, *29*(5), 753–761. https://doi.org/10.1002/acp.3161

Van Prooijen, J. W., & Jostmann, N. B. (2013). Belief in conspiracy theories: the influence of uncertainty and perceived morality. *European Journal of Social Psychology*, *43*(1), 109–115. https://doi.org/10.1002/ejsp.1922

Wood, M. J., Douglas, K. M., & Sutton, R. M. (2012). Dead and alive: beliefs in contradictory conspiracy theories. *Social psychological and personality science*, *3*(6), 767–773. https://doi.org/10.1177/1948550611434786

Zebrowitz, L. A., Franklin, R. G. Jr., & Palumbo, R. (2015). Ailing voters advance attractive congressional candidates. *Evolutionary Psychology*, *13*(1), 16–28. https://doi.org/10.1177/147470491501300102