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Thinking disposition, thinking style, and susceptibility to causal illusion predict fake news discriminability

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Abstract

Acceptance of fake news is probably modulated by an intricate interplay of social, cultural, and political factors. In this study, we investigated whether individual-level cognitive factors related to thinking and decision making could influence the tendency to accept fake news. A group of volunteers responded to a COVID19-related fake news discrimination scale as well as to questionnaires assessing their thinking style (reflective vs. intuitive) and thinking disposition (actively open-mindedness). Furthermore, they completed a computerized contingency learning task aimed at measuring their tendency to develop a causal illusion, a cognitive bias leading to perceive causal connections between non-contingent events. More actively open-minded and more reflective individuals presented higher fake news discrimination scores. In addition, those who developed weaker causal illusions in the contingency learning task were also more accurate at differentiating between fake and legitimate news. Actively open-minded thinking was the main contributor in a regression model predicting fake news discrimination.

KEYWORDS
analytic thinking, causal illusion, COVID 19, critical thinking, fake news, open-mindedness

1 | INTRODUCTION

At first glance, having a wide variety of resources at hand allows us to be more protected against false or misleading information. Nevertheless, this can only be true if we know how to discriminate corroborated and substantiated information from "fake news." Fake news is fabricated news designed to appear legitimate and spread through social media with the aim of deceiving the general public for ideological, social, or financial gain (Bronstein et al., 2019; Lazer et al., 2018). The COVID19 pandemic has clearly evidenced the amount of fake news circulating through our main communication channels (Kouzy et al., 2020; Li et al., 2020), and has brought to light the important negative consequences of the proliferation of fake news at both the individual and social levels. For example, although the extent to which fake news influences health behavior is still unclear (Greene & Murphy, 2021) being exposed to misinformation regarding COVID19 might decrease the intention to get vaccinated against it (Loomba et al., 2021).

In this scenario, it seems of utmost importance to determine who may be more susceptible to being influenced by misinformation and why. The distribution of fake news is likely to be modulated by the complex interplay of social, cultural, and political factors. Nevertheless, inter-individual variability might also play a role in the endorsement of fake news. In this sense, cognitive factors related to the way we think and make decisions could be influencing our predisposition to accept fake news. Following Bronstein et al. (2019), we propose that a particular thinking style, specifically, analytical or reflective thinking, as well as certain thinking dispositions, specifically,

inclination to actively open-minded thinking (AOT), could be protective against harmful influence of fake news.

Analytic or reflective thinking style has been previously associated with reduced belief in fake news and increased fake news discriminability (Bago et al., 2020; Bronstein et al., 2019, 2020; Greene & Murphy, 2020; Pennycook, McPhetres, et al., 2020). Reflectiveness refers to working memory-dependent, that is, conscious and deliberate, thinking processes which, if prompted, can intervene in the fast default responses provided by intuitive thinking (see the Type 1 vs. Type 2 distinction in the dual-process theory by Evans & Stanovich, 2013). Thus, a preference for reflective thinking could be, at least in part, responsible for the enhanced capacity of some individuals to avoid falling for the intuitive appeal of (mis)information distributed through fake news (Bronstein et al., 2019; Pennycook & Rand, 2019).

Furthermore, Bronstein et al. (2019) proposed that reduced AOT (Baron, 1985) could also play a role in fake news acceptance. AOT refers to the tendency to evaluate information avoiding contamination from our own prior beliefs, thus reflecting openness to change in beliefs and cognitive flexibility (Stanovich & West, 1997). Bronstein et al. (2019, 2020) observed a positive association between scores obtained in a self-report questionnaire aimed to measure AOT and the individuals' ability to discriminate between real and fake news, suggesting that this thinking disposition could be promoting resistance to misinformation. This is of special interest because, as opposed to cognitive capacities, thinking dispositions might be more easily malleable (Baron, 1985; Stanovich & West, 1997) and, hence, allow for the development of teaching interventions aimed at optimizing them.

Although reflectiveness and AOT are conceptually related to each other, they can be considered to capture different aspects of the more general process of analytic thinking. Thus, reflectiveness refers to the willingness to engage in analytic processes which could end up in the override of default-intuitive responses. In contrast, AOT refers to variability with regards to the use of evidence (e.g., how one treats disconfirmatory information, our inclination to look for alternatives…) when we develop or update our beliefs (Bronstein et al., 2019). In this study we propose that, together with specific thinking styles and thinking dispositions, basic cognitive processes such as those involved in causal inferences, could also play a relevant role in the acceptance of fake news. Adequate causal inference is crucial to understand our environment. Nevertheless, individuals are known to vary in their proneness to develop causal illusions, that is, erroneous perceptions of causal relationships between unconnected events (Matute et al., 2015). For instance, even though there is no evidence indicating that the 5G network causes COVID19, some individuals could have a stronger tendency to interpret the fact that 5G network has appeared at the same time as the coronavirus pandemic as convincing evidence favoring the causal connection between these two events. Given that many fake news stories rely on unwarranted causal relations (e.g., vodka is an effective preventive measure for COVID19; the pandemic was designed to influence the US elections; gargling with lemon juice reduces the risk of coronavirus infection…), we propose that individuals more prone to develop causal illusions could also be less able to discriminate between legitimate and fake news because they are biased toward accepting causal connections even when lacking adequate evidence.

Causal illusion has been frequently studied in the laboratory by means of contingency learning tasks in which the participants are asked to ascertain whether two events, the tentative cause (e.g., drug administration) and the outcome (e.g., healing from a medical condition) are causally related or not (Barberia et al., 2019; Blanco et al., 2015). In this task, the volunteers are presented with a set of trials displaying different combinations of absence or presence of the two events, after which the participants have to decide to what extent they are causally connected (e.g., how effective the drug is against the medical condition). Crucially, the task is set so that the contingency between cause and outcome is null (i.e., the probability of the outcome is unaffected by the presence or absence of the cause). Hence, the two events cannot be causally connected. Nevertheless, many volunteers end up believing that there exists a causal relation between them, especially when certain conditions, such as a high outcome density (i.e., the effect occurs often) are met (Blanco et al., 2013), as in the case of medical conditions with high rate of spontaneous remission.

Along with the causal judgment provided at the end of the task, the behavior of the participant during the task can also be informative of their causal learning strategies. In *active* versions of the contingency learning task (e.g., Barberia et al., 2013, 2018; Blanco et al., 2011) participants are free to decide whether or not to make the potential cause present in each trial (e.g., to give the drug to each patient or not). In that case, the percentage of times they do so is assumed to indicate their information search strategy, which usually is biased in a way that participants tend to test the hypothesis that the drug heals the medical condition by frequently administering the drug (Barberia et al., 2013). In a situation in which the healing occurs spontaneously, this search strategy allows for more coincidental drug-healing pairings, which might reinforce the erroneous idea that the potential cause and the outcome are actually related. This is consistent with the positive association found between the percentage of trials in which participants introduce the potential cause (e.g., drug) and the intensity of the causal illusion they report by the end of the task (Blanco et al., 2011). As suggested by Griffiths et al. (2018), this search strategy might be expressing a broad bias in favor of conjunctive events (i.e., occasions in which the drug and the healing co-occur) compared to disjunctive events (i.e., cases in which the drug is taken but no healing happens or cases in which healing is not preceded by the administration of the drug). In passive versions of the contingency learning task, this general bias would be expressed as more weight given by the participant to trials in which both the potential cause and the outcome co-occur (interpretation bias) whereas, in active tasks, it might also show up in the search strategies that are turned on when evaluating the causal relationship under examination (search bias).

Causal illusion is of especial interest for this study because previous research has shown that individuals prone to develop stronger illusions also tend to endorse epistemically unwarranted beliefs such as belief in the paranormal or pseudoscience (Blanco et al., 2015;

Griffiths et al., 2018; Torres et al., 2020). Moreover, the more general phenomenon of illusory pattern perception has also been associated with acceptance of epistemically suspect beliefs (van Prooijen et al., 2018; Walker et al., 2019). The association between causal illusion and unwarranted beliefs has been observed both in passive (Torres et al., 2020) and active (Blanco et al., 2015; Torres et al., 2022) versions of the contingency learning task and, in the latter ones, those individuals that more strongly endorse unwarranted beliefs also show stronger search biases (Blanco et al., 2015; Torres et al., 2022), which suggests that unwarranted beliefs might be associated both with a bias in the interpretation of causal information and with a bias when searching for causal information (as noted by Griffiths et al., 2018).

Following previous observations with regards to unwarranted beliefs, we hypothesize that the inability to properly assess causal relationships could influence fake news discrimination. In this sense, individuals less able to properly assess a causal connection might also be less prepared to detect a fake news story (e.g., one attributing COVID spreading to 5G) and to adequately discriminate it from legitimate ones.

Of note, previous studies have presented educational interventions which effectively reduce causal illusions, both when these illusions are created through passive (Rodríguez-Ferreiro et al., 2021) and active (Barberia et al., 2013, 2018) contingency learning tasks. If causal reasoning biases play a role in the acceptance of fake news, then we could expect these kinds of interventions to be able to reduce the spreading of fake news too.

In the present study, a group of volunteers completed a fake news discrimination scale consisting of real and fabricated news related to the COVID19 pandemic, thinking style and thinking disposition questionnaires, as well as a contingency learning task. Our hypothesis was that, compared to individuals with better abilities to discriminate between real and fake news, those with poorer abilities would be less actively open-minded, less inclined to reflective reasoning, and more prone to develop stronger causal illusions.

2 | METHODS

2.1 | Participants

For a priori sample size estimation, we decided to sequentially add participants until we reached a Bayes factor (BF) higher than 10 in favor or against the alternative hypothesis, that is, that participants with lower fake news discrimination index would show a stronger causal illusion. Due to practical reasons, we set up a limit of 150 participants, after which, if none of these values were reached, we would finish the experiment (see Barberia et al., 2019 for a similar strategy). Sensitivity analyses for correlation using G*Power 3.1.9.7 (Erdfelder et al., 2009) indicate that this sample size is adequate to detect a small-medium effect size of $r = .23$ with $\alpha = .05$ and $1 - \beta = .8$. A total of 152 volunteers completed the experiment (140 females, mean age = 20.4, $SD = 3.2$). They were all native Spanish speakers studying Psychology at the University of Barcelona, who provided informed consent before participating in the study. The study protocol was approved by the ethics committee of the University of Barcelona (Institutional Review Board IRB00003099).

2.2 | Materials and procedure

The experiment was presented online through Qualtrics (www.qualtrics.com). Participants were asked to follow the instructions on their computer screen, which were presented in Spanish. The volunteers were first asked to state their sex and age. Then, they started with the contingency learning task.

2.3 | Contingency learning task

The volunteers were asked to assess the effectiveness of a certain drug to heal headaches. In each of 40 trials, they were presented with one patient suffering from a headache and they were given the opportunity to administer the drug or not by clicking on one of two buttons ("Yes" or "No"). After 1 s, feedback was provided stating whether the patient had recovered from the headache or not. Then, a new trial started showing a new patient. The order of trial presentation was randomized. The proportion of patients healing was prefixed at 75% irrespective of the volunteer administering the drug or not. This high outcome density is known to promote the development of causal illusions in the participants (Alloy & Abramson, 1979; Blanco et al., 2013; Hannah & Beneteau, 2009). The proportion of cause-present trials, that is, how many times the volunteer chose to administer the medicine out of 40 possible patients, was registered as an indicator of the participant's search strategy during the task. After all 40 patients had been presented, the volunteers were asked to indicate "To what extent do you think the drug is effective as a cure for headache?" by selecting a value between 0 ("Not effective at all") and 100 ("Totally effective") on a slider. Given that the contingency between drug administration and drug intake experimented by the participants was close to null, higher values provided on this scale are assumed to indicate a stronger causal illusion.

2.4 | Fake news discrimination scale

After the contingency learning task was finished, the participants responded to a scale aimed to assess their capacity to discriminate between COVID19-related real and fake news. We presented the volunteers with 14 news items in random order. Each item consisted of a headline accompanied by a picture as they usually appear on social media. Seven of them corresponded to real news (e.g., "Many nursing homes have failures in the infection control.") either extracted from La Vanguardia, a major newspaper in Spain, or from Calvillo et al. (2020). The other seven were fake news (e.g., "The homemade hand sanitizer made with vodka helps stop coronavirus.") taken from Calvillo et al. (2020) or rephrased from stimuli by Roozenbeek et al. (2020).

Participants rated the headlines on a scale from 1 (not at all reliable) to 10 (very reliable). Three dependent variables were registered from this task: Fake news acceptance score, that is, mean values provided in response to fake news; real news acceptance score, that is, mean values provided in response to real news; and fake news discrimination index, difference between mean values provided in response to real and fake news (note that, for the analyses, the discrimination index was calculated using z-scores for the real and fake news endorsement). Higher values in the latter indicate a better ability to recognize real news as legitimate and/or fake news as untrustworthy.

2.5 | Thinking style and thinking disposition

Finally, the participants were presented with Spanish translations of two questionnaires in random order, the cognitive reflection test (CRT, Sirota & Juanchich, 2018) and the AOT Scale (AOT8, Bronstein et al., 2019). The CRT is a reasoning questionnaire aimed to assess the volunteer's ability to suppress an intuitive, incorrect, answer, and engage in deliberate thinking to find the correct answer. We used a multiple-choice version of the test (CRT MCQ-4, Sirota & Juanchich, 2018) including the three original items by Frederick (2005) as well as four new items by Thomson and Oppenheimer (2016). This version of the test, which presents four possible responses to each question (reflective response, intuitive response, and two fillers), has been shown to be as reliable as the original one with open-text responses, but it is completed and corrected more quickly (Sirota & Juanchich, 2018). The order of questions and responses was randomized between participants. We recorded two values from the participants' performance on this questionnaire: a reflectiveness score, the amount of correct responses, and an intuitiveness score, the amount of intuitive incorrect responses. The AOT8 is the short version of the original test by Stanovich and West (1997), including eight items aimed to assess the volunteer's proneness to open-minded thinking (e.g., "A person should always consider new possibilities"). The questionnaire uses a six-point scale ranging from "Disagree strongly" to "Agree strongly" and has obtained good reliability values in previous research (Bronstein et al., 2019). We calculated the mean score, after reverse scoring when appropriate, to get an AOT index.

3 | RESULTS

The full dataset generated in this study is provided at https://osf.io/e3cmk/. We analyzed the data in JASP (JASP Team, 2021). Given that most of the variables were not distributed normally, Shapiro–Wilk >0.9, $p < .001$, we analyzed the correlation between them by means of Kendal's τ. We report the results of both frequentist (i.e., p value-based significance testing) and Bayesian analyses. In that last case, we report BF_{10} statistics, which indicate to what extent the analyzed data are more probable under the alternative hypothesis than the null hypothesis. For a qualitative interpretation of this data we followed Wagenmakers et al. (2018).

TABLE 1 Summary descriptive statistics for the contingency learning task and the questionnaires

	Mean	*SD*	ω
Contingency learning task			
Administration rate	0.59	0.18	
Experienced contingency	0.01	0.19	
Effectiveness rating	49.8	28.5	
Questionnaires			
Real news	6.5	1.4	.71
Fake news	2.8	1.3	.71
News discriminability	3.7	1.6	
AOT	4.8	0.6	.62
CRT-reflectiveness	2.8	1.9	
CRT-intuitiveness	3.1	1.7	

Abbreviations: AOT, active open-minded thinking; CRT, cognitive reflection test.

3.1 | Descriptive statistics

A summary of the results is presented in Table 1. Regarding the contingency learning task, although it was designed so that the probability of recovery was the same for patients irrespective of the participants introducing the drug or not, the fact that the volunteers were free to choose when to introduce the potential cause implies that they could end up being exposed to different cause-outcome contingency values. With this in mind, we conducted a one-sample t test which confirmed that the mean contingency experienced by the participants (P(healing)|drug − P(healing)| ∼ drug) was not significantly different from 0, $t(141) = 0.78$, $p = .438$, $BF_{10} = 0.13$.

As for the fake news discrimination questionnaire (see Table 1), consistency values were adequate (Hair et al., 2009) for both the real news and the fake news subscales and the participants rated real news as more reliable than fake news, $t(151) = 28.46$, $p < .001$, $BF_{10} = 9e + 58$. Finally, the AOT questionnaire showed an acceptable (Hair et al., 2009) level of consistency.

3.2 | Zero-order correlations

Results of correlation analyses including relevant variables obtained from the thinking style, thinking disposition and contingency learning tasks is presented in Table 2. Regarding the contingency learning task, the experienced contingency value was significantly associated with the effectiveness judgment. Drug administration rate and effectiveness judgment were also significantly correlated with each other, confirming that individuals with higher drug administration rates develop stronger causal illusions (Blanco et al., 2011, 2015). As for the questionnaires, neither the reflectiveness nor the intuitiveness scores were significantly correlated with the AOT index, indicating some degree of independence between thinking style and thinking disposition measures in our study. Interestingly, the intensity of the causal illusion

TABLE 2 Summary of the correlation analyses including scores obtained in the thinking style, thinking disposition, and contingency learning tasks

	AOT		CRT_Ref.		CRT_Int.		Effect		Admin	
	r_τ (BF_{10})	p	r_τ (BF_{10})	p	r_τ (BF_{10})	p	r_τ (BF_{10})	p	r_τ (BF_{10})	p
CRT-reflectiveness	0.09 (18.22)		–							
CRT-intuitiveness	−0.08 (0.29)		−0.67 (7e + 30)	<.001	–					
Effect. rating (CLT)	−0.1 (0.47)		−0.15 (3.69)	.014	0.12 (1.27)	.04	–			
Admin. rate (CLT)	0.01 (0.11)		0.01 (0.107)		−0.05 (0.16)		0.37 (4e + 8)	<.001	–	
Exp. cont. (CLT)	−0.05 (0.16)		0.08 (0.27)		−0.01 (0.11)		0.29 (3e + 4)	<.001	0.14 (1.96)	.021

Abbreviations: Admin. rate, administration rate; Admin, administration rate; AOT, actively open-minded thinking; CLT, contingency learning task; CRT-Int., cognitive reflection test—intuitiveness; CRT-Ref., cognitive reflection test—reflectiveness; Effect., effectiveness rating; Effect. rating, effectiveness rating; Exp. cont., experienced contingency.

TABLE 3 Summary of the correlation analyses including scores obtained in the fake news discrimination questionnaire and the other tasks

	Fake news		Real news		Discrimination	
	r_τ (BF_{10})	p	r_τ (BF_{10})	p	r_τ (BF_{10})	p
AOT	−0.18	.004	0.075		0.15	.012
	(18.22)		(0.27)		(4.53)	
CRT reflectiveness	−0.14	.021	0.04		0.15	.009
	(2.36)		(0.14)		(5.19)	
CRT intuitiveness	0.16	.007	0.04		−0.08	
	(7.34)		(0.134)		(0.29)	
Drug administration rate (CLT)	0.01		−0.001		−0.04	
	(0.11)		(0.11)		(0.13)	
Causal illusion (CLT)	0.07		−0.03		−0.12	.037
	(0.25)		(0.13)		(0.99)	

Abbreviations: AOT, actively open-minded thinking; CLT, contingency learning task; CRT, cognitive reflection test.

negatively correlated with reflectiveness. A significant but less reliable association between causal illusion and intuitiveness also appeared in the analyses. These results indicate that more reflective, and less intuitive, individuals tend to develop weaker causal illusions.

After analyzing the results of the different tasks separately, we analyzed whether the results of the fake news discrimination questionnaire were correlated with those of the analytic thinking questionnaires and the contingency learning task (see Table 3). Our participants' scores in response to fake news were negatively correlated with their AOT scores and CRT reflectiveness scores and positively correlated with CRT intuitiveness scores. Thus, more actively open-minded individuals and those showing more reflective, and less intuitive, thinking patterns considered fake news as less reliable. In contrast, their scores in response to real news were not correlated with the responses in any of the other two questionnaires. Furthermore, volunteers with better abilities to discriminate between real and fake news showed more AOT and reflective reasoning strategies.

Regarding the possible relation between fake news discrimination and causal illusion, a significant negative correlation appeared between fake news discrimination values and effectiveness judgments (see Table 3). According to this result, individuals with better abilities to discriminate between real and fake news show weaker causal illusions. Of note, this effect was maintained in a subsequent partial correlation analysis in which the association between fake news discriminability and causal illusion was conditioned on the contingency experienced by each participant in the contingency learning task, $r_\tau = -0.12$; $p = .035$, suggesting that the effect was robust to deviances from zero in the contingency between drug administration and healing experienced by the participants during the task. In contrast, drug administration rate was not associated with scores obtained in the fake news discrimination scale.

Finally, in order to study the relative contribution of thinking disposition, thinking style and causal illusion to fake news discrimination, we conducted a regression analysis including AOT and reflectiveness scores as well as causal illusion values as predictors and the discrimination index as dependent variable. Although the amount of explained variance was small, ${}_{Adj}R^2 = .08$, the model significantly predicted fake news discrimination ability, $p = .002$, AOT $\beta = .22$, $p = .006$; reflectiveness $\beta = .14$, $p = .08$; causal illusion $\beta = -.08$, $p = .315$. The removal of the non-significant causal illusion predictor from the model led to similar results, AOT $\beta = .24$, $p = .003$, reflectiveness $\beta = .16$, $p = .048$.

4 | DISCUSSION

We presented volunteers with a fake news discrimination scale, as well as thinking style and thinking disposition questionnaires. Moreover, our participants also completed a contingency learning task aimed to generate a causal illusion. We expected that individuals with reduced ability to discriminate between real and fake news would be less actively open-minded and reflective (Bronstein et al., 2019, 2020), as well as more susceptible to develop stronger causal illusions. Our results generally confirmed our initial hypotheses.

We replicated the observations by Bronstein et al. (2019, 2020) as both actively open-mindedness and reflectiveness scores positively correlated with fake news discrimination abilities, indicating that more open-minded and more reflective individuals present better abilities to adequately distinguish between real and fake news.

Regarding our novel hypothesis, as expected, effectiveness judgments in the contingency learning task also correlated, negatively, with fake news discrimination scores. The fact that drug administration rates did not correlate with fake news discrimination scores suggests that sensitivity to fake news might be associated with differences in the interpretation of causal information (interpretation bias), but not with differences in the way in which individuals search for causal information (search bias). Nevertheless, note that we did not give participants the opportunity to search for information supporting or discrediting the claims made by the news (an opportunity that could be present in real-life situations), which might have hindered the identification of such an association.

Although our results suggest that individuals developing weaker causal illusions better discriminated between real and fake news, Bayesian statistics indicated that this effect was less reliable than the previously mentioned ones. Indeed, when the three variables (i.e., open-mindedness, reflectiveness, and causal illusion) were included in a regression analysis to predict fake news discrimination abilities, only the first two appeared to provide a meaningful contribution to the predictive model.

Previous studies had linked susceptibility to develop stronger causal illusions with the endorsement of beliefs closely related to fake news, such as paranormal or pseudoscientific beliefs (Blanco et al., 2015; Griffiths et al., 2018; Torres et al., 2020, 2022). We specifically predicted that one individual's tendency to develop causal misattributions, such as causally linking two events based on mere temporo-spatial coincidences (e.g., the 5G network and COVID19), could be contributing to their inclination to accept fake news as reliable. The significant correlation between fake news discriminability and effectiveness judgments in the contingency learning task in our study suggests that the basic cognitive processes involved in causal illusion could also be playing a relevant role in fake news discriminability. Nevertheless, the evidence we have gathered in this study is not sufficient to draw strong conclusions in this respect, so further research should be conducted to ascertain whether cognitive biases specifically related to causal inference are associated with acceptance of fake news. A possible reason for this weak effect could be that processes involved in causal illusion only affect fake news discriminability when causal inference is crucial for the news item assessed. In our study, some of the fake news items (e.g., "Chinese authorities confirm that Africans are genetically resistant to coronavirus") were not obviously based on causal connections, which might have diminished our capacity to detect a consistent relation between fake news discriminability and causal illusion. Future studies could investigate the association between these two constructs using fake news more clearly related to causal links between events.

When separately analyzing each of the components of the fake news discrimination index (i.e., fake news acceptance and real news acceptance indexes), we observed significant negative associations between both actively open-mindedness and reflectiveness and fake news acceptance, whereas no association appeared with regards to real news acceptance. These results suggest that the relation between fake news discrimination and thinking disposition and thinking style relies on the tendency of less reflective and less actively open-minded individuals to accept fake news to a greater extent. In contrast, although a sensitivity analysis indicated that our sample was adequate to detect small-medium effect sizes in bivariate correlations, we were not able to identify a significant correlation between causal illusion and fake news acceptance. Given that the association between fake news discrimination and causal illusion we observed was itself quite weak, we cannot discard that our study was not adequate to detect an association between causal illusion and fake news acceptance parallel to that observed with regards to actively open-mindedness and reflectiveness. As stated above, further studies using a fake news questionnaire more aligned with causal inference might help clarifying this issue.

It is worth noting that we also found a negative association between the strength of the causal illusions manifested in the contingency learning task and the reflectiveness scores obtained by the participants in the CRT (see Sulik et al., 2020 for a related result). The finding is consistent with the idea that causal illusions might be the consequence of a simple (intuitive) learning process, mainly driven by coincidences between the potential cause and the outcome (i.e., conjunctive events), and that overcoming these illusions would require instruction on a (non-intuitive) scientific thinking (Matute et al., 2015). In this respect, participants scoring lower in reflectiveness on the CRT, might be the ones that are more prone to face the contingency learning task by more intensely overweighting cause-outcome coincidences, which would lead them to develop stronger causal illusions. More generally, the association between the causal illusion bias and lack of reflectiveness could help explain previous findings linking the tendency to jump to conclusions (i.e., the tendency to draw an inference on the basis of very limited information, Irwin et al., 2014) with endorsement of unwarranted beliefs in subclinical individuals (Moreno-Fernández et al., 2021; Rodríguez-Ferreiro & Barberia, 2021; Sanchez & Dunning, 2021).

A limitation of our study is related to the nature of the sample, which was exclusively composed of university students. Our results can be taken to reflect individual-level cognitive factors related to the tendency to accept fake news of individuals with high education levels who tend to be frequent users of social media platforms, and are, hence, particularly likely to be exposed to fake news in their

everyday lives (Leeder, 2019). Moreover, most of them were women, making us unable to study possible sex- or gender-related differences with regards to possible mediators of fake news discriminability. Further studies including more varied samples should be conducted to ascertain whether our conclusions hold for individuals with other socio-demographic characteristics.

In this study, we used the eight-stimuli AOT scale by Bronstein et al. (2019) which asks about beliefs (e.g., "Beliefs should always be revised in response to new information or evidence"). Nevertheless, it should be noted that a revised version of the scale exists (Pennycook, Cheyne, et al., 2020) which changes the wording of some items so they refer to opinions (e.g., "Opinions should always be revised in response to new information or evidence"). Although the scale has been shown to be strongly predictive of a wide range of beliefs and opinions (e.g., political inclinations, moral views, religious values, unwarranted beliefs…) regardless of the minimal changes in the wording (Pennycook, Cheyne, et al., 2020), further research could study whether our pattern of results is replicated when participants are asked about open mindedness specifically related to opinions.

Another important limitation stems from the use of a correlational design. In this study, we have identified an association between specific cognitive traits and the ability to discriminate fake news items from legitimate ones. Nevertheless, it remains unclear whether a causal connection exists between them. On the basis of our data, we could hypothesize that an AOT disposition prevents fake news acceptance. As we have already mentioned in the introduction, thinking dispositions are assumed to be malleable (Baron, 1985; Stanovich & West, 1997), and, thus, are susceptible to modification by means of, for instance, teaching interventions. One way to test this hypothesis, which leads us to the practical implications of our results, would be to design and implement an intervention aimed at alerting individuals regarding the risks of using preconceptions as the starting point for reasoning, and provide them with strategies to avoid contamination from prior beliefs (e.g., interventions based on the reduction of the confirmation bias such as that presented by Barberia et al., 2018; Rodríguez-Ferreiro et al., 2021). If we are correct, such an intervention should lead to an increased ability to adequately discriminate, and reject, fake news.

5 | CONCLUSIONS

All in all, our study confirmed the associations between both cognitive disposition and cognitive style and fake news discrimination. Specifically, more actively open-minded and more reflective individuals presented higher fake news discrimination scores. We also identified an association between the causal illusion bias and fake news discrimination, as individuals who developed weaker causal illusions in a contingency learning task were less able to discriminate real news items from fake ones. Nevertheless, this effect was weak and it did not survive inclusion in a regression analysis with the thinking style and thinking disposition measures, so it remains unclear whether it conveys new information beyond that explained by those constructs. We encourage future studies to continue investigating this association focusing on fake news directly linked to suspect causal connections and further exploring the role of information search strategies by allowing participants to gather information to aid them checking the news.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

Data generated during this study is available at the OSF repository https://osf.io/e3cmk/

ETHICS STATEMENT

The study protocol was approved by the ethics committee of the University of Barcelona (Institutional Review Board IRB00003099).

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