Maybe a Free Thinker but not a Critical One: High Conspiracy Belief is Associated With low Critical Thinking Ability

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Abstract

Critical thinking is of paramount importance in our society. People regularly assume that critical thinking is a way to reduce conspiracy belief, although the relationship between critical thinking and conspiracy belief has never been tested. We conducted two studies (Study 1, $N = 86$; Study 2, $N = 252$), in which we found that critical thinking ability—measured by an open-ended test emphasizing several areas of critical thinking ability in the context of argumentation—is negatively associated with belief in conspiracy theories. Additionally, we did not find a significant relationship between self-reported (subjective) critical thinking ability and conspiracy belief. Our results support the idea that conspiracy believers have less developed critical thinking ability and stimulate discussion about the possibility of reducing conspiracy beliefs via the development of critical thinking.

Keywords: critical thinking, conspiracy belief, reasoning ability, argumentation

Maybe a Free Thinker but not a Critical One: High Conspiracy Belief is Associated With Low Critical Thinking Ability

In the last few years, a number of training courses and tools specifically designed to enhance critical thinking have been developed. Whereas these initiatives seem premature in view of the current state of knowledge on this topic (Bronner et al., 2016), these resources are assumed to be an effective way of reducing the spread of conspiracy theories and conspiracy beliefs (Éduscol, 2019; Université de Paix asbl, 2017). An ethnographic fieldwork study suggests that people from the Dutch conspiracy milieu depict themselves as "critical freethinkers" (Harambam & Aupers, 2017). This finding may reflect the rhetoric of believers in conspiracy theories glorifying the so-called critical thinking of individuals who subscribe to these narratives (Konda, 2019, p. 7; Nairn, 2017, p. 20). Interestingly, this "rational conspiracist hypothesis" (van Prooijen, 2019)—commonly attributed to conspiracy believers—does not seem to be in line with reality. Indeed, when it comes to *objective* rather than *subjective* critical thinking, a variety of indirect evidence suggests that conspiracy believers are less likely to rely on a rational mindset (called "gullible conspiracist hypothesis", van Prooijen, 2019). Surprisingly, the link between critical thinking and belief in conspiracy theories has never been directly tested.

Conspiracy theories refer to attempts to explain the ultimate cause of an important event (social, political, climatic, etc.), by accusing a hidden coalition of perceived malicious and powerful people or organizations of having secretly planned and implemented these events (Butter & Knight, 2020; Douglas & Sutton, 2008; Keeley, 1999). In recent years, a great deal of studies have examined the psychological underpinnings of belief in conspiracy theories (Douglas & Sutton, 2018; Douglas et al., 2017, 2019), such as personality and individual differences (Lantian et al., 2020), motivations and emotions (Douglas et al., 2020),

group processes (Biddlestone et al., 2020), diffusion (Bangerter et al., 2020), and social-cognitive processes (van Prooijen et al., 2020).

Among the cognitive skills potentially associated with conspiracy belief, results point to the compatibility of certain forms of cognitive style with conspiratorial thinking. In accordance with the gullible conspiracist hypothesis, several studies (Adam-Troian et al., 2019; Barron et al., 2018; Georgiou et al., 2019; Ståhl & van Prooijen, 2018; Stojanov & Halberstadt, 2019; Swami et al., 2014; van der Wal et al., 2018; van Prooijen, 2017; Wagner-Egger et al., 2019) have pointed out that people who strongly believe in conspiracy theories show a low level of analytic thinking (characterized as being slow, controlled, and resource-demanding; Franssens & De Neys, 2009). Taking this further, eliciting analytic thinking through different procedures causally decreases conspiracy beliefs (Studies 2-4, Swami et al., 2014). Van Prooijen (2017) argues that analytical thinking could be an information processing mechanism that mediates the negative association between educational level and belief in conspiracy theories. The latter link has been established many times, although only in a correlational way (e.g., Federico et al., 2018; Freeman & Bentall, 2017; Georgiou et al., 2019; Mancosu et al., 2017; Oliver & Wood, 2014; Ståhl & van Prooijen, 2018; Uscinski & Parent, 2014; van Prooijen, 2017).

Research has refined the conditions under which cognitive constructs are related to beliefs in conspiracy theories. According to Ståhl and van Prooijen (2018), analytic thinking alone is not sufficient to distance individuals from conspiracy theories. Valuing epistemic rationality (i.e., the motivation to form beliefs on rational grounds) is also necessary in order to observe the negative association between analytic thinking and conspiracy belief. In their first study, they found that among people with a higher tendency to rely on analytic thinking (operationalized via a measure of analytic cognitive style and specified as a tendency to apply analytic processing), only those who valued epistemic rationality believed less in conspiracy

theories. In their second study, this tendency to rely on analytic processing has been distinguished from cognitive skills to process analytically (Ståhl & van Prooijen, 2018). The authors found that when these two predictors are simultaneously taken into account in addition to the valuation of the epistemic rationality, it is only the interaction between the valuation of the epistemic rationality and cognitive skills (and not tendency to rely on analytic thinking) that remained related to conspiracy belief (despite the failure to reach the conventional level of significance). Adam-Troian et al. (2019) took a step forward by focusing on the causal effect of rationality on the negative association between general cognitive skills (measured by combining the cognitive reflection test [for details, see Primi et al., 2016] and the Numeracy subtest of the Cognitive Ability task [for details, see Schwartz et al., 1997]) and conspiracy belief. The researchers have strengthened the link between these two variables by merely asking participants to answer a question about rationality (i.e., priming the concept of rationality) before completing all the other measures.

By considering in more detail different underlying aspects of general cognitive ability, Jastrzębski and Chuderski (2017) did not find evidence of a significant relationship between fluid intelligence ("the ability to solve novel problems by means of abstract reasoning", Jastrzębski & Chuderski, 2017, p. 2290) and conspiracy belief. Beyond criticisms of measurement choices (for details, see Jastrzębski & Chuderski, 2017), the role of general cognitive ability and more especially, reasoning ability, in conspiracy belief can be considered as a controversial issue. To go beyond the establishment of a set of independent (or partially interdependent) cognitive skills associated with conspiracy belief, and to investigate a more integrative framework about this phenomenon, it is relevant to focus on critical thinking. This construct is considered as a high-level thinking skill encompassing rationality, cognitive skills, and analytic thinking, and it could actually be a better psychological construct for understanding belief in conspiracy theories.

Among various definitions, critical thinking is defined as "reasonable, reflective thinking that is focused on deciding what to believe or do" (Ennis, 1985, p. 45) and as "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (Scriven & Paul [1987] for the Foundation for Critical Thinking). In a consensus about multidimensionality of critical thinking, most researchers share the conception that a "critical thinker" refers to the self-identity (Celuch et al., 2009) of someone who masters two complementary dimensions of critical thinking: dispositions and abilities (Black, 2008; Boisvert, 2015; Ennis, 1985; Facione, 2015; Halpern, 1999; Norris, 1989). While the dispositional dimension of critical thinking refers to a person's consistent internal motivation to use critical thinking (Facione, 2000), the ability dimension of critical thinking refers to a set of specific cognitive skills (e.g., analyzing argument, inference, etc.; Ennis, 1985). To illustrate the large number of cognitive skills investigated in the literature, critical thinking ability has been assessed (aimed at different target groups) through various formats, such as multiple-choice tests (e.g., the *California Critical Thinking Skills Test*; Facione, 1990; the *Halpern Critical Thinking Assessment*; Halpern, 2016) with or without written justifications, and open-ended tests (Ennis, 1993; Ku, 2009). In line with the aim to understand belief in conspiracy theories, the latter type of test and particularly the *Ennis-Weir Essay Test* (EWCTET; Ennis & Weir, 1985) could be relevant for measuring critical thinking because it requires the use of critical thinking ability in the context of argumentation.

When it comes to conspiracy theories, the capacity to appraise an argument, to formulate an argument in response—to use critical thinking ability in the context of argumentation—seems to be crucial. Indeed, the spread of conspiracy theories usually involves exposure to a narrative that relies on a series of fallacious arguments (e.g., *ad*

populum, *ad hominem*, appeal to ignorance, circular reasoning; Bangerter et al., 2020; Oswald, 2016; Young et al., 1990). According to Bronner (2013, 2020), the rhetoric process whereby a believer in conspiracy theories tries to convince people is particularly convincing because it overwhelms its recipient through multi-layered stacks of (weak) arguments. Critical thinking ability provides the capacity to analyze and identify inferential relations (real or voluntary) and implicit information in arguments, descriptions, or other types of representations, to judge their credibility and make decisions in practical domains (Black, 2008; Boisvert, 2015; Facione, 2015).

Considering these different cognitive skills, critical thinking ability should theoretically help individuals to distance themselves from suspect epistemological beliefs such as conspiracy theories, *via* an accurate judgment of reliability and credibility of sources (Kennedy et al., 1991). Blair (2012) illustrates the theoretical negative link between critical thinking ability and conspiracy theories with a concrete case: the "Keegstra affair". This affair refers to a scandal in which a high-school teacher in Canada disseminated various anti-Semitic conspiracy theories. According to Blair (2012), in principle, the exercise of students' critical thinking ability (in this case, appropriate use of authorities and evidence, testing hypotheses and considering alternative hypotheses, etc.) should lead them to the rejection of these conspiracy theories. Overall, before attempting to reduce conspiracy beliefs through critical thinking, it would first seem necessary to test the existence of the relationship between critical thinking ability—measured by a test in a context or argumentation—and belief in conspiracy theories. In line with the gullible conspiracist hypothesis, it leads us to formulate the hypothesis of a negative association between conspiracy belief and critical thinking ability.

Study 1

Method

Preregistration

We preregistered our hypotheses, planned sample size, exclusion rules, and general analytic strategy on *Aspredicted* (https://aspredicted.org/blind.php?x=vn2ty3)[1]. We planned to recruit 90 participants. This sample size allows us to detect an existing correlation of $r = .29$, with power = .80 and α set to .05. The materials of this study, as well as the data and the corresponding statistical code are publicly available and can be found at https://osf.io/64wmc/. In this study, "we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study" (Simmons et al., 2012, p. 4).

Human Studies and Subjects

Despite the absence of legal requirements for going through an ethics committee for non-interventional research outside of biological and medical development in France, we used the ethical standards set by the Psychology Department that follows the American Psychological Association Ethical Principles of Psychologists and Code of Conduct (APA, 2017) for the ethical treatment of human participants in all our studies. Regarding participant consent, for this study, participants gave their informed consent at the beginning of the semester by enrolling in a course consisting of participating in a certain number of studies in exchange for course credits.

Participants

We recruited 89 undergraduate psychology students from a French University (M_{age} = 18.82, SD_{age} = 2.67, 86 females, 1 male, 1 unspecified) who participated in exchange for course credits. Three participants were removed from the final sample because of too many

[1] We discovered an unfortunate mistake in the formulation of our main hypothesis in our pre-registration document. Instead of "We expect a *positive* relationship between belief in conspiracy theories and critical thinking," one should read: "We expect a *negative* relationship between belief in conspiracy theories and critical thinking."

missing answers on one of the two main measures (n = 2)[2] or loss of the response sheet by one of the judges (n = 1). The final sample was composed of 86 participants (M_{age} = 18.82, SD_{age} = 2.70, 84 females, 1 male, 1 unspecified).

Materials and Procedure

Participants were organized in groups of 20 in a classroom borrowed for this study that was presented as a study on information processing and worldview. Participants were instructed to complete a booklet containing our two main measures (i.e., belief in conspiracy theories and critical thinking ability) in a counterbalanced order, followed by secondary measures.

Conspiracy Belief Scale. We assessed belief in conspiracy theories with the *Generic Conspiracist Beliefs scale* (GCB; Brotherton et al., 2013) validated in French (Lantian et al., 2016). This is a 15-item scale (from 1 = *Definitely not true* to 5 = *Definitely true*) measuring the general tendency to believe in conspiracy theories. This scale was deliberately constructed in such a way as to avoid referring to known examples of conspiracy theories but only very general ideas (e.g., "Certain significant events have been the result of the activity of a small group who secretly manipulate world events"). Following the recommendations of several researchers who express concerns about the lack of information on the psychometric qualities of measures of belief in conspiracy theories (Atari et al., 2019; Goreis & Voracek, 2019; Swami et al., 2017), exploratory and confirmatory factorial analyses were performed on this scale. The presumed unidimensional nature of the scale was not empirically supported, but for the sake of simplicity and given the common practice in this research field, in this section, we report the results based only on the mean of all the items present in the GCB, as originally intended (see the Appendix A for the main results reported by each sub-factor of conspiracy

[2] Keeping these participants in the sample does not change the conclusions of this study.

belief). We averaged all the items to form a unique score, with a higher score corresponding to higher conspiracy beliefs ($\alpha = .86$).

Critical thinking Ability Test. We measured critical thinking ability with a French version of the *Ennis-Weir Critical thinking Essay Test* (Ennis & Weir, 1985), edited specifically for the study. The test consists of reading a letter to the editor of a fictional newspaper. The writer of the letter argues in eight paragraphs in defense of the idea that overnight parking should be prohibited in a specific area. The participants were asked to reply to each paragraph by assessing and explaining the relevance (or not) of the arguments and for the 9th paragraph, they reported their overall evaluation of the letter as a whole. They were asked to write their responses in the format of a letter to the editor (in reply to the letter they had to review). The test was scheduled to last a maximum of 40 minutes. Later, three judges independently assessed the arguments provided by the participants, following the recommendations of the test manual (for details, see Ennis & Weir, 1985). Briefly, the scoring system emphasizes a list of critical thinking competence, such as getting the point, identifying good arguments or assumptions, seeing other possibilities or explanations, avoiding overgeneralization, irrelevance, equivocation, circular reasoning, and so on. Independent judges applied specific criteria leading to the addition or subtraction of points for errors or unspecified insights with the following scoring: participants justified adequately (+3), justified semi-adequately (+2), judged correctly without justification (+1), made no response (0), showed bad judgment in justifying or made incorrect judgment (-1). For example, in the first paragraph of the letter, participants had to recognize an equivocation or shift in meaning in the use of the word “garage” in the argument to obtain all the points (+3). To assess rater reliability, we used Intraclass Correlation Coefficient (ICC; Koo & Li, 2016; Shrout & Fleiss, 1979) with multiple-measurements (mean rating of 8 measurements), consistency-agreement,

2-way random-effects model. The ICC[3] obtained between the three judges was 0.728, 95% CI = [0.611, 0.814], indicating a moderate to good interrater reliability. Then, we averaged the mean assessment score of the three judges to form a single score of critical thinking ability, with a higher score meaning higher critical thinking ability ($\alpha = .73$).

After completing the two measures, participants were asked if they believed that there may be a link between belief in conspiracy theories and critical thinking ability (yes/no answer), and if it was the case, to make a guess about the direction of this association. Finally, we collected demographic information and participants could leave a free comment. Participants were debriefed and thanked.

Results

Confirmatory Analysis

As predicted by the gullible conspiracist hypothesis (see Figure 1), the higher people scored on the critical thinking test ($M = 3.61$, $SD = 4.54$), the less they believed in conspiracy theories ($M = 2.77$, $SD = 0.69$). This relationship approached significance, $r(84) = -.20$, $p = .064$, 95% CI = [-.40, .01]. See the Appendix A for additional analyses, including a test of the presence of an order effect.

Discussion

In line with our prediction inspired by the gullible conspiracist hypothesis, results showed a marginal negative association between critical thinking ability and conspiracy beliefs. Although this result is encouraging, it needs to be replicated.

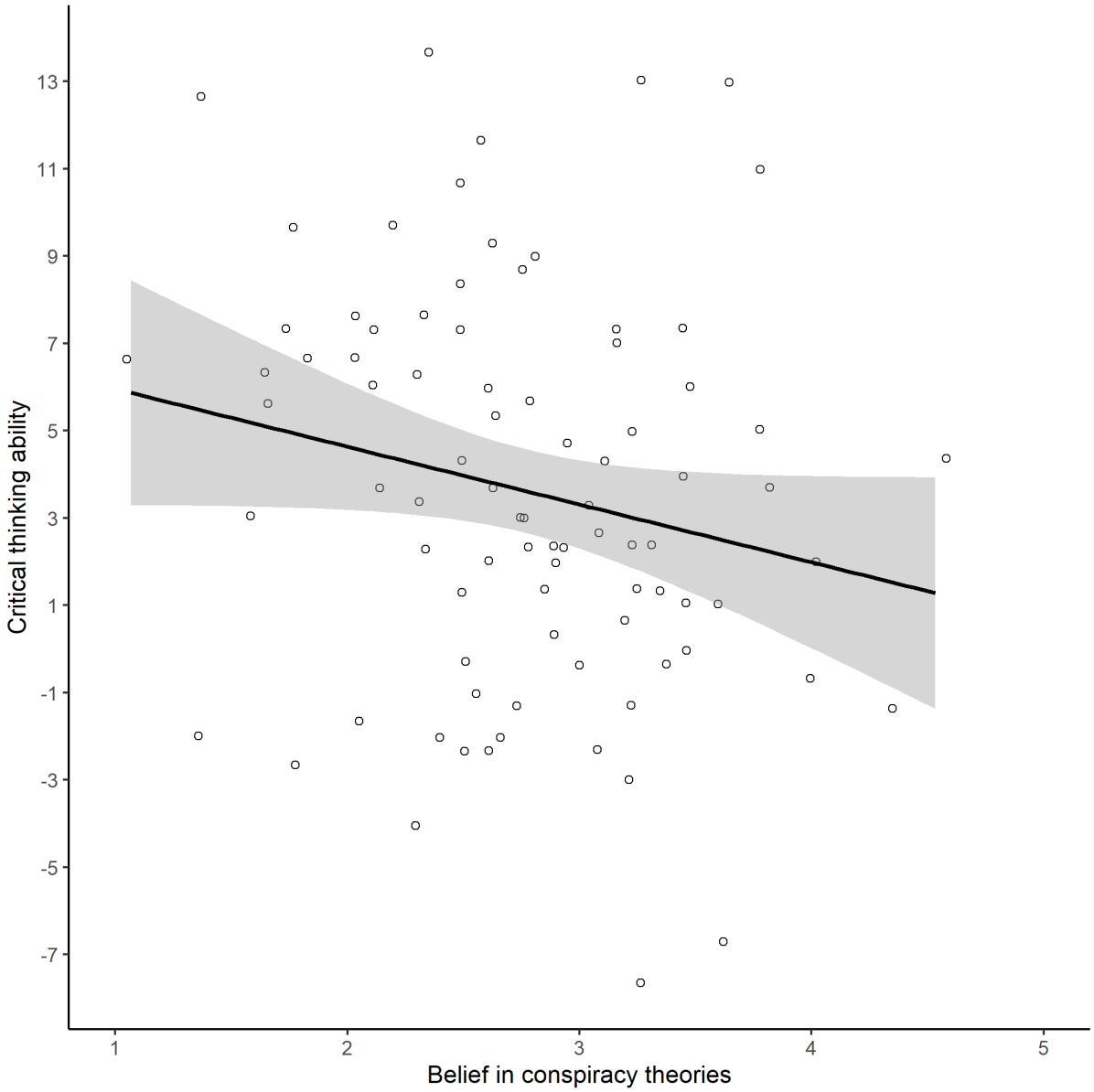
Returning to the rational conspiracist hypothesis, as previously stated, this hypothesis could come more from a self-reported (subjective) critical thinking ability rather than a measured (objective) critical thinking ability (assuming a lack of perfect relationship between these two constructs). In any event, we still do not know whether these allegations of a high

[3] This value was obtained by using the 'irr' package (v. 0.84.1; Gamer et al., 2012) in R (v. 3.6.1).

level of critical thinking based on reported speeches of a visible sub-population of conspiracy believers (Harambam & Aupers, 2017; Konda, 2019; Nairn, 2017; Voogt, 2017) could be generalized to a larger population of conspiracy believers. We will focus on this secondary question in Study 2, with an additional measure of subjective critical thinking ability.

Figure 1

Relationship Between Belief in Conspiracy Theories and Critical Thinking Ability.



Note. Gray area around the regression slope corresponds to the 95% confidence interval.

Study 2

The two aims of Study 2 were to confirm the negative association between critical thinking ability and the belief in conspiracy theories and to aim not to restrict this association to students from one university and on the same academic level. To this end, we recruited a larger sample of participants from two different universities. Our main expectation concerned the negative link between conspiracy beliefs and critical thinking ability. Additionally, as we relied on two sources of data collection (i.e., two universities), we planned to examine this link while taking into account the university location.

One of our secondary hypotheses[4] is in line with our question about the rational conspiracist hypothesis. More explicitly, if the extracted sample from previously reported statements (Harambam & Aupers, 2017; Konda, 2019; Nairn, 2017) are representative of what conspiracy theorists actually think, then a positive linear relationship between beliefs in conspiracy theories and self-reported (subjective) critical thinking ability can be observed. An intriguing possibility is that people who strongly disbelieve in conspiracy theories, just as those who believe in them, consider themselves to have better subjective critical thinking ability than people with an average level of belief in conspiracy theories (forming a "mirror effect"). For this reason, we intended to also test a curvilinear relationship between belief in conspiracy theories and individuals' self-reported (subjective) critical thinking ability.

Method

Preregistration

We preregistered our hypotheses, planned sample size, exclusion rules, and general analytic strategy on *Aspredicted* (https://aspredicted.org/blind.php?x=xy4vg4). Based on the effect size found in the previous study (r = .20), we aimed to recruit about 260 participants (statistical power > .90, α = .05). As in Study 1, the materials, the data and the corresponding

[4] Note that space limitations do not allow us to cover in this section other complementary hypotheses (relatively less important at theoretical level) that we mentioned in the preregistration. These secondary analyses are presented in the Appendix B.

statistical code are publicly available: https://osf.io/64wmc/. Concerning the criteria of exclusion set *a priori*, we decided to remove participants who had demonstrably spent an unrealistically short time on the page on which the letter was displayed[5].

Participants

For this study, 267 undergraduate psychology students from two French universities (M_{age} = 21.74, SD_{age} = 8.94, 222 women, 45 men, 1 unspecified) were recruited. According to the criteria of exclusion set *a priori*, participants who spent too short a time on the reading of the letter (n = 15) were removed from the sample. Although it was not anticipated in the preregistration, we removed one participant because his/her answers were unrelated to the task. The final sample was composed of 252 participants (M_{age} = 21.80, SD_{age} = 9.18, 209 women, 42 men, 1 unspecified).

Materials and Procedure. The materials and procedure for Study 2 were the same as Study 1 with three exceptions: (1) the task was presented on a computer rather than using paper and pencil, (2) minor changes to the French version of the letter rectified certain potential ambiguities, and (3) a measure of subjective critical thinking ability was added after the measure of belief in conspiracy theories and critical thinking ability (presented in a counterbalanced order).

As in Study 1, the internal reliabilities of both belief in conspiracy theories (α = .90, see the Appendix B for more details on the psychometric properties of the scale) and critical thinking ability (α = .93) were satisfactory. The ICC obtained between the four judges was 0.930, 95% CI = [0.915, 0.943], indicating excellent inter-rater reliability.

To measure participants' self-reported (subjective) critical thinking ability, we created three items (e.g., "I have good critical thinking ability"), including a reverse-coded item (from 1 = *Strongly disagree* to 7 = *Totally agree*). We averaged these three items to create a unique

[5] The letter was 569 words long. Reading and understanding this letter in less than 46 s would mean reading more than 700 words per minute.

score (α = .83), with a high score corresponding to a high subjective critical thinking ability. As in Study 1, at the end of the procedure, we asked participants whether they believed that there may be a link between conspiracy beliefs and critical thinking ability (yes/no answer), and if this was the case, if they had any idea about the direction of this link. Finally, participants were asked to provide their demographic information and they were free to leave a comment in an open-ended section. Participants were debriefed and thanked.

Results

Confirmatory Analyses

As expected (see Figure 2), we found a negative correlation between critical thinking ability (M = 7.82, SD = 5.18) and belief in conspiracy theories (M = 2.71, SD = 0.81), $r(250) = -.18$, $p = .005$, 95% CI = [-.05, -.29].

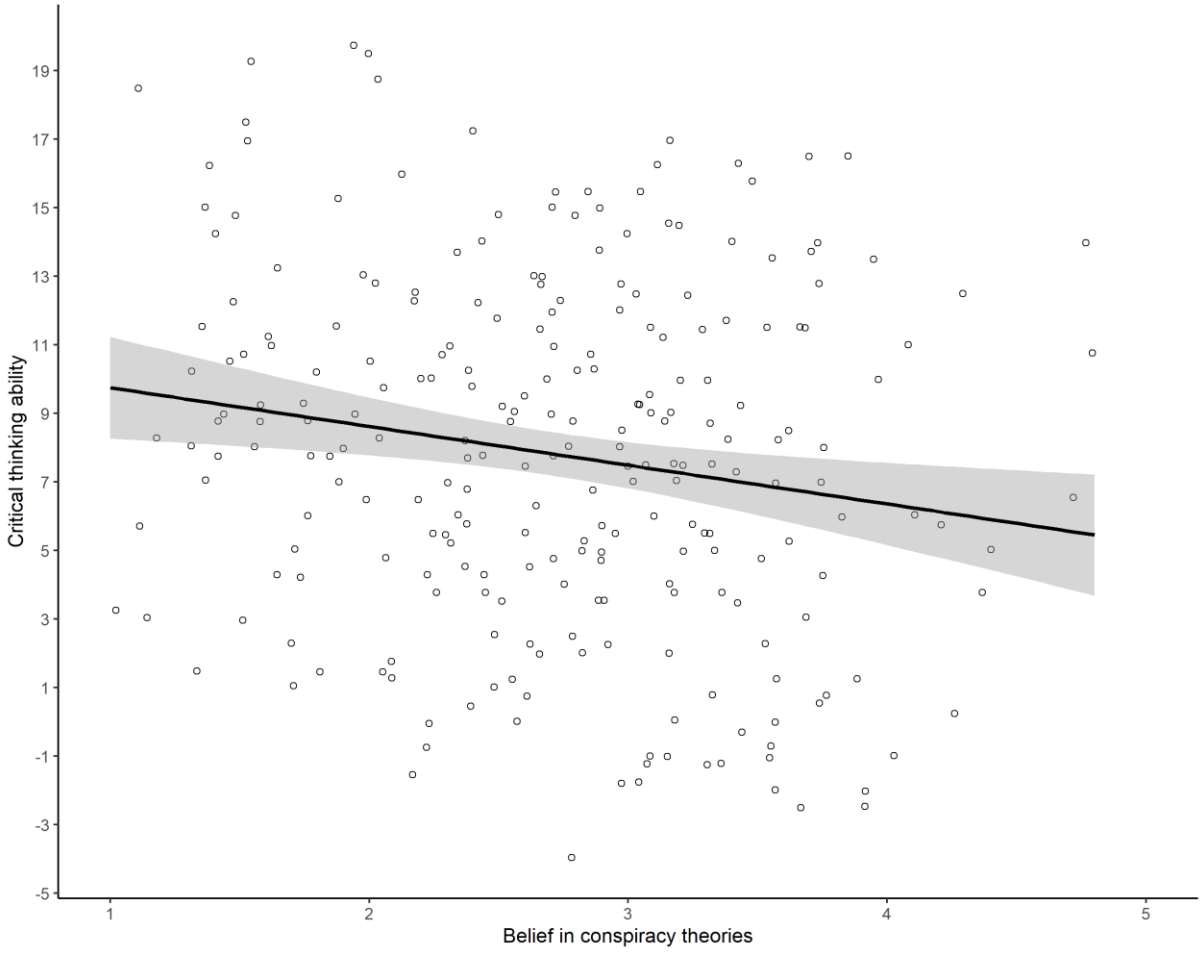
Following this test, we run a multiple regression analysis with belief in conspiracy theories as the dependent variable and three predictors (critical thinking ability [mean-centered], the university location [contrast-coded: -1/1], and the interaction between these two variables)[6]. The university location did not significantly affect the negative relation between our two key variables, $t(248) < 1$ (corresponding to the test of the interaction effect between belief in conspiracy theories and university location on critical thinking ability). Then, when removing the interaction term, this multiple regression analysis showed that, when controlling for the level of conspiracy belief, the university location was significantly associated with the

[6] We originally planned (in the pre-registration) to run a multilevel model analysis to take into account the role of university location on the association between belief in conspiracy theories and critical thinking ability. We fitted a linear mixed model to examine the effect of critical thinking ability on belief in conspiracy theories with university location included as a random effect. As this model yielded an unexpected singular fit, we refined our model by excluding the random slope for the university location, leaving only a random intercept for this variable. On the basis of this model, the link between critical thinking ability and belief in conspiracy theories becomes only marginally significant, $t(249.98) = -1.70$, $p = .096$. We present this result for the sake of completeness, but we are aware and would like to warn about the limits in terms of statistical power of the use of this type of model in our case, with only two groups (see Bressoux, 2020; and Westfall et al., 2014; for more details).

level of critical thinking ability[7], $t(249) = -4.00$, $p < .001$, $\eta^2_p = .06$. In this latter statistical model, belief in conspiracy theories was no longer significantly related to critical thinking ability when the university location was controlled, $t(249) = -1.62$, $p = .106$, $\eta^2_p = .01$. See the Appendix B for additional analyses, including a test of the presence of an order effect.

Figure 2

Relationship Between Belief in Conspiracy Theories and Critical Thinking Ability.



Note. Gray area around the regression slope corresponds to the 95% confidence interval.

Secondary Analyses

Finally, we tested the relationship between subjective critical thinking ability (M = 4.63, SD = 1.15) and conspiracy belief. We did not observe a linear relationship between

[7] Note that the difference between the average performance on the test of critical thinking ability is consistent with the characteristics of the samples, in the sense that students with more academic seniority performed better in the test.

these two variables, $r(250) = -.01$, $p = .837$, 95% CI = [-.14, .11]. As the conventional significance tests cannot establish the absence of an effect, we used the two one-sided tests (TOST) procedure (Lakens et al., 2018)[8] to assess whether an effect was at least as extreme as the smallest effect size of interest (SESOI), the size below which an effect can be considered as negligible (i.e., statistically equivalent to 0). With 252 participants, our study had 80% power to detect a correlation of .18. Given $\Delta L = -.18$ and $\Delta U = .18$, the effect was statistically equivalent (i.e., falls within the interval indicated by the equivalence bounds), $p = .004$. Thus, r values at least as extreme as ±.18 can be rejected (with $\alpha = .05$).

Descriptively, participants with low and high levels of belief in conspiracy theories seemed to score higher on the measure of subjective critical thinking ability, but neither the quadratic term of the quadratic regression model, $t(249) = 1.32$, $p = .188$, $\eta^2_p = .007$, nor the "two-lines" analyses (see Simonsohn, 2018) testing the U-shaped relationship were significant. Indeed, for this last analysis, the average slope for people with a conspiracy belief mean score between 1 to 2.47 (cutoff calculated by the algorithm of the two-lines test) was negative but not significant ($b = -0.45$, $z = -1.46$, $p = .144$), whereas the average slope for people with a conspiracy belief mean score between 2.47 to 4.80 was positive but not significant $b = 0.04$, $z = 0.23$, $p = .820$). Interestingly, participants seemed to display a form of lucidity, because the better they performed in the critical thinking ability test, the more they evaluated themselves as having a high subjective critical thinking ability, $r(250) = .13$, $p = .046$, 95% CI = [.00, .25].

Discussion

In Study 2 using a standardized and controlled method, we found the expected negative association between critical thinking ability and belief in conspiracy theories. Lastly,

[8] Note that this specific test was not preregistered. We add it following the insightful suggestion of an anonymous reviewer.

there was no evidence that subjective critical thinking ability was linearly or quadratically related to conspiracy belief.

Internal Meta-Analysis

To get additional evidence of the presence of a negative association between critical thinking ability and belief in conspiracy theories, we conducted an internal mini meta-analysis (see Goh et al., 2016) of Studies 1 and 2 (using the package 'meta' [v. 4.9-7; Schwarzer, 2007] in R [v. 3.6.1]). We first transformed the correlations to *z* scores (Fisher's transformation) for analysis and converted back to Pearson's correlations. We performed a random-effects model using the inverse variance method. The overall effect size for the association between critical thinking ability and belief in conspiracy theories was $r = -.19$, 95% CI [-.08, -.29], $z = -3.41$, $p < .001$[9]. The same conclusion holds if, for Study 2, we use the partial correlation between critical thinking ability and belief in conspiracy theories controlling for the effect of the university location (partial $r = -.10$) instead of using the zero-order bivariate correlation between these two variables, even if, unsurprisingly, this overall effect is descriptively lower in size, $r = -.13$, 95% CI [-.02, -.23], $z = -2.29$, $p = .023$.

General Discussion

The main aim of this work was to test whether individuals with lower critical thinking ability believed more in conspiracy theories. From two distinct studies, regardless of the method of administering the test (paper-pencil or computerized format), we can reasonably conclude that participants who performed less well in an open-ended test capturing critical thinking ability in the context of argumentation believed more in conspiracy theories.

These results help to reinforce the credibility of the gullible conspiracist hypothesis (van Prooijen, 2019). Critical thinking ability could help individuals to seek contradictory

[9] The fixed-effects model gives identical results because studies are homogenous, $Q(1) = 0.03$, $p = .87$, $I^2 = 0\%$ (for more details, see Cumming, 2013, p. 226).

evidence rather than blindly trusting a conspiracy theory as long as it challenges an established version. Another contribution of this empirical work is the use of a self-reported (subjective) measure of critical thinking ability, a hint of the participants' lucidity regarding their own level of critical thinking ability, while recognizing the limitations of a measure potentially contaminated by social desirability. Despite the small positive correlation between objective and subjective critical thinking ability, we did not detect any significant relationship between subjective critical thinking ability and belief in conspiracy theories. This inconclusive result does not support the rational conspiracist hypothesis (van Prooijen, 2019) nor does it indicate a possible curvilinear relationship. This null result undermines the idea of an easily noticeable relationship between the subjective feeling of being a critical thinker and belief in conspiracies, but does not prevent a more subtle or complex relationship that would require a much larger sample size.

The presumed role of critical thinking in belief in conspiracy theories is continuously discussed by researchers, journalists, and by lay people on social networks. One example is the capacity to exercise critical thinking ability to distinguish bogus conspiracy theories from genuine conspiracy theories (Bale, 2007), leading us to question when critical thinking ability could be used to support this adaptive function. Sometimes, it is not unreasonable to think that a form of rationality would help to facilitate the detection of dangerous coalitions (van Prooijen & Van Vugt, 2018). In that respect, Stojanov and Halberstadt (2019) recently introduced a distinction between irrational versus rational suspicion. Although the former focuses on the general tendency to believe in any conspiracy theories, the later focus on higher sensitivity to deception or corruption, which is defined as "healthy skepticism." These two aspects of suspicion can now be handled simultaneously thanks to a new scale developed by Stojanov and Halberstadt (2019). In our study, we found that critical thinking ability was associated with lower unfounded belief in conspiracy theories, but this does not answer the

question as to whether critical thinking ability can be helpful for the detection of true conspiracies. Future studies could use this new measurement to address this specific question.

As a precaution, it is necessary to recognize a modest robustness of some of the results presented in this work. We obtained a marginal negative link between our two main variables in Study 1 and inconclusive results in Study 2, when we take into account the university location in our analyses. Regarding the mere association critical thinking ability and belief in conspiracy theories, these seemingly mixed-results should not be a source of serious concern if we look at the big picture, that is, if we rely on meta-analytic thinking (Cumming, 2013, 2014) rather than dichotomous thinking. Regarding, this same association that becomes non-significant when we control for the university location, this suggests that, in this particular context, other sources of variation between samples (e.g., level of education) obscure the effect of interest. In order to get a clearer picture, future studies will need to increase statistical power to more accurately estimate this effect size, for instance, by collecting more participants. At the same time, to ensure that this result could be generalized to the population from which these samples were drawn (e.g., in our case, to psychology undergraduate students), it may be crucial to increase the number of sample sources (e.g., university locations) in order to be able to be in an appropriate situation to conduct multilevel models. Moreover, it might be instructive to try to generalize this finding to social environments beyond the student community and to other cultures.

The observational nature of our studies is only a first step in a new avenue of research. The design of our studies prevents us from making causal inference about the effect of critical thinking ability on belief in conspiracy theories. For example, these results do not even exclude the possibility of a reverse causal relationship (i.e., believing in conspiracy theories bypasses the exercise of critical thinking ability). To test the potential link of causality between critical thinking ability and conspiracy belief, subsequent studies could use a

longitudinal design or manipulate critical thinking ability via training or teaching, as has been done in the literature (see Abrami et al., 2008 for a review).

There are practical and theoretical reasons to investigate further whether developing critical thinking ability would reduce belief in conspiracy theories (Swami, 2018). Given that critical thinking courses reduce paranormal and pseudoscientific beliefs (Wilson, 2018; albeit the lack of a control group; see also Abrami et al., 2008), it is likely that this may also generalize to other epistemically unwarranted beliefs such as conspiracy theories. In this vein, Dyer and Hall (2019) have recently attempted to reduce unfounded beliefs, including a set of specific conspiracy theories, via critical thinking lessons specifically oriented toward epistemically unwarranted beliefs. Compared to other forms of belief, conspiracy theories were less affected by these interventions. One potential explanation is the relative lower degree of belief in specific conspiracy theories assessed in their study, compared to the other unwarranted beliefs measured (suggesting a potential floor effect). That said, it does not tell us about the effectiveness of these interventions on new belief in conspiracy theories that may develop after the intervention, or in other words, whether this gain could be transferred to other conspiracy theories. To answer this question, future studies could use newly formed conspiracy theories (such as used by Bost & Prunier, 2013; Lantian et al., 2017; van Prooijen & Jostmann, 2013; van Prooijen & van Dijk, 2014) rather than classical conspiracy theories. Thanks to its open-ended format, the EWCTET (Ennis & Weir, 1985) has the advantage of being particularly comprehensive (Ennis, 1993). This specific format does not come without a cost in terms of time and effort (e.g., the considerable work done by the multiple graders to assess the answers) but allows us to provide informative and valuable results. This test covers a large area of cognitive skills underlying critical thinking ability beyond classical logical deductive reasoning (analyzing reasons and assumptions, detecting relevant arguments, considering alternatives, avoiding overgeneralization and reasoning mistakes, and so on; for

details, see Ennis & Weir, 1985) and can be considered as an ecological task to measure critical thinking ability. Nevertheless, in reference to the multidimensionality of critical thinking, the use of a single test such as the EWCTET (Ennis & Weir, 1985) to measure the ability dimension in a fictive context has limitations. It has been found that, unexpectedly, this test also identifies the dispositional factor of critical thinking (Taube, 1997). This complementary aspect of critical thinking refers to several subdimensions such as the disposition to seek alternatives and be open to them or the desire to be well informed (Ennis, 1996; Facione, 2000; Facione et al., 1995). These subdimensions can also play an important role in belief in conspiracy theories. Further studies will have to identify specific dispositions of critical thinkers leading to the potential reduction in belief in conspiracy theories.

To conclude, our research provides support for the link between lack of critical thinking ability and belief in conspiracy theories, in line with the gullible conspiracist hypothesis. This negative association between critical thinking ability and conspiracy belief should encourage the implementation of initiatives to reduce conspiracy beliefs through the enhancement of critical thinking ability. In this era of the modification of YouTube's recommendations algorithms to reduce the promotion of conspiracy theory videos, it is important not to neglect efforts in critical thinking education that would allow individuals to behave as autonomous and informed citizens.

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Supporting Information

Appendix A: Study 1 - Additional analyses

Exploratory Factorial Analysis of the GCB

Before conducting an exploratory factorial analysis, we tested the appropriateness of the data for the procedure by using Bartlett's test of sphericity, $X^2 = 502.08$, $df = 105$, $p < .001$ and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.72). After inspecting the scree plot of eigenvalues, considering Eigenvalues (λ) above 1.0, and conducting a parallel analysis, we ran a maximum-likelihood exploratory factor analysis with forced two-factor solution (accounting for 43.5% of the variance) using Promax oblique rotation to account for the correlation between the two sub-factors ($r = .44$). The first extracted factor ($\lambda = 4.58$) accounting for 27% of the total variance, corresponded to general belief in conspiracy theories in view of items' loadings (hereafter sub-factor general belief in conspiracy theories; $\alpha = .86$). The second factor ($\lambda = 1.42$) accounting for 18% of the total variance, seemed to correspond to extraterrestrial beliefs because only the three items referring to extraterrestrial conspiracies loaded highly (between .84 and 1) on this second factor (hereafter sub-factor belief in extraterrestrial conspiracy theories; $\alpha = .90$).

Confirmatory Factorial Analysis of the GCB

Then, we conducted two confirmatory factorial analyses (using maximum likelihood estimator). The two-factor model (sub-factors general and extraterrestrial belief in conspiracy theories) produced an acceptable fit (χ^2 [89, $N = 78$] = 149.59, normed chi-square (χ^2/df) = 1.68, comparative fit index [CFI] = .86, mean square error of approximation [RMSEA] = .09 [90% CI = .07, .12], standardized root mean square residual [SRMR] = .08. The test of the single-factor model (combining all the items onto a single factor) indicated a poor fit (χ^2 [90, $N = 78$] = 276.31, normed chi-square (χ^2/df) = 3.07, CFI = .58, RMSEA = .16 [90% CI = .14,

.19], SRMR = .12). Unsurprisingly, the two-factor model fitted significantly better than the single-factor model, $\chi^2(1) = 126.72$, $p < .001$.

Correlations Between the two Sub-factors of Belief in Conspiracy Theories and critical thinking

We did not detect a significant association between the sub-factor general belief in conspiracy theories and critical thinking ability, $r(76) = -.11$, $p = .32$, 95% CI = [-.33, .11], however, we found a significant negative association between the sub-factor extraterrestrial belief in conspiracy theories and critical thinking ability, $r(76) = -.28$, $p = .015$, [-.47, -.06].

Additional Descriptive Statistics

Approximately half of our participants ($n = 44$) believed that there may be a link between conspiracy beliefs and critical thinking ability (2 participants did not answer this question). We tested whether the link between belief in conspiracy theories and critical thinking ability could be moderated by participants' expectancies about the existence (or not) of a link between these two variables. We did not find evidence of a moderator role of participants' expectancies, $t(80) < 1$.

Additionally, out of the 44 participants who believed there may be a link between conspiracy beliefs and critical thinking ability, 29 participants reported what they thought about the direction of this potential association[10]. The most frequent answer of these participants was classified in the category "out of scope" ($n = 12$), followed by participants who admitted having no idea ($n = 7$). The remaining answers were mixed between prediction of a positive link ($n = 4$) and a negative one ($n = 6$). As the sample sizes corresponding to these answers were too low, we did not conduct any more analyses including these response categories.

Order Effect

[10] These answers were classified by a judge in *ad hoc* categories.

Additionally, in this study, we noted a significant interaction effect of the order of presentation of measures (i.e., conspiracy beliefs then critical thinking ability or the reverse order) with the relationship between these two constructs, $t(82) = 2.58$, $p = .012$, $\eta^2_p = .075$. Specifically, starting by completing the measure of conspiracy belief before the test of critical thinking ability reinforced the negative association between these two measures ($t[82] = 3.24$, $p = .002$, $\eta^2_p < .113$), which was not the case for the other order ($t[82] = 0.01$, $p = .996$, $\eta^2_p < .001$). We could speculate that making people think of conspiracy theories may lead them to respond differently in the critical thinking ability test depending on their initial conspiracy belief. However, besides its unexpected occurrence, this result remains difficult to interpret at this stage.

Appendix B: Study 2 - Additional analyses

Exploratory Factorial Analysis of the GCB

The Bartlett's test of sphericity, $X^2 = 1825.71$, $df = 105$, $p < .001$ and the KMO measure of sampling adequacy (0.91) allowed us to make sure of the appropriateness of the data for the factorial analysis procedure. Based on the same criteria as Study 1, we ran a maximum-likelihood exploratory factor analysis with forced two-factor solution (accounting for 50% of the variance) using Promax oblique rotation. As in Study 1, the first extracted factor ($\lambda = 5.88$), accounting for 33% of the total variance, corresponded to general belief in conspiracy theories ($\alpha = .90$), and the second factor ($\lambda = 1.12$), accounting for 16% of the total variance, corresponded to extraterrestrial beliefs ($\alpha = .89$), the two being correlated ($r = .54$).

Confirmatory Factorial Analysis of the GCB

Then, we conducted two confirmatory factorial analyses (using maximum likelihood estimator) testing the same models as Study 1. The two-factor model fitted well with the data (χ^2 [89, $N = 252$] = 228.65, normed chi-square (χ^2/df) = 2.60, CFI = .92, RMSEA = .08 [90% CI = .07, .09], SRMR = .06. The single-factor model provided a poor fit, (χ^2 [90, N = 252) =

558.19, normed chi-square (χ^2/df) = 6.20, CFI = .74, RMSEA = .14 [90% CI = .13, .16], SRMR = .10. The two-factor model fitted the data significantly better data than the single-factor model, χ^2 (1) = 329.54, $p < .001$.

Correlations Between the two Sub-factors of Belief in Conspiracy Theories and critical thinking ability

The sub-factor general belief in conspiracy theories correlated negatively and significantly with critical thinking ability, $r(250) = -.18$, $p = .004$, 95% CI = [-.30, -.06]. However, we did not find a significant negative association between the sub-factor general belief in conspiracy theories and subjective critical thinking ability, $r(250) = -.09$, $p = .15$, [-.21, .03].

Additional Descriptive Statistics

Additionally, the most frequent answer of the 150 participants who believed there may be a link between conspiracy beliefs and critical thinking ability was classified in the "no idea" category ($n = 65$), followed by the "out of scope" category ($n = 54$), which highlights the difficulty encountered by participants in answering this question. The remaining answers were perfectly balanced between prediction of a positive ($n = 14$) and negative ($n = 14$) link. As the sample sizes of these answers were too low, we did not perform more analyses including these response categories.

More than half of the participants (60.7%) believed that there may be a link between conspiracy beliefs and critical thinking ability (1 participant did not answer this question). As in Study 1 (and in line with the exploratory analysis we mentioned in our preregistration), we tested whether the link between conspiracy theories and critical thinking ability could be moderated by participants' expectancies about the existence (or not) of a link between these two variables. We did not find evidence of a moderator role of participants' expectancies

about the existence of a link between conspiracy theories and critical thinking ability on this link, $t(247) < 1$.

Order Effect

In the preregistration, we planned to test whether the negative relationship between belief in conspiracy theories and critical thinking ability was significantly stronger when participants completed the measures with conspiracy belief assessed before critical thinking ability than in the reverse order. This time, we did not observe a role of the order of presentation of measure in this relationship, $t(248) = 1.07$, $p = .287$, $\eta^2_p = .005$, albeit descriptively, the pattern of results followed what we observed in the previous study: a more pronounced negative association between conspiracy beliefs and critical thinking ability when conspiracy belief was measured before critical thinking ability than in the reverse order.