

Is Cognitive Ability Related with Rejecting Pseudoscience, Conspiracist, and Paranormal Beliefs? A Field Study

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Abstract

A field study examined how strongly the three categories of epistemically unwarranted beliefs: pseudoscience, conspiracist, and paranormal beliefs, can be predicted by cognitive ability in young participants from several European countries. Each type of beliefs was significantly and strongly correlated with the remaining two types of beliefs, but only weakly related with cognitive ability, suggesting a minor role of reasoning and problem solving processes for forming and holding unwarranted beliefs. However, a role of cognitive ability for rejecting unwarranted beliefs was stronger in males than in females.

Keywords: cognitive ability; epistemically unwarranted beliefs

Introduction

Why, how, and which people hold so-called epistemically unwarranted beliefs, including pseudoscience, conspiracist, and paranormal theories and claims, has been the topic of recent research in psychological and cognitive science (for reviews see Dean et al., 2022; Stasielowicz, 2022). As from one quarter of population in relatively sceptic Czech (Willard & Cingl, 2017) up to three quarters in the US (Bader, Mencken, & Baker, 2011) accepts at least one unwarranted belief, the phenomenon in question is quite universal. A huge influence on institutions, societies, public health, education, and economy of such kinds of beliefs as the COVID antivaccination, the climate change denial, the US election fraud, and alternative medicine, to name only a few, indicates the profound importance of identifying and understanding the factors which can lead to holding unwarranted beliefs.

Several findings now look relatively firm. First, different kinds of beliefs moderately intercorrelate (Darwin, Neave, & Holmes, 2011; Lobato et al., 2015). For instance, people adopting one kind of belief, such as a pseudoscience claim that the COVID vaccines are not effective or even harmful, are likely to hold another kind of belief, such as a conspiracy theory on governments and the pharmaceutical industry cheating citizens. Therefore, unwarranted beliefs tend to form a belief system which is internally consistent, even if not true. Second, unwarranted beliefs are boosted by so-called intuitive style (a thinking disposition to follow immediate intuitions and fast judgements), but are attenuated

by analytic thinking style (Pennycook et al., 2020; Yelbuz, Madan, & Alper, 2022), which includes such dispositions as reflectiveness (Cacioppo, Petty, & Kao, 1984; Epstein et al., 1997) and active open-mindedness (Stanovich & West, 1997). Third, people who reject unwarranted beliefs often display more valid reasoning skills in such tasks as logical inference, probability estimation, and causal reasoning (Brotherton & French, 2014; Rogers, Davis, & Fisk, 2009; Torres, Barberia, & Rodríguez-Ferreiro, 2020), as well as they avoid fallacious lines of argumentation (e.g., authority, personal experience; Lobato & Zimmerman, 2019). They are also less prone to semantic distraction during reasoning, including belief bias which comprises acceptance of familiar but invalid conclusions, as well as rejection of valid but unbelievable conclusions (Toplak, West, & Stanovich, 2011).

All the latter evidence might suggest that holding unwarranted beliefs could be related with poor reasoning in a more general way, that is, believers might display lower levels of general cognitive ability (general intelligence). That would prevent them from running apt and valid cognitive processes during the evaluation of the probability and logical necessity of a given unwarranted claim. Low ability may also distort the process of establishing coherence of that claim with the body of generally accepted scientific knowledge, and might also lead to a worse access to such a knowledge.

Unfortunately, existing evidence for the role of general cognitive ability in rejecting unwarranted beliefs is not unequivocal. Some studies indeed suggested weak to moderate links (around $r = .15$) between cognitive ability and unwarranted beliefs (Toplak et al., 2011; Betsch, Aßmann, & Glöckner, 2020). Other studies failed to find significant links between unwarranted beliefs and cognitive ability (Erceg, Babić, & Gulić, 2019; Royalty, 1995). Recent meta-analyses suggested that the relationships of conspiracy (Stasielowicz, 2022) and paranormal beliefs (Dean et al., 2022) with cognitive ability were at the edge of statistical significance even if large samples were combined. Rare reports on the cognitive ability correlations with pseudoscience beliefs suggested significant links (e.g., Jastrzębski & Chuderski, 2022), but more evidence is needed.

Noteworthy, several strong correlates of cognitive ability, such as education (Betsch et al., 2020; Jastrzębski &

Chuderski, 2022) and openness (Stasielowicz, 2022) were unrelated to unwarranted beliefs, adding to the conundrum.

Therefore, how much cognitive ability contributes to rejection of unwarranted beliefs is uncertain. In our opinion, the fuzziness of the picture so far could be increased by three factors which to date have been weakly accounted for. The first factor pertains to the fact that virtually all existing studies were conducted in a psychological laboratory. However, self-reporting of unwarranted beliefs can be highly sensitive to situational factors. For instance, they can be prone to the so-called white coat effect (enclotted cognition; Adam & Galinsky, 2012), when in the lab context the participants tend to demonstrate more careful and deliberate thinking (e.g., more critically evaluate their beliefs), as compared to more natural testing situations. Also, the lab testing may affect some participants, who normally hold highly unwarranted beliefs, to tone down reporting of their beliefs (self-censorship), as such beliefs are generally controversial. As a result, lab testing may attenuate correlations of unwarranted beliefs with cognitive ability. Online studies may allow more anonymity, and thus more sincere responses in the belief questionnaires, but they offer low control over performing ability tests as instructed, and do not prevent checking the correct responses in the internet. In this context, field studies may constitute the golden mean for the lab vs. home testing trade-off, because real-life situations (e.g., filling in a response form when waiting for a class or sitting in a park) do not seem to invoke the white coat and critical thinking effects, the examination is highly anonymous (an experimenter knows nothing about a participant, who reports only age and gender), but – unlike in online testing – the use of online prompts in ability tests can be ruled out. Unfortunately, as far as we know, field studies are absent in the literature on cognitive ability and unwarranted beliefs.

Second, for practical reasons, so far virtually all studies have examined participants from one and the same country. However, as noted above, populations differ across countries in their propensity to unwarranted beliefs. So, single-country studies may yield restricted or biased distributions of belief estimates, as compared to cross-country studies.

Finally, rare studies to date have probed the three types of unwarranted beliefs concurrently (e.g., Bensley et al., 2019; Čavojová et al., 2020; Jastrzębski & Chuderski, 2022), and especially pseudoscience has so far been underrepresented in the literature. It is thus uncertain whether cognitive ability predicts either variance shared among various beliefs or some specific variance instead.

This study aimed to address these three methodological issues. First, we measured cognitive ability and unwarranted beliefs by administering paper-and-pencil tools anonymously in the field. Second, we examined a sample of 334 participants coming from several European countries: France, Germany, Italy, Poland, Spain, and the United Kingdom. Third, we probed our participants on three types of unwarranted beliefs: pseudoscience, paranormal, and conspiracist.

Let us start with defining unwarranted beliefs. Pseudoscientific beliefs were defined as claims which are presented as reflecting scientific knowledge, but assume existence of entities or phenomena rejected by real science, and/or use non-replicable and non-falsifiable methodology, and/or lack supporting evidence. Pseudoscientific beliefs pretend to be equally trustworthy as widely accepted scientific facts, but cannot be supported using the same rigorous theories, methods, and data. Pseudoscience does not directly reject science, but tries to mimic it to promote (a system of) alternative unwarranted claims.

Paranormal beliefs were defined as supernatural and magical claims that ascribe to a certain phenomenon, belonging to the physical, biological, or psychological category, some core properties belonging to another category (e.g., mental power moving physical objects, planets conjunction affecting personality; see Lindeman & Aarnio, 2006). Unlike pseudoscience claims, which pretend to be testable, paranormal beliefs violate fundamental ontological assumptions about the nature, so there is no point even to try to validate such beliefs, and they can be rejected a priori with even basic knowledge from physics, biology, or psychology.

Conspiracist beliefs comprise the following five necessary components (van Prooijen and van Vugt, 2018): (i) an anomalous pattern of causal relations between people, objects, or events (e.g., unnatural death), (ii) resulting from deliberate plans (agency), (iii) devised and implemented by a coalition of agents, (iv) potentially harmful or deceptive, (v) carried out in deep secrecy. These features distinguish conspiracy theories from both pseudoscientific and paranormal phenomena, because the latter two are assumed to occur naturally and their presumed causes are overt.

Our main objective was to provide a more representative estimate (at least for the European context) of the mutual relationships between unwarranted beliefs and cognitive ability, as compared to data provided thus far. Understanding how much the individual power of reasoning and critical thinking helps in rejecting unwarranted beliefs can inform us whether holding unwarranted beliefs depends on insufficient cognitive resources, or such resources do not play a crucial role and we should seek for potential explanations in other realms of psychology (e.g., personality, emotions, culture).

The Study

Participants

A total of 334 volunteers (164 females, 140 males, 30 refused to report) aged 14 to 51 (mean = 20.4, $SD = 4.6$) participated, including 77 participants below age 18. Participants received a small gratification (an equivalent of 2.5 Euros in local currency). The study materials were handed to participants in a paper form on a street, in a building, etc. The participants were left alone to fill in the materials, they folded them so as the research assistants could not see the answers, and then returned the materials. The sample included 4 British, 57 French, 4 German, 119 Italian, 32 Polish, 107 Spanish

citizens as well as 11 citizens from other countries. The participants were Erasmus students, corporate employees, and meeting attendees who at the time of the study stayed in Krakow, Poland. No personal data except for age and gender were collected. All participants were informed that their data were fully anonymous and that they could quit the experiment at any moment. In all other aspects, the study conformed to the ethical principles of the WMA's Declaration of Helsinki.

Materials

Each participant responded to a questionnaire which included the items described below. It had five linguistic variants: English, French, Italian, Polish, and Spanish, and participants decided by themselves which variant they responded to.

Cognitive Ability Measures Cognitive ability was probed using three short measures suitable for a field study. Four items were drawn from the Expanded Cognitive Reflection Test (Toplak, West, & Stanovich, 2014). Each such item required to solve a numerical problem, for instance "If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?" (the correct response: "5 minutes"; a primed incorrect response: "100 minutes"). This test strongly correlates with other measures of cognitive ability (Otero, Salgado, & Moscoso, 2022). Another four items consisted of number series, such as "36 34 30 28 24 ?" (the correct response: 22), which is also a recognized test of cognitive ability (Snow, Kyllonen, & Marshalek, 1984). For each test, the score equaled the number of items solved correctly. Finally, seven items drawn from the Need for Cognition questionnaire (Cacciopo, Petty, & Kao, 1984) required to mark on a 5-point Likert scale how well statements referring to typical cognitive activity apply to a respondent, for instance "I like deliberating on a task, even if I am unable to complete it" and "I search for multiple solutions to one problem." The Need for Cognition is a trait-level measure of cognitive style which correlates at around $r = .40$ with standard intelligence tests (Hill et al., 2013). The score was the sum of the seven responses.

Pseudoscience Items Ten questions probed beliefs in pseudoscience, and were responded to using a 7-point Likert scale ranging from "definitely false", via "don't know", to "definitely true" (the same 7-point Likert scale was applied for conspiracist and paranormal items). These items yielded the highest validity and reliability in our previous research with a larger number of pseudoscience items. The table below presents the questions, their mean acceptance (MA) rates (in 0 to 6 range), and the loadings (λ) of the pseudoscience factor, reflecting the variance shared by all items.

Pseudoscience beliefs item	MA	λ
The proper flow of energy in an organism is dependent on energy centers in the human body	3.49	.47
Although the theory of evolution is accepted by most of scientists, it is only a theory and there is little evidence that it is true	2.45	.45

Consuming genetically modified organisms (GMO) may increase the likelihood of getting cancer via inducing certain changes in the DNA structure of the consumer's body cells	3.83	.34
Mercury in vaccines may increase the probability of small children getting autism	2.75	.49
Bioenergy therapy can be an effective method of healing, as it aims to restore an organism's energy balance	3.13	.42
Crystals possess qualities which protect against negative influence of electromagnetic radiation	2.97	.48
Although not always effective, homosexuality can be treated with special therapy	1.59	.37
Detecting underground water sources using a pendulum is possible due to electromagnetic forces	3.27	.43
Regular masturbation leads to sexual disorders	2.42	.37
Children conceived by the in-vitro method have more frequent genetic disorders	2.12	.46

Paranormal Items Nine paranormal items were based on the Revised Paranormal Beliefs Scale (Tobacyk, 2004):

Paranormal beliefs item	MA	λ
Some people possess the ability to move objects using only their mental power	1.36	.52
You can't rule out that magic exists	1.54	.55
Under some conditions, the mind or the soul can leave the human body and return afterwards	2.36	.68
In some cases, it is possible to communicate with the dead	2.27	.56
Some people have a scientifically unexplainable ability to predict the future	2.01	.64
Reading other people's minds is sometimes possible	1.96	.63
It is possible to put a curse on a person	1.64	.60
Breaking a mirror may bring you bad luck	0.77	.44
There is some evidence that some numbers are lucky and some are unlucky	0.98	.67

Conspiracist Items Nine conspiracist items were formulated after Generic Conspiracist Beliefs scale (Brotherton, French, & Pickering, 2013), specifically:

Conspiracist beliefs item	MA	λ
Natural catastrophes are sometimes caused by the testing or use of secret advanced technologies	2.85	.53
The drugs for many diseases, such as cancer and AIDS, are known, but are deliberately not administered and kept secret from patients	2.60	.57
The spread of many viruses and diseases is the result of deliberate, concealed efforts of some organizations and governments	2.34	.70

Many terrorist attacks were organized by the secret service and government of the country, in which the attacks took place	2.52	.61
A small secret group of people are responsible for making major world decisions, such as wars	3.16	.65
Members of diverse secret organizations infiltrate governments to control world events	3.28	.67
Mind-controlling technology is used on people without their knowledge	2.52	.65
Governments conceal that they gather secret information about the life of all their citizens	3.63	.49
Some materials are secretly instilled in the environment by governments to control society	2.28	.70

Results

For cognitive ability measures, the participants on average solved correctly 1.72 out of the 4 Cognitive Reflection Test items ($SD = 1.38$), and they solved correctly 2.44 out of 4 Number Series items ($SD = 1.42$). The mean score on the Need for Cognition scale was 20.13 out of 28 ($SD = 4.58$). The two former scores intercorrelated at $r = .483$, and they correlated with the latter score at $r = .168$ and $r = .103$, respectively, each $p < .03$. We calculated the cognitive ability factor using these three measures.

The mean acceptance rate was lower for the paranormal belief items ($MA = 1.65$), as compared to pseudoscience and conspiracist belief items ($MA = 2.80$ each), which is a typical result for young European participants (see Bensley et al., 2019; Čavojová et al., 2020; Jastrzębski & Chuderski, 2022).

The correlations between the cognitive ability, pseudoscience, conspiracist, and paranormal factors (i.e., latent variables) were modeled using Confirmatory Factor Analysis (CFA). Expressing each such construct as a latent variable increases its reliability, as compared to, for instance, the sum of Likert scores, because latent variables reflect the variance shared by all items/scores and thus can filter out specific and unwanted sources of variance (Kline, 1998). All the four latent variables were allowed to correlate.

The resulting model is presented in Figure 1. The model fitted the data well, as indicated by Root Mean Square Error of Approximation, $RMSEA = .066$ [.063, .069] (criterion value $< .08$), and Standardized Root Mean Square Residual, $SRMR = .065$ (criterion value $< .08$). All factor loadings on consecutive measures were satisfactory ($\lambda > .40$, Matsunaga, 2010), except for the loading of cognitive ability on the Need for Cognition ($\lambda = .22$), most probably because this measure relied on self-report and not on objective performance. We retained this measure, as it did not affect the resulting model (see below). Overall, the loadings of the three types of beliefs on the items were moderate (mean $\lambda = .54$), which is typical for Likert scales probing beliefs.

The three categories of unwarranted beliefs significantly intercorrelated. In the case of pseudoscience beliefs, each correlation was strong, understood as $r > .30$ (with $r > .20$ called moderate, and $r > .10$ called weak, Gignac & Szodorai,

2016). Especially, pseudoscience and conspiracist beliefs shared 50.4% of their variance, which is an exceptionally strong relationship. Pseudoscience and paranormal beliefs shared 22.1% of variance, and paranormal and conspiracist beliefs shared 14.4% of variance.

Most importantly, each type of unwarranted beliefs significantly correlated negatively with cognitive ability at a comparable strength. The numerically strongest correlation was observed for pseudoscience beliefs, with 6.8% shared variance. This amount dropped to 3.2% for paranormal beliefs, and to 2.6% for conspiracist beliefs, but the three values did not differ significantly, $Z = 1.15$, $p > .10$.

As the correlations between Need for Cognition and the two ability tests were weak overall, we also computed the model in which only Cognitive Reflection Test and Number Series comprised the cognitive ability variable. Excluding Need for Cognition from the model yielded no significant difference to the model estimates, with the maximum change in the correlation equaling $\Delta r = .02$ in the case of paranormal beliefs and cognitive ability ($r = -0.20$ instead of $r = -0.18$).

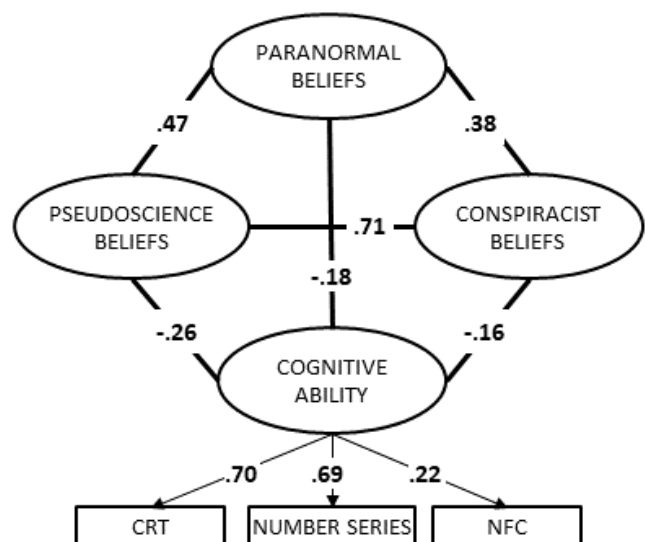


Figure 1: The CFA model of relationships between the cognitive ability, pseudoscience beliefs, conspiracist beliefs, and paranormal beliefs latent variables (factors), represented by ovals. Arrows reflect factor loadings on manifest variables (shown only for cognitive ability), lines stand for the latent variable Pearson correlations. CRT = Cognitive Reflection Test; NFC = Need for Cognition.

In the next step, we examined whether the above relationships differed between females and males. Previous research suggested that gender can be a significant predictor and mediator of the relationships between unwarranted beliefs and cognitive factors (Bensley et al., 2019; Jastrzębski & Chuderski, 2022). While both genders did not differ in mean acceptance rates for all the three types of beliefs, each $t < 1$, data in Table 1 suggest that the relationship of cognitive

ability with pseudoscience and conspiracist beliefs was significantly stronger in males than in females. The correlation strengths for males were around $r = |0.3|$, while the correlation strengths for females surpassed $r = |0.1|$, and the latter links were not statistically significant. Only for paranormal beliefs, there was no significant difference between the two genders.

Table 1: Pearson correlations of the cognitive ability factor with the unwarranted beliefs factors, shown separately for the female (N = 164) and male subsample (N = 140), as well as the statistical significance of their difference (the Z test).

Non-significant correlations in italics.				
Factor	Females <i>r</i>	Males <i>r</i>	Z value	<i>p</i> value
Pseudoscience	<i>-0.167</i>	-0.361	1.76	.039
Conspiracist	<i>-0.103</i>	-0.279	1.71	.044
Paranormal	<i>-0.219</i>	-0.256	0.37	.356

In the final analysis, we checked how much of the substantial amount of variance shared by the three types of unwarranted beliefs could be attributed to cognitive ability. Specifically, we compared the latent variable correlations for unwarranted beliefs in the CFA model with the respective correlations between these variables' disturbances in the structural equation model (SEM), in which the cognitive ability latent variable predicted each unwarranted beliefs latent variable, and the disturbance term reflected a latent variable variance after cognitive ability had been partialled out. The SEM results, compared with the original CFA correlations, are presented in Figure 2. After accounting for cognitive ability, the links between unwarranted beliefs dropped only slightly, $\Delta r = -.05, -.03, \text{ and } -.04$, and neither drop was statistically significant, each $p > .10$. This suggests that the strong intercorrelations of the three types of unwarranted beliefs are relatively intrinsic.

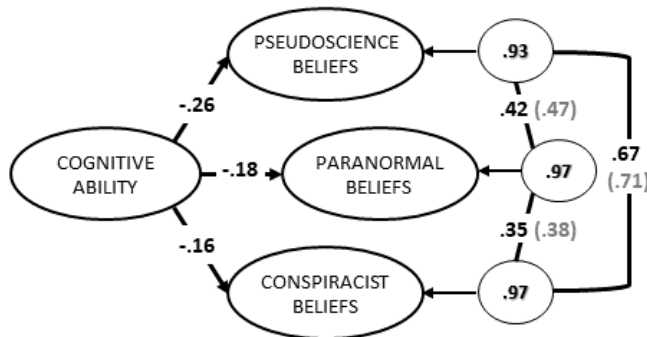


Figure 2: The SEM analysis in which the cognitive latent variable predicts the three unwarranted beliefs latent variables (depicted as ovals), and each unwarranted beliefs variance unaccounted by cognitive ability (depicted by circles with the amount of such variance presented inside) were allowed to correlate. Arrows reflect regression paths, lines reflect correlations. Gray numbers in brackets show original latent variable correlations from the CFA model.

Discussion

We observed statistically significant correlations between cognitive ability and pseudoscience, conspiracist, and paranormal beliefs (rarely studied altogether in one and the same work). These correlations were relatively stronger than those reported thus far. For example, a recent meta-analysis on conspiracist beliefs (Stasielowicz, 2022) estimated their link with cognitive ability at $r = -.13$, while our estimate was $r = -.16$. For paranormal beliefs, Dean et al. (2022) suggested that no reliable link exists with cognitive ability, as the numbers of reported small effects and the numbers of null effects were comparable. At the same time, we established a reliable $r = -.18$ link. For pseudoscience beliefs, no meta-analysis is available, but the effects in single studies were typically stronger than for paranormal and conspiracist beliefs – here we estimated such an effect at $r = -.26$.

These relatively stronger and definitely reliable negative correlations might have occurred because this field study as the first one examined participants from more than one country, as well as applied measurement situation which more strongly resembled natural condition (a survey), as compared to existing laboratory studies. All of that might have resulted in less restricted and less biased responding.

These moderate correlations suggest that general cognitive ability may have a certain role for forming and holding unwarranted beliefs. To some extent, our individual capacity for comprehension, inference, and validation seems to translate onto critical evaluation and rejection of beliefs which do not, or could not, receive support from actual evidence. Cognitive ability is perhaps most helpful for rejecting pseudoscience beliefs – the role of reasoning and comprehending may be most important when pseudoscience claims need to be confronted with the objective body of scientific knowledge. Such cognitive processes may be, however, less critical for evaluating conspiracist claims that “by definition” cannot be directly tested. For accepting such claims, it may be more important if someone generally fails to involve in regular thinking, instead relying on delusional and paranoid ideation, typical for increased schizotypy and some other personality disorders (Darwin et al., 2011; Denovan et al., 2018; Swami et al., 2014).

An interesting finding was that the cognitive ability relationship with pseudoscience and conspiracist beliefs was substantially stronger in the male subsample than in females. We have no reasonable explanation of this difference, especially as females and males displayed comparable levels of each type of unwarranted beliefs. Males demonstrated on average a higher level of cognitive ability, but their small advantage over females ($\Delta M = 0.36$ of z-score) could unlikely explain the above differences. Perhaps some emotional, personality, or social factors, beyond cognitive domain, responsible for gender differences in the cognitive ability-unwarranted beliefs links, can be identified in future studies.

One limitation of the present study is the fact that for a multi-national, relatively heterogenous sample, our 334 participant sample size locates itself at the lower end of accepted sizes. A larger sample (and a larger number of countries)

would be required for a sufficiently stable and fully informative CFA model of unwarranted beliefs and cognitive ability, which may be a subject of future research.

Conclusion

The main aim of this field study was to explore the relationships between cognitive ability and pseudoscience, paranormal, and conspiracist beliefs in young participants from several European countries. The crucial result of the study is that each type of unwarranted beliefs seems to be reliably related negatively with cognitive ability. On the one hand, these relationships were moderate in size, suggesting that effective comprehension, reasoning, and critical evaluation of the epistemically relevant factors might to some extent help in rejecting unwarranted claims. On the other hand, the core “unwarranted world-view”, reflected by strong intercorrelations between the three types of beliefs, remained virtually unchanged even when cognitive ability had been accounted for. That suggests that although cognitive ability is important for forming and holding one’s specific beliefs, perhaps other cognitive dimensions, such as cognitive styles, open-mindedness, reflection, and lack of schizotypy (Darwin et al., 2011; Lobato & Zimmerman, 2019; Pennycook, Fugelsang, & Koehler, 2015; Stasielowicz, 2022; Swami et al., 2014) may be more crucial in determining how much rational world-view (the entire system of beliefs) one adopts. Why people are prone to epistemically unwarranted claims is an important but still poorly understood phenomenon which requires future research and novel explanations.

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