Received: 12 July 2021 | Revised: 14 December 2021 | Accepted: 4 January 2022
DOI: 10.1002/acp.3914

RESEARCH ARTICLE

WILEY

Disproven but still believed: The role of information and individual differences in the prediction of topic-related pseudoscience acceptance

Josue García-Arch[1,2,3] | Marc Ballestero-Arnau[1,2,3] | Lorena Pérez Hoyas[4] | Francesca Giaiotti[1,5]

[1]Department of Cognition, Development and Educational Psychology, Faculty of Psychology, University of Barcelona, Barcelona, Spain
[2]Cognition and Brain Plasticity Group, Bellvitge Institute for Biomedical Research, Hospitalet de Llobregat, Barcelona, Spain
[3]Institute of Neurosciences, University of Barcelona, Barcelona, Spain
[4]Barcelona Graduate School of Economics, Pompeu Fabra University, Barcelona, Spain
[5]Department of Life Sciences, University of Trieste, Trieste, Italy

Correspondence
Josue García-Arch, Department of Cognition, Development and Educational Psychology, Faculty of Psychology, University of Barcelona, Pg. Vall d'Hebrón, 171, Barcelona, 08035, Spain.
Email: j.garcia.arch@ub.edu

Abstract

The spread of pseudoscience (PS) is a worrying problem worldwide. The study of pseudoscience beliefs and their associated predictors have been conducted in the context of isolated pseudoscience topics (e.g., complementary and alternative medicine). Here, we combined individual differences (IIDD) measures (e.g., personality traits, thinking styles) with measures related with the information received about PS: familiarity and disproving information (DI) in order to explore potential differences among pseudoscience topics in terms of their associated variables. These topics differed in their familiarity, their belief rating, and their associated predictors. Critically, our results not only show that DI is negatively associated with pseudoscience beliefs but that the effect of various IIDD predictors (e.g., analytic thinking) depends on whether DI had been received. This study highlights the need to control for variables related to information received about pseudoscientific claims to better understand the effect of other predictors on different pseudoscience beliefs topics.

KEYWORDS
familiarity, individual differences, pseudoscience, unwarranted beliefs

1 | INTRODUCTION

Pseudoscience acceptance is a problem that is beginning to receive attention and empirical research by scientists around the world. Although this field has encountered repeated conceptual problems that have made it difficult to differentiate between pseudoscientific and scientific claims (Fasce, 2017), Fasce and Picó (2019a) have recently proposed a well-grounded and useful definition of pseudoscience. According to these authors, in order to define a pseudoscientific claim as such, it must adhere to certain standards. First, it must be presented as scientific knowledge. Second, it should meet at least one of the following criteria: (a) it refers to at least one field or process considered outside the domains of science; (b) it uses procedures that are deficient or do not correspond to the scientific method; and (c) it is not supported by scientific evidence.

Nowadays, even after major advances in many scientific fields during the last century, and the easy accessibility to scientific knowledge, the devotion to pseudoscience is still widespread throughout the world (Blancke et al., 2019). Current research has shown that people may be even more willing to transmit pseudoscientific claims than their scientific counterparts (Mercier et al., 2018). It also has been suggested that pseudoscience could easily deceive both nonspecialists and experts into believing that it is well supported by evidence (Lilienfeld, 2015), which contributes to its growing acceptance.

One remarkable example of the spread of pseudoscience is the use of complementary and alternative medicine (CAM). In that sense, an interesting study from the Royal College of Physicians of United Kingdom revealed that a considerable portion of physicians (more than 20%) in the United Kingdom were employing some kind of CAM, even when most of them were never instructed about these

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2022 The Authors. *Applied Cognitive Psychology* published by John Wiley & Sons Ltd.

practices (Posadzki et al., 2012). Moreover, this phenomenon is not limited to medical domains and expands to other fields such as education or psychology (Ferrero et al., 2016; Furnham & Hughes, 2014; Macdonald et al., 2017), where it can produce unfruitful investments of time and resources on programs relying on unproven assumptions (Macdonald et al., 2017).

Beyond their spread, beliefs in pseudosciences have concerned both scientists and specialists from different fields because of the consequences they generate. Some examples are the use of CAM instead of evidence-based therapies by patients with severe medical conditions (Sanford et al., 2019), as well as vaccination refusal, which can lead to outbreaks of otherwise avoidable diseases (Hussain et al., 2018). In the same vein, although it has been repeatedly reported that the use of genetically modified organisms (GMOs) is widely contributing to the development of a sustainable type of agriculture (Ammann, 2005; Blancke et al., 2015; Subramanian & Qaim, 2010), there is an increasing discrepancy between scientific knowledge and public opinion regarding the safety of its consumption (Blancke et al., 2015). In turn, the avoidance of GMO use can have tragic consequences, costing thousands of lives (Wesseler & Zilberman, 2014). Thus, expanding knowledge on the factors underlying susceptibility to pseudoscientific claims is crucial for establishing proper educational interventions aiming at reducing pseudoscience-related risks (Standing & Huber, 2003; Wilson, 2018).

Given the social and economic impact of beliefs in pseudoscience (Hussain et al., 2018; Macdonald et al., 2017; Sanford et al., 2019), there is a growing interest in trying to find variables able to predict this phenomenon. Some of the variables in the field of individual differences (IIDD) most commonly included in studies are personality traits (extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience) and cognitive styles (analytic and intuitive thinking). Although personality traits have been shown to be strong predictors of all types of outcomes, including different types of beliefs (Ozer & Benet-Martínez, 2006), they have neither proved to be associated with susceptibility to pseudoscientific claims nor with other types of unwarranted beliefs (Furnham, 2007; Goreis & Voracek, 2019), with the exception of extraversion (Fasce & Picó, 2019a; Swami et al., 2012). In contrast, associations have been found between both analytic and intuitive cognitive styles, and different kinds of unwarranted beliefs. Results regarding these predictors have shown that higher scores in analytical thinking are related to lower levels of unwarranted beliefs, while faith in intuition is positively associated with higher acceptance of such statements (Aarnio & Lindeman, 2005; Bensley et al., 2014; Blancke et al., 2015; Bronstein et al., 2019; Pennycook et al., 2012). However, the evidence in this regard is still very limited and these studies do not use measures of purely pseudoscientific beliefs (but see, Fasce & Picó, 2019b) nor are they free of mixed findings (Majima, 2015). Therefore, more specific research is needed to determine the weight of IIDD predictors in the acceptance of pseudoscientific claims.

The lack of predictive capacity shown by personality traits in this domain implies the need to find alternative predictors in the area of IIDD. One possibility is the use of narrower traits that manage to capture specific aspects of such beliefs. Although the use of narrower traits is less likely to allow the prediction of a wide range of phenomena, they can increase the accuracy and provide incremental validity (Ozer & Benet-Martínez, 2006). In line with this proposal, it has been highlighted that beliefs in pseudoscience go against the dominant standards of scientific knowledge and can be considered unconventional (Cano-Orón, 2019; Waters, 2020). This suggests that IIDD in the inclination toward an unconventional way of thinking might be a source of variation in pseudoscientific claims' acceptance (Bishop et al., 2007). As a dimension, unconventionality is relatively captured by a large and widely known personality trait: openness to experience (Lee & Ashton, 2008; Mccrae & Jr, 1977). Although no relationship has been found between openness to experience and beliefs in pseudoscience (Fasce & Picó, 2019a; Furnham, 2007), this is not incompatible with a relationship between unconventionality and pseudoscience believing: some of the characteristics of unconventionality in itself may not be captured by this dimension, since it is only a small part of one of the largest personality factors that have been defined (Kaufman, 2013). A promising way of assessing whether a tendency to think in an unconventional fashion can predict beliefs in pseudoscience, is to create scales able to capture this construct. Although there have been recent attempts to capture this dimension (Andreas et al., 2016), further research on both the measurement of this dimension and its use in predicting unwarranted beliefs is needed.

As mentioned above, the study of IIDD as predictors of pseudoscience beliefs is promising, and other possible IIDD predictors have also recently been proposed, such as ontological confusions (Lindeman & Svedholm, 2012), authoritarianism, and social axioms (Fasce et al., 2021), and causal illusions (Torres et al., 2020). However, empirical research in this area rarely includes variables unrelated to individual characteristics, which could potentially reduce the possibility of accurately predicting pseudoscience beliefs. In this sense, independently of their individual features, every individual who develops a belief in (or against) pseudoscience has presumably been exposed to information that supports and/or discredits it. Therefore, considering the current spread of pseudoscience as well as the efforts aimed at combating it, the inclusion of measures related to the information received in relation to different pseudoscientific practices could be important to the understanding of this phenomenon.

In line with this idea, it is worth noting that most previous studies have not included familiarity as a predictor of susceptibility to pseudoscientific claims (Piejka & Okruszek, 2020), although it has been shown that familiarity is closely related even to beliefs in implausible claims (Fazio et al., 2019; Pennycook et al., 2018). Future research should consider including a familiarity measure in pseudoscience-related studies, as this would allow to analyze its effect on pseudoscience acceptance as well as the spread of different pseudoscientific beliefs.

In terms of information received by interested parties, it seems also logical to assume that just as claims about various pseudosciences are bolstered by information in their favor; they might also be met, to some extent, with disproving information (DI) that discredits them. Including this component (i.e., whether a given claim has been accompanied by DI) in studies that try to predict beliefs in pseudoscience

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

may be important for analyzing whether pseudoscientific claims' credibility is lower once DI has been received. Furthermore, this could also help us to identify predictors capable of explaining the variability in pseudoscience beliefs that have already received DI as well as whether the effect of DI depends on recipients' individual characteristics. This is especially relevant for the investigation of which variables might predict an effective integration of information in educational contexts in order to reduce beliefs in pseudoscience (Schmaltz & Lilienfeld, 2017).

The present research had two major aims. The first aim was to explore the above-mentioned IIDD and information-related measures as predictors of susceptibility to pseudoscientific claims as well as their differential functioning across pseudoscience topics (Study 2). The second aim was to examine which predictors (if any) were especially relevant for those pseudoscientific beliefs that had already been met with DI (Study 2). Importantly, this research focused on the three most commonly studied pseudoscience topics (CAM, psychology-related pseudoscience [PRP], and causes of harm-related pseudoscience [CHRP]). Given that these topics have been mostly studied in isolation, this research also set out to explore the performance of the items belonging to these three major topics when presented together (Study 1) in order to provide psychometric robustness to the potential conclusions to be drawn from Aims 1 and 2.

We hypothesized that the tendency to think unconventionally (Hypothesis 1) and familiarity (Hypothesis 2) would be positively associated with pseudoscience beliefs, while having received DI would be associated with lower pseudoscience beliefs (Hypothesis 3). Additionally, we predicted the previously demonstrated relationships between pseudoscience beliefs and both cognitive styles (Prediction 1) and extraversion (Prediction 2) to be replicated.

2 | STUDY 1

2.1 | Introduction

Research on pseudoscience beliefs is young and has commonly been thematically focused, with the most frequent themes being CAM (Bishop et al., 2005, 2007, 2008; Braun et al., 2000), PRP (Bensley et al., 2014; Dekker et al., 2012; Furnham & Hughes, 2014; Gardner & Brown, 2013; Macdonald et al., 2017) and CHRP, such as GMO or vaccination (Blancke et al., 2015; Bryden et al., 2018). These topics have so far been studied in isolation. This approach has probably been adopted to address concerns stemming from the fields to which these pseudoscience topics belong, in an effort to effectively address the dangers that pseudoscientific practices pose in their daily work. However, it has been suggested that attention should also be drawn to potential differences and/or similarities between the different kinds of pseudoscientific beliefs, in regard to both their thematic content and their spread among the population (Bensley & Lilienfeld, 2015; Lindeman & Svedholm, 2012). This would allow for a more efficient targeting of efforts to reduce them. In this sense, it has recently been suggested that both that the underlying motivations for different types of pseudoscience beliefs may not be the same (Blancke et al., 2019; Zaboski & Therriault, 2020), and that widely studied variables such as analytic and intuitive cognitive styles may be differentially related to health and PRP beliefs (Bensley et al., 2014), calling for such a possibility to be explored in empirical research.

The few empirical studies that have addressed this question to date (i.e., potential variations of predictors across pseudoscience topics) have found that the variables associated with different pseudoscientific beliefs vary according to their topic (Piejka & Okruszek, 2020; Rutjens et al., 2018). Although this research field is at a very early stage and the theoretical framework is not elaborate enough to explain why these differences exist, some authors have suggested that it is crucial to use this information to target interventions aimed at reducing pseudoscience beliefs, tailoring them to each subject matter according to the respective predictor variables (Rutjens et al., 2018). Despite these promising results, these studies were conducted using pseudoscientific belief measures lacking an adequate psychometric validation. Such a validation is necessary given that differences in the predictors of distinct pseudoscience topics could be increased or reduced after subjecting their items to dimensionality reduction techniques (necessary for psychometric validation) such as exploratory factor analysis (EFA). Therefore, future research should subject its measures of pseudoscience beliefs to these and other psychometric procedures, especially when intermixing pseudoscience topics.

The aim of this study was to explore the performance of the items belonging to the three most studied pseudoscience topics (CAM, PRP, and CHRP) when presented together in a single questionnaire.

This objective was pursued in an exploratory way (EFA) allowing for any type of item grouping. The purpose of this approach was not to obtain a general model for pseudoscience beliefs, since there are many types of pseudoscience that were not included (such as climate change denial or flat earth theories; McCright & Dunlap, 2011; York, 2017). Rather, the purpose was to explore the functioning of the differently themed items when intermixed together in a single and thematically balanced questionnaire. This is especially important given that items belonging to the three main topics proposed could be grouped in a different way than one might expect, which justifies the need of using exploratory statistical techniques. For example, a study by Bryden et al. (2018) suggested that CAM and CHRP beliefs had a common link to the health domain. Therefore, by mixing them with PRP beliefs, it might be possible to obtain (for instance) two factors, one more strictly health-related and the other one related to psychological practices. This calls for the need to ensure the functioning of these items by means of multivariate statistical techniques such as parallel analysis (PA) and EFA without assuming that the three pseudoscience topics included will behave as such when intermixed together. Consequently, the ultimate aim of this approach was to obtain a replicable pseudoscience belief grouping that would be able to explain in a parsimonious way the functioning of the items included. This clustering would allow us to analyze whether, as some authors have suggested, predictors of pseudoscience beliefs might vary according to their topic (Study 2).

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2.2 | Methods

2.2.1 | Participants

A total of 120 participants (72 females) with ages ranging from 18 to 52 with a mean of 36.35 years (SD = 6.39) were recruited via social media.

2.2.2 | Instruments

We created an online survey containing 18 pseudoscience statements. The purpose of this instrument was to assess participants' beliefs about CAM, PRP, and CHRP. During the questionnaire construction process, both validated scales (Fasce & Picó, 2019a; Torres et al., 2020) and different studies that included beliefs in pseudoscience related to any of the aforementioned topics were inspected (Braun et al., 2000; Furnham, 2007; Furnham & Hughes, 2014; Gardner & Brown, 2013; Kallery-Vlahos, 2001; Lilienfeld & Beyerstein, 2011; Mercier et al., 2018; Piejka & Okruszek, 2020). The spectrum of subtopics finally included in the questionnaire together with their main sources is reported in Table 1.

2.2.3 | Procedure

The questionnaire was administered using the popular survey platform Qualtrics. Participants responded to the 18 items included using a Likert scale from 1 to 8. In order to analyze criterion validity, participants also responded to a measure of paranormal beliefs (RPBS-Sp) (Díaz-Vilela & Álvarez-Gonzál-Ez, 2004), as has been done in previous studies (Torres et al., 2020).

2.3 | Results

The main objective of this study was to explore the functioning of items belonging to three major pseudoscience-related topics when presented together. To meet this objective, two well-known multivariate statistical tests were applied: PA and EFA. These methods are data-driven and allow to evaluate the best factor structure given a dataset, without assuming prior hypotheses. PA is a technique that returns the optimal number of nontrivial factors with a valid factor structure to be retained from a given dataset. It works by creating correlation matrices of random variables based on the same sample size as well as on the same number of variables in the original dataset and comparing its random versus observed eigenvalues (Hayton et al., 2004). In turn, EFA is a statistical data reduction method that aims at reaching a more parsimonious understanding of measured variables, and it is especially appropriate when there is not enough available knowledge for specifying a priori the number of factors and the patterns underlying them. Consequently, we considered the combination of both techniques to be the most appropriate approach for the present study.

TABLE 1 Pseudoscience thematic spectrum included and main sources (references)

Topic	Reference
Complementary and alternative medicine	
Homeopathy	Torres et al. (2020), Fasce and Picó (2019a, 2019b), and Majima (2015)
Bach flowers	Torres et al. (2020)
Nutritional supplements	Torres et al. (2020)
Detox therapy/diet	Torres et al. (2020) and Majima (2015)
Vitamin C and common cold	Braun et al. (2000)
Herbal medicine	Harnack (2003) and Zhang (2008)
Psychology-related pseudoscience	
Hypnosis and trauma	Torres et al. (2020)
Graphology	Torres et al. (2020)
Dream interpretation	Torres et al. (2020)
Learning languages	Torres et al. (2020)
Neurolinguistic programming (NLP)	Torres et al. (2020) and Fasce and Picó (2019a, 2019b)
Mozart effect	Torres et al. (2020) and Piejka and Okruszek (2020)
Causes of harm-related pseudoscience	
Mobile phone radiation	Torres et al. (2020) and Majima (2015)
GMOs	Fasce and Picó (2019a, 2019b) and Piejka and Okruszek (2020)
Negative emotions & Cancer	Fasce and Picó (2019a, 2019b)
Wi-Fi	Torres et al. (2020)
Vaccines and autism	Fasce and Picó (2019a, 2019b) and Bryden et al. (2018)
Chemophobia (pesticides and additives)	Fasce and Picó (2019a, 2019b)

Note: Items in bold are the ones finally included in the thematic spectrum.

An EFA was conducted on the 18 items with promax rotation. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy suggested that data was appropriate for factor analysis (KMO = 0.73). Bartlett's test of sphericity indicated that the correlation in the data for factor analysis was sufficiently significant $\chi^2(153) = 779.55$, $p < .001$. To determine the number of factors to be retained we conducted a PA, which determined that the optimal number of factors to be retained was 3. The threshold for considering relevant the obtained factor loadings was set to 0.4 (Comrey & Lee, 2013). Below this threshold, items were considered as not providing sufficient information for any of the factors. Results from EFA determined that these three factors explained a total of 39% of the variance. Factor 1 contained only CAM-related items and explained 14% of the variance. Factor 2 contained only psychology-related items and explained 13% of the variance, and Factor 3 contained only causes of harm-related items and explained 11% of the variance. Five items had factor loadings under 0.3 (under the established threshold of 0.4) and were

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

considered not pertaining to any of the factors. After excluding these items, we repeated the Factor Analysis obtaining the same three factors, which explained 52% of the variance (Factor 1: 20%, with factor loadings ranging from 0.46 to 0.64; Factor 2: 18%, with factor loadings ranging from 0.49 to 0.81; Factor 3: 15%, with factor loadings ranging from 0.64 to 0.94). No cross-loading problems were detected (minimum absolute difference between factor loadings was 0.22). Further, no reliability problems were detected in any of the factors obtained (Factor 1: $\alpha = .76$; Factor 2: $\alpha = .79$; Factor 3: $\alpha = .85$). Pearson product–moment correlations showed significant and positive relationships between factors, CAM with PRP $r(118) = .24$, $p = .008$, CAM with CHRP $r(118) = .44$, $p < .001$ and PRP and CHRP $r(118) = .42$, $p < .001$. Further, no reliability problems were detected in any of the factors obtained, CAM ($\alpha = .76$), PRP ($\alpha = .79$), and CHRP ($\alpha = .85$). A list of the items finally included in the thematic spectrum can be seen in Appendix A.

In order to analyze criterion validity, we tested the relationship between the average belief rating in each pseudoscience topic and a measure of paranormal beliefs (RPBS-Sp), following prior research recommendations (Torres et al., 2020). Scores from RPBS-Sp ($M = 2.72$, $SD = 1.48$) were not normally distributed $W(141) = .87$, $p < .001$, therefore we conducted nonparametric Kendall's tau tests to analyze the correlations between RPBS-Sp and our pseudoscience measures. Results showed significant positive and low correlations between RPBS-Sp and pseudoscience beliefs about psychology $r_\tau = .19$, $p = .004$, CAM $r_\tau = .16$, $p = .013$, and causes of harm $r_\tau = .19$, $p < .003$.

Finally, we explored whether beliefs in pseudoscience differed in their average rating according to their topic. To this end, we conducted a repeated measures analysis of variance (RM ANOVA) with pseudoscience topic (CAM, PRP, and CHRP) as a within-subjects factor and the average belief rating as the dependent variable. Results showed a significant effect of pseudoscience topic on the average belief rating $F(2, 238) = 198$, $p < .001$, $\eta^2 = .62$. The post-hoc analysis was conducted computing three separate paired t-tests (Bonferroni corrected). Pairwise comparisons revealed significant differences between both PRP and CHRP $t(119) = 13.661$, $p < .001$, $d = 1.34$ and PRP and CAM $t(119) = 18.94$, $p < .001$, $d = 2.13$, as well as significant differences between CHRP and CAM $t(119) = 6.06$, $p < .001$, $d = .58$. Thus, the most believed pseudoscience topic was PRP $M = 6.456$, $SD = 1.374$, 95% CI[6.21, 6.702], followed by CHRP $M = 4.338$, $SD = 1.73$, 95% CI[4.028, 4.647] and CAM $M = 3.39$, $SD = 1.497$, 95% CI[3.122, 3.658].

2.3.1 | Findings

In short, the obtained results suggest that the three major pseudoscience beliefs topics included in our questionnaire (CAM, PRP, and CHRP) remain as separated but interrelated factors when presented together, which will serve to guide further psychometric studies. Besides, our data also suggest that belief ratings are significantly different across pseudoscience topics. Although replication of these results is needed, they offer an insight into the potential differences between the included pseudoscience topics, which could be useful for the design of educational interventions.

3 | STUDY 2

The present study was developed to address two main objectives. First (Aim 1), we set out to explore whether certain variables of interest might be able to predict pseudoscience beliefs, as well as whether they might vary across pseudoscience topics. As previously stated, the possible predictors we focused on are IIDD (analytical and intuitive cognitive styles; extraversion and openness to experience personality traits; unconventional thinking) and prior exposure to pseudoscience-related information (DI and familiarity). Second (Aim 2), we examined which predictors (if any) would be especially relevant for those pseudoscientific beliefs that had already been met with DI.

In parallel, in order to provide greater robustness, this study set out to replicate the results obtained in Study 1.

3.1 | Methods

3.1.1 | Participants

A total of 291 individuals, who did not participate in Study 1, were recruited through social media to participate in our survey-based study. We excluded 23 participants that failed to correctly respond to a question designed to work as an attentional check ("Please select: I disagree"). Thus, 268 (163 females) participants composed the final sample. Ages ranged from 18 to 70, with a mean of 32.97 years ($SD = 11.84$). Sixty-two percent of participants were either graduate or undergraduate students.

3.1.2 | Instruments

The data was collected through an online survey programmed in Qualtrics. The survey was divided into two major blocks. In the first block, participants had to report their beliefs regarding the 13 items extracted from the short validation of our previous study, which consisted of different beliefs in pseudosciences belonging to three main thematic blocks: CAM, PRP, and CHRP. For each item, we also obtained a measure of familiarity on a scale from 1 to 4 ((1)"I have never heard this statement"; (2) "I have heard this statement before"; (3) "I have heard this statement several times"; (4) "I have heard this statement many times") and a measure of DI ("I have heard that this statement is false"; "I have never heard that this statement is false"). The second block contained the following IIDD measures: (1) cognitive styles: intuitive thinking ($M = 3.43$, $SD = 0.48$, $\alpha = .81$) and analytic thinking ($M = 3.62$, $SD = 0.61$, $\alpha = .79$), measured with a short version of the rational-experiential inventory (Reyna & Ortiz, 2016), (2) personality traits: extraversion ($M = 3.43$, $SD = 0.65$, $\alpha = .81$) and openness to experience ($M = 3.56$, $SD = 0.65$, $\alpha = .76$), measured

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

with Hexaco (Roncero, 2013), and (3) five items designed to measure Unconventional thinking. The order of the two blocks was randomized.

3.1.3 | Control measures

In our survey, we also collected additional variables in order to control for their effects, if any. One of the variables included to explore its possible relevance was academic background (AB) (university vs. nonuniversity studies). The rationale behind the inclusion of this variable is that there has been much debate about whether university studies have any influence on pseudoscientific beliefs. There are studies suggesting that AB might be related to lower levels of pseudoscience acceptance (Bensley et al., 2014; Hughes et al., 2013; Taylor & Kowalski, 2004). In the same vein, another study found that as participants progressed and passed credits in their degrees, a downward shift in these types of beliefs was noted (Gardner & Dalsing, 1986). On the other hand, there are also studies in which acquisition of academic knowledge had virtually no effect on pseudoscientific belief levels (McKeachie, 1960; Vaughan, 1977). However, it is important to note that most of these studies have been conducted on participants who were already university students (e.g., Wilson, 2018). Considering that this debate is still unsolved, we believe that the inclusion of this variable might be valuable both in order to control its possible effects as well as to provide some information for future research in education. Finally, as has been done in prior research, sociodemographic data such as gender and age was also included in our survey (Fasce & Picó, 2019a).

3.2 | Results

3.2.1 | Replication of Study 1

The results obtained in Study 1 suggested that the three major thematic divisions recurring in the literature on pseudoscience beliefs behaved as such when presented in a single questionnaire (i.e., as three distinguishable factors). Although these results justify the intuitions of past work, the approach used in Study 1 had not been previously undertaken. Therefore, before proceeding to analyze the relationships between beliefs in pseudoscience and our variables of interest, we repeated the analyses conducted in Study 1 on a larger sample ($n = 268$).

As in Study 1, we set out to explore the dimensionality of the pseudoscience beliefs presented in a single questionnaire that intermixed three different pseudoscience topics (CAM, PRP, and CHRP). In order to determine the number of factors to be retained we conducted a PA, which determined that the optimal number of factors to be retained was 3. Subsequently, the results obtained by EFA fully replicated those obtained in Study 1. A summary table describing the final factor structure and its associated factor loadings is reported in Appendix B.

Study 1 also provided information on differences in average belief rating across pseudoscience topics. Here, we also aimed to replicate these results with a new and larger sample. The results from RM ANOVA showed a significant effect of pseudoscience topic on the average belief rating $F(2,534) = 170.55$, $p < .001$ $\eta^2 = .163$. Pairwise comparisons (Bonferroni corrected) revealed significant differences between both PRP and CHRP $t(267) = 11.60$, $p < .001$, $d = .69$ and PRP and CAM $t(267) = 19.27$, $p < .001$, $d = 1.11$, as well as significant differences between CHRP and CAM $t(267) = 5.86$, $p < .001$, $d = .34$. Thus, the most believed pseudoscience topic was PRP $M = 5.498$, $SD = 1.566$, 95% CI[5.311, 5.686] followed by CHRP $M = 4.357$, $SD = 1.73$, 95% CI[4.151, 4.564] and CAM $M = 3.81$, $SD = 1.48$, 95% CI [3.632, 3.986] (see, Figure 1). In conclusion, the results obtained in Study 1 were fully replicated in the present study.

Given that the present study was provided with a measure to represent the spread of pseudoscience (i.e., familiarity), we decided to carry out the same analysis to explore whether the differences in the acceptance of pseudoscientific claims across pseudoscience topics would be accompanied by differences with respect to their spread. To do so, we followed the same procedure as above (RM ANOVA). We found significant differences between pseudoscience topics regarding their average familiarity $F(2,534) = 14.58$, $p < .001$, $\eta^2 = .021$. Pairwise comparisons (Bonferroni corrected) revealed significant differences between both PRP and CHRP $t(267) = 4.99$, $p < .001$, $d = .32$ and PRP and CAM $t(267) = 4.38$, $p < .001$, $d = .29$. No significant differences were found between CHRP and CAM $t(267) = .71$, $p = .48$, $d = .048$. Thus, the most familiar pseudoscience topic was PRP $M = 2.90$, $SD = 0.61$, 95% CI[2.896, 2.973], followed by CHRP $M = 2.70$, $SD = 0.65$, 95% CI [2.619, 2.774] and CAM $M = 2.726$, $SD = 0.57$, 95% CI[2.657, 2.795] (see, Figure 1). Finally, we explored potential differences between pseudoscience topics with respect to the likelihood of having received DI on their respective items. Considering the dichotomous nature of this measure (DI; yes/no), we conducted a logistic regression with DI as dependent variable, pseudoscience topic as fixed effect, and participant ID and item (specific statement) as random effects. The results obtained showed that the likelihood of having received DI was significantly greater for CAM than for CHRP $\beta = .646$, $SE = 0.261$, $z = 2.479$, $p = .013$, with a small effect size (OR = 1.908; similar to Cohen's $d < .3$, Chen, Cohen, & Chen, 2010). Significant and small differences were also obtained between CAM and PRP $\beta = 1.068$, $SE = 0.262$, $z = 4.077$, $p < .001$; (OR = 2.809, similar to Cohen's $d <. 4$). Finally, no differences were found between CHRP and PRP $\beta = .422$, $SE = 0.276$, $p = .126$, OR = 1.525.

3.2.2 | Predicting pseudoscience beliefs through IIDD and pseudoscience information-related measures

Brief validation of unconventional thinking dimension

Before obtaining the statistical models, we conducted an initial validation of the unconventional thinking measure. We designed five items to reflect such a construct (e.g., "I enjoy being someone who thinks differently"). This short scale was inspired by recent attempts to

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

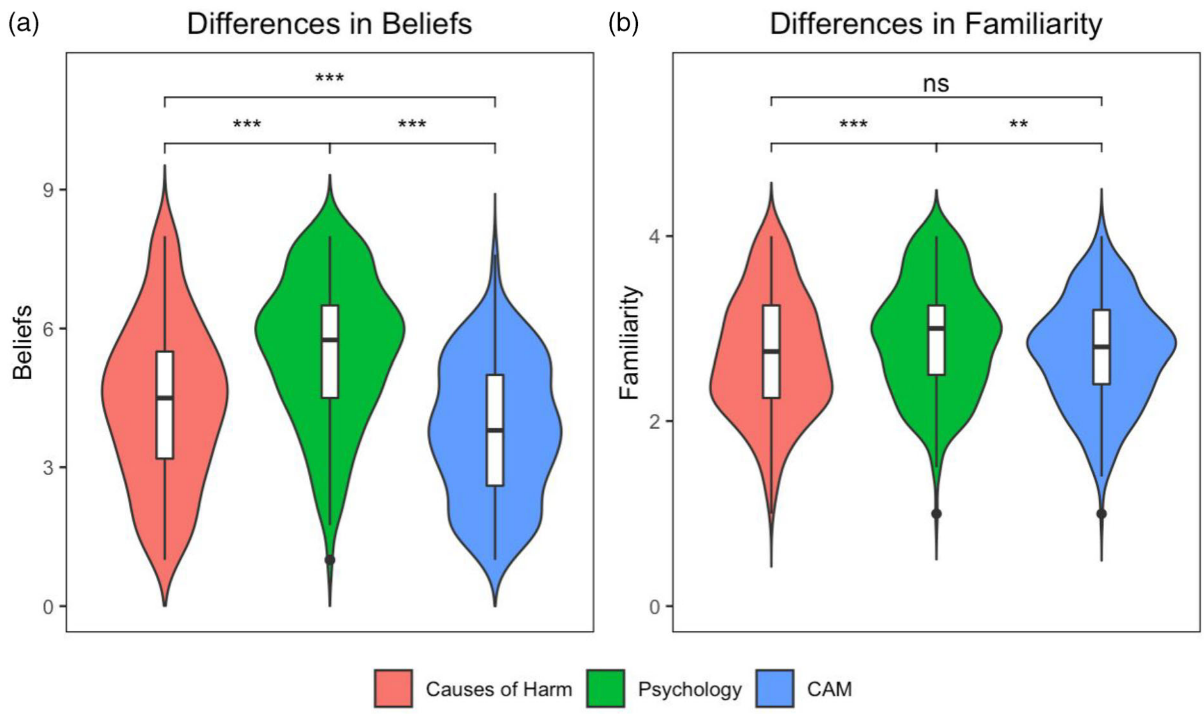

FIGURE 1 Average beliefs rating and familiarity by pseudoscience topic. CAM, complementary and alternative medicine; CHRP, causes of harm-related pseudoscience; PRP, psychology-related pseudoscience. In both plots, ns, non-significance; *$p < .05$; **$p < .01$; ***$p < .001$

capture a more general notion of unconventionality, but all items were designed to reflect aspects of thinking, leaving aside other domains that may show unconventionality, such as emotions, behaviors, or the way we relate to others (Andreas et al., 2016). In order to determine the number of factors to be retained, we conducted a PA, which extracted 1 factor. Results from factor analysis showed that this factor explained 42% of the variance with factor loadings ranging from 0.54 to 0.73 (all above 0.3). Further, no problems of reliability were detected ($M = 3.45$, $SD = 0.69$, $\alpha = .78$). In order to provide evidence for criterion validity, we conducted a Pearson product–moment correlation between unconventional thinking and openness to experience. The results showed a significant and positive correlation between both dimensions $r(266) = .49$, $p < .001$. The list of items included in this dimension can be found in Appendix C.

Statistical models

One of the aims of the present study was to analyze possible predictors of pseudoscience beliefs as well as to explore their possible variation across pseudoscience topics (Aim 1). Furthermore, this study also aimed at exploring whether the relationship between the included predictors and beliefs in pseudoscience depended on having received DI (i.e., a given trait would make people more or less prone to accept pseudoscience claims for which they have received DI) (Aim 2). In order to test both possibilities, we obtained three separated linear mixed models (LMMs), one for each pseudoscience topic (CAM, PRP, and CHRP). All starting models included: (1) main effects for all predictors, (2) two-way interactions between DI and all predictors, and (3) Participant ID and item (specific pseudoscience statement) as random effects (intercept). In order to reduce model complexity, we used a widely known screening method: stepwise regression (backward elimination). This method performs automatic backward elimination of both fixed and random effects of LMMs. First, backward elimination of the random part is conducted, followed by backward elimination of the fixed part. Elimination of the fixed effect is performed following the marginality principle (Kuznetsova et al., 2017) by means of likelihood ratio test (LRT). For every model selection, we ran a nested-models comparison (full models vs. stepwise regression model). If there were no significant differences between them in terms of explained variability, we kept the model with less predictors, following the parsimony principle. In order to provide a comparable measure for the effects of all predictors and interactions, standardized regression coefficients were computed, which can be used as effect size indices (Kim, 2011).

Model 1: Psychology-related pseudoscience beliefs:

The model with all predictors and interactions was compared to the model obtained with the stepwise regression procedure. There were no significant differences in terms of the variability explained by both models $\chi^2(3) = 4.356$, $p = .225$, therefore, following the parsimony principle, we selected the model obtained by stepwise regression (marginal $R^2 = 0.19$; conditional $R^2 = 0.58$). Further, random effects for both Participant ID ($\sigma^2 = 1.19$), $\chi^2(1) = 177.45$, $p < .001$, and Item ($\sigma^2 = 0.52$), $\chi^2(1) = 142.75$, $p < .001$ were significant. A summary of the final LMM for PRP

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

beliefs (regression coefficients, standard errors, *t* values, *p* values, and description of random effects) is reported in Table 2.

Model 2: Complementary/alternative medicine beliefs: The model with all predictors and interactions was compared to the model obtained with the stepwise regression procedure. There were no significant differences in terms of the variability explained by both models $\chi^2(8) = 6.457$, $p = .596$, therefore, following the parsimony principle, we selected the model obtained by stepwise regression (marginal $R^2 = 0.17$; conditional $R^2 = 0.48$). Further, random effects for both Participant ID ($\sigma^2 = 1.23$), $\chi^2(1) = 206.815$, p < 001, and Item ($\sigma^2 = 0.24$) $\chi^2(1) = 85.58$, p < 001 were significant. A summary of the final LMM for CAM beliefs (regression coefficients, standard errors, *t* values, *p* values, and description of random effects) is reported in Table 2.

Model 3: Causes of harm-related pseudoscience beliefs: The model with all predictors and interactions was compared to the model obtained with the stepwise procedure. There were no significant differences in terms of the variability explained by both models $\chi^2(5) = 6.854$, $p = .232$, therefore, following the parsimony principle, we selected the model obtained by stepwise regression (marginal $R^2 = 0.22$; conditional $R^2 = 0.61$). Further, random effects for both Participant ID ($\sigma^2 = 1.76$), $\chi^2(1) = 261.02$, p < 001, and item ($\sigma^2 = 0.18$),

TABLE 2 Linear mixed models for each pseudoscience theme, restricted maximum-likelihood (REML) estimates, standardized coefficients

	Estimate	Std. error	*df*	*t* value	Pr(>|*t*|)
Psychology-related					
(Intercept)	0.207	0.177	3.777	1.168	.311
AB (university)	−0.210	0.076	258.986	−2.748	.006
Familiarity	0.269	0.028	1041.510	9.715	<.001
Intuitive thinking	0.167	0.039	260.443	4.225	<.001
Extraversion	0.019	0.044	319.803	0.439	.661
Unconventional thinking	0.042	0.046	350.714	0.923	.357
Analytic thinking	−0.014	0.047	340.242	−0.304	.762
Disproving information (yes)	−0.220	0.055	1037.905	−3.982	<.001
Extraversion × disproving information (yes)	0.132	0.059	1037.693	2.237	.025
Unconventional thinking × disproving information (yes)	0.157	0.059	1032.727	2.641	.008
Analytic thinking × disproving information (yes)	−0.188	0.061	1033.575	−3.050	.002
Complementary and alternative medicine (CAM)					
(Intercept)	0.157	0.120	6.686	1.305	.235
AB (university)	−0.251	0.077	263.353	−3.258	<.001
Familiarity	0.248	0.025	1295.635	9.934	<.001
Intuitive thinking	0.237	0.039	262.724	6.035	<.001
Extraversion	0.098	0.041	262.414	2.372	.018
Analytic thinking	−0.120	0.040	262.267	−2.993	.003
Causes of harm-related					
(Intercept)	0.016	0.107	4.219	0.147	.889
Familiarity	0.287	0.026	1020.087	11.219	<.001
Intuitive thinking	0.252	0.045	256.705	5.577	<.001
Extraversion	0.051	0.051	327.139	1.004	.316
Unconventional thinking	−0.041	0.051	336.098	−0.801	.423
Analytic thinking	−0.158	0.049	255.029	−3.231	<.001
Disproving information (yes)	−0.076	0.053	1016.670	−1.437	.151
Extraversion × disproving information (yes)	0.120	0.055	1032.904	2.175	.029
Unconventional thinking × disproving information (yes)	0.125	0.054	1028.793	2.305	.021

Note: AB reference category: No university studies; Disproving Information reference category: No.
Abbreviations: AB, academic background.

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

$\chi^2(1) = 58.78$, $p < 001$ were significant. A summary of the final LMM for CHRP beliefs (regression coefficients, standard errors, *t* values, *p* values, and description of random effects) is reported in Table 2.

3.3 | Discussion

The present research aimed at analyzing the effect of various (IIDD and pseudoscience information-related) predictors on beliefs in pseudoscience, exploring possible variations of such effects depending on the pseudoscience topic. The different pseudoscience topics under study included those most commonly reported in the empirical literature in this field: CAM, PRP, and CHRP. However, given the lack of psychometric studies in this field and the possibility that these topics could be grouped in some unexpected way (e.g., health- vs. non-health-related pseudoscience beliefs, Bryden et al., 2018), a brief psychometric exploratory study (Study 1) was conducted to analyze the dimensionality of these topics when presented together. Our results (fully replicated in Study 2) suggest that these topics behave as separate but interrelated entities, which supports the field-specific work conducted to date (Bensley et al., 2014; Blancke et al., 2015; Furnham & Hughes, 2014; Posadzki et al., 2012). Presenting these three topics together allowed us to explore possible differences between them in terms of (1) their acceptance, (2) their spread, (3) their likelihood of having been met with DI, and (4) the variables to which they are related. This has been suggested to be crucial for adequately adjusting interventions aimed at reducing beliefs in pseudoscience (Ferrero et al., 2016; Piejka & Okruszek, 2020; Rutjens et al., 2018).

Concerning their spread and acceptance, the obtained results suggest that not only are PRP beliefs very prevalent and familiar, but they are more so than those pertaining to other topics (CAM and CHRP). Although this is in line with proposals by other authors (Bensley et al., 2014), other studies found no differences in the acceptance of pseudoscientific claims between the proposed pseudoscience topics (Piejka & Okruszek, 2020). As some authors have suggested, these discrepancies could be due to differences in the popularity of different types of pseudoscience across countries (Dekker et al., 2012). It could potentially explain the differences between the results obtained in our research (Spanish sample) and those obtained by Piejka and Okruszek (2020) (Polish sample). However, the latter study does not report the same comparison regarding the familiarity of the different pseudoscience topics; therefore future research should further investigate this possibility. Apart from the mentioned differences in terms of spread and acceptance between pseudoscience topics, our results suggest that CAM statements were more likely to have received DI, although the differences compared to the other two pseudoscience topics were small. The inclusion of this and related measures in future studies could enable researchers to monitor the spread of information undermining pseudoscience beliefs and how effectively it reaches key audiences.

In relation to the prediction of pseudoscience beliefs and the possible variation of predictors as a function of pseudoscience topic (Aim 1), our results showed that most of the (IIDD and pseudoscience information-related) measures studied were related to pseudoscience beliefs. Furthermore, various predictors (unconventional thinking, DI, and AB) were differentially associated with the acceptance of different pseudoscience topics. This is in line with previous findings (Piejka & Okruszek, 2020; Rutjens et al., 2018) and offers useful and particularized information to combat the different branches of pseudoscience. As already suggested by other authors, campaigns and interventions aimed at combating pseudoscience should be tailored to the particularities of each branch, according to its respective predictors (Rutjens et al., 2018).

As we predicted (Prediction 1), our results are in line with prior literature on the relationship between cognitive styles and beliefs in pseudoscience (Aarnio & Lindeman, 2005; Blancke et al., 2015; Bronstein et al., 2019; Fasce & Picó, 2019a; Pennycook et al., 2012; but see Majima, 2015), in that analytic thinking was found to be negatively associated with beliefs in pseudoscience, while intuitive thinking showed a positive relationship. Previous studies have suggested that the relationship between these cognitive styles and pseudoscience beliefs may vary depending on the pseudoscience topic (Bensley et al., 2014). To the best of our knowledge, the present study represents the first empirical evidence in this regard and shows an effect of intuitive and analytical cognitive styles on the three included pseudoscience topics. However, it is noteworthy that in the case of PRP beliefs, analytical thinking was only related to lower levels of acceptance of pseudoscientific proposals that had already been met with DI (Aim 2). One possible explanation may derive from the fact that PRP statements were the most familiar to the participants of our study among the three pseudoscience branches (see, results Study 2). In this sense, it has been suggested that high levels of familiarity reduce the possibility of efficiently using analytical thinking strategies (Garcia-Marques et al., 2016; Smith et al., 2006). Moreover, there is evidence that highly repeated messages are processed much more superficially and less analytically than when they are less frequently presented (Claypool et al., 2004; Garcia-Marques & Mackie, 2000, 2001). Taken together, it seems possible that the high familiarity of PRP practices might require DI to favor the effect of analytical thinking. If it were the case, it might imply that interventions based on the promotion of critical thinking (e.g., Wilson, 2018) should be accompanied by explicit DI, when the target is the reduction of beliefs in highly familiar pseudoscientific practices.

The results obtained with regard to the personality factor extraversion (Prediction 2) also supported the findings of previous studies (Fasce & Picó, 2019a). Further, this IIDD measure showed an interaction with DI, with a positive sign (i.e., higher levels of extraversion were associated with higher susceptibility toward pseudoscientific claims for which individuals had received DI). Therefore, contrary to analytical thinking, higher levels of extraversion may be a risk factor for the persistence of pseudoscientific beliefs. Nevertheless, it is noteworthy that this interaction was not found when predicting CAM beliefs. One possible explanation could be that CAM

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

statements were the least believed in both Study 1 and Study 2. This could mean that higher levels of pseudoscience acceptance are required for there to be variability in the effect of the information received against it as a function of that trait (extraversion). Alternatively, it is also possible that the lack of interaction is due to the fact that information received against CAM statements had no effect (its effect was not significant when predicting CAM beliefs; see Table 2). Further studies should analyze these possibilities to better understand the interplay between extraversion and DI as predictors of pseudoscience acceptance.

This study included a short validation of a dimension intended to capture the tendency to think unconventionally (i.e., unconventional thinking) and the validation results supported its use. The results of the LMM indicated that this dimension was a significant and positive predictor of beliefs in pseudoscience (supporting Hypothesis 1) specifically for those who had received DI (Aim 2). In this sense, the fact that pseudoscientific proposals go against scientific standards and can be considered unconventional (Cano-Orón, 2019; Waters, 2020) could help understand why people who have a general tendency to think unconventionally are more prone to accept such proposals. The fact that this relationship was specifically found for beliefs regarding which DI had been received, may imply a core aspect of the unconventional thinking dimension: Preference for alternative/nonconventional explanations. Arguably, if one does not receive DI against a given statement, there is no opportunity to consider it as an alternative to conventional knowledge. Similarly, if DI received against a proposal that challenges the basis of conceptual knowledge (i.e., pseudoscience) has no effect, one would not expect the acceptance of such a proposition to vary as a function of levels of unconventional thinking (which might explain why there is no such interaction when predicting beliefs in CAM). In any case, the preference for nonconventional knowledge may lead to biased information-seeking processes, opening the door to greater susceptibility to accept pseudoscientific claims, which are in turn more likely to be influenced by confirmation bias (Nickerson, 1998). This finding may be of great importance, as it not only includes a new predictor of beliefs in pseudoscience, but also captures an aspect of those beliefs themselves, that is, the preference for unconventional knowledge. Future research should extend the validation of the proposed dimension (i.e., unconventional thinking) as well as investigate the concrete relationship between these two constructs. This might be especially important because the inclusion of unconventional thinking in the investigation of pseudoscience beliefs could bring specific knowledge to an area of research that has been suggested to be theoretically underdeveloped (Fasce & Picó, 2019a).

In addition to the IIDD dimensions reported, this study also included two measures that aimed at capturing two different aspects of the information received on pseudoscientific claims: familiarity and DI. In line with our Hypothesis 2, the obtained results showed that familiarity was a good predictor of pseudoscience beliefs. Moreover, its effect was found independently of pseudoscience topic. These findings extend recent work that has highlighted the importance of including familiarity in the study of pseudoscience beliefs (Piejka & Okruszek, 2020). Our results suggest that all topics of pseudoscience were familiar (their average familiarity was above the midpoint scale), which could be interpreted as an indicator of their spread. We consider that future research in this field should include familiarity as a predictor of pseudoscience beliefs, as it also allows to analyze pseudoscience spread and to control the effect of other predictors when modeled together. In parallel, given that familiarity is related to beliefs in pseudoscience and other nonevidence-based beliefs (Fazio et al., 2019; Pennycook et al., 2018), it would be important to analyze whether the effect of familiarity varies depending on the source of the information. In this sense, it has been suggested that information favoring the establishment of misconceptions in general can come from sources as varied as rumors, works of fiction, governments, or politicians, among others (Lewandowsky et al., 2012); it is therefore especially important to individually examine the effect of these and other sources on the familiarity-belief association in order to better direct efforts to combat pseudoscience.

In the current study, we introduced another information-related measure in order to register whether DI had been received for each of the pseudoscience claims included in the analysis. To our knowledge, DI has never been included as a predictor in any regression-based model that has analyzed susceptibility to pseudoscientific claims. As we hypothesized (Hypothesis 3), our results suggest that having received information that discredits a particular claim is related to lower acceptance of that claim, which is crucial for educational interventions (Schmaltz & Lilienfeld, 2017). This is in line with previous work suggesting that offering information that refutes misconceptions about science is useful, as it helps recipients to re-evaluate their knowledge and consider alternatives to their current beliefs (Bensley et al., 2014; Lassonde et al., 2016). Notably, when exploring the variation in its effect as a function of pseudoscience topic (Aim 1), we found that having received DI was related to lower acceptance of PRP and CHRP claims, but not to a reduction in CAM beliefs. In this sense, the results obtained in both study one and study two suggest that CAM claims were least accepted (with only a slightly higher likelihood of receiving DI; Study 2), which could indicate that DI is especially effective when acceptance of pseudoscientific proposals is high, and less or not effective when acceptance is lower. Another possible explanation could be that the source of information in favor of the different pseudoscience topics was not the same. In particular, CAM beliefs are often promoted by authorities in the field of medicine (Posadzki et al., 2012), which could make the information received against them less effective if it does not come from a source with the same level of authority. In this sense, it has been suggested that resistant biases toward unsubstantiated beliefs might be better tackled by combining both adequate information from reliable sources and a first-person experience to help such information to be integrated (García-Arch et al., 2021). All these suggestions should be examined in future research in order to understand the differential effect of DI on different types of pseudoscience beliefs.

Finally, this research also had the aim to explore possible interactions between having received DI and the effect of the included IIDD measures on pseudoscience beliefs (Aim 2). In this sense, our

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

results show that the effect of receiving DI on pseudoscience beliefs depends on the level of certain traits (unconventional thinking, analytic thinking, and extraversion). Future research should take this into account, given that a tendency to persist in believing already discredited information is of significant concern. This information can be used to adjust interventions and campaigns aimed at counteracting pseudoscience acceptance, which should pay special attention to the individual characteristics (IIDD) of the audience as well as to the DI offered.

3.3.1 | Control measures

As discussed (see instruments; Study 2), this study included several measures to control their possible effects: age, gender, and AB. The inclusion of age and gender was based on common practice for empirical studies in young research fields. As in previous studies, no relationship was found between these variables and beliefs in pseudoscience (Fasce & Picó, 2019a; Piejka & Okruszek, 2020). The rationale behind the inclusion of AB was based on the fact that there is debate about the effect of higher education (university) on the acceptance of pseudoscientific practices (Bensley et al., 2014; Hughes et al., 2013; McKeachie, 1960; Taylor & Kowalski, 2004; Vaughan, 1977).

Our results show that AB is negatively related to beliefs in pseudoscience, suggesting that individuals with university education are less susceptible to accepting pseudoscientific claims. In this sense, it has been suggested that one of the major goals of higher education is to correct students' misconceptions and misinterpretations in order to prepare them for real-life practice (Lobato et al., 2014). Interestingly, the effect of AB on pseudoscience acceptance was found for CAM and PRP beliefs but not for CHRP beliefs. This study is the first to explore these differences, which need to be replicated in future research. However, the reported results may be particularly important for designing educational practices in a university context that allow for a generalized effect of higher education on the acceptance of any kind of pseudoscientific claims. In this sense, it has been suggested that the stimulation of critical thinking together with the acquisition of specialized knowledge could more effectively diminish unsubstantiated beliefs (Bensley et al., 2014). However, having university education or even being an expert in a given field does not work as a pseudoscience-proof shield, as it is accepted and even promoted by some professionals in different fields (Dekker et al., 2012; Lilienfeld, 2015; Posadzki et al., 2012). Consequently, more research is needed to effectively understand and combat the large range of pseudoscience topics that are currently spread around the world.

4 | CONCLUDING REMARKS

As other authors have recognized, pseudoscientific beliefs are a complex construct with a wide thematic spectrum, and the validity of their measurement may be affected over time by the effect of increasing scientific knowledge (Fasce & Picó, 2019a). These limitations imply that existing scales will need to be psychometrically revised over time. Our study offers strategies to deal with these limitations through the inclusion of variables related to the information received for each pseudoscientific claim: familiarity and DI. Both measures can vary over time, therefore including them in models that attempt to predict these beliefs could represent a useful control tool. Nonetheless, it is also worth noting that this study has focused on the three most commonly investigated pseudoscience topics. Future research should extend this analysis to a standardized and exhaustive list of pseudoscience-related topics, in order to explore similarities and differences regarding their possible predictors and to help focus efforts to combat the spread of pseudoscience.

The results obtained in the present study show that understanding and predicting beliefs in pseudoscience is a complex process, as recently suggested (Fasce & Picó, 2019b). Although our results need to be replicated and studied in-depth, the analytical approaches provided in this study could be useful for any type of proposal or intervention aiming at reducing pseudoscience acceptance (Barberia et al., 2013, 2018; Lilienfeld et al., 2012, 2014; Matute et al., 2015; McLean & Miller, 2010; Wilson, 2018).

As scientists, we must not only strive to adequately address the phenomena related to our field of study, but we must also prevent possible misinterpretations arising from our work. The effective communication of science as well as the debunking of pseudoscience requires significant effort; in the future, both scientists and popularisers as well as teachers, educators, and politicians must join forces to combat this pervasive pandemic. We hope that this work represents a step in this direction and will stimulate future research.

CONFLICT OF INTEREST

This research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. All authors have approved the manuscript and agree with its submission to "Applied Cognitive Psychology."

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.

ORCID

Josue García-Arch https://orcid.org/0000-0002-2412-9090

REFERENCES

Aarnio, K., & Lindeman, M. (2005). Paranormal beliefs, education, and thinking styles. *Personality and Individual Differences*, *39*(7), 1227–1236. https://doi.org/10.1016/j.paid.2005.04.009

Ammann, K. (2005). Effects of biotechnology on biodiversity: Herbicide-tolerant and insect-resistant GM crops. *Trends in Biotechnology*, *23*(8), 388–394. https://doi.org/10.1016/j.tibtech.2005.06.008

Andreas, S. F. K., Zech, S., Coyle, T. R., & Rindermann, H. (2016). Unconventionality and originality: Does self-assessed unconventionality increase original achievement? *Creativity Research Journal*, *28*(2), 198–206. https://doi.org/10.1080/10400419.2016.1162556

Barberia, I., Blanco, F., Cubillas, C. P., & Matute, H. (2013). Implementation and assessment of an intervention to Debias adolescents against

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

causal illusions. *PLoS One*, *8*(8), e71303. https://doi.org/10.1371/journal.pone.0071303

Barberia, I., Tubau, E., Matute, H., & Rodríguez-Ferreiro, J. (2018). A short educational intervention diminishes causal illusions and specific paranormal beliefs in undergraduates. *PLoS One*, *13*(1), 1–14. https://doi.org/10.1371/journal.pone.0191907

Bensley, D. A., & Lilienfeld, S. O. (2015). What is a psychological misconception? Moving toward an empirical answer. *Teaching of Psychology*, *42*(4), 282–292. https://doi.org/10.1177/0098628315603059

Bensley, D. A., Lilienfeld, S. O., & Powell, L. A. (2014). A new measure of psychological misconceptions: Relations with academic background, critical thinking, and acceptance of paranormal and pseudoscientific claims. *Learning and Individual Differences*, *36*, 9–18. https://doi.org/10.1016/j.lindif.2014.07.009

Bishop, F. L., Yardley, L., & Lewith, G. (2005). Developing a measure of treatment beliefs: The complementary and alternative medicine beliefs inventory. *Complementary Therapies in Medicine*, *13*(2), 144–149. https://doi.org/10.1016/j.ctim.2005.01.005

Bishop, F. L., Yardley, L., & Lewith, G. T. (2007). A systematic review of beliefs involved in the use of complementary and alternative medicine. *Journal of Health Psychology*, *12*(6), 851–867. https://doi.org/10.1177/1359105307082447

Bishop, F. L., Yardley, L., & Lewith, G. T. (2008). Treatment appraisals and beliefs predict adherence to complementary therapies: A prospective study using a dynamic extended self-regulation model. In. *British Journal of Health Psychology*, *13*(4), 701–718. https://doi.org/10.1348/135910707X249570

Blancke, S., Boudry, M., & Braeckman, J. (2019). Reasonable irrationality: The role of reasons in the diffusion of pseudoscience. *Journal of Cognition and Culture*, *19*(5), 432–449. https://doi.org/10.1163/15685373-12340068

Blancke, S., Van Breusegem, F., De Jaeger, G., Braeckman, J., & Van Montagu, M. (2015). Fatal attraction: The intuitive appeal of GMO opposition. *Trends in Plant Science*, *20*(7), 414–418. https://doi.org/10.1016/j.tplants.2015.03.011

Braun, C. A., Halcön, L. L., & Bearinger, L. H. (2000). Adolescent use of alternative and complementary therapies: A framework for research. *Journal of Holistic Nursing*, *18*(2), 176–191. https://doi.org/10.1177/089801010001800208

Bronstein, M. V., Pennycook, G., Bear, A., Rand, D. G., & Cannon, T. D. (2019). Belief in fake news is associated with delusionality, dogmatism, religious fundamentalism, and reduced analytic thinking. *Journal of Applied Research in Memory and Cognition*, *8*(1), 108–117. https://doi.org/10.1016/j.jarmac.2018.09.005

Bryden, G. M., Browne, M., Rockloff, M., & Unsworth, C. (2018). Anti-vaccination and pro-CAM attitudes both reflect magical beliefs about health. *Vaccine*, *36*(9), 1227–1234. https://doi.org/10.1016/j.vaccine.2017.12.068

Cano-Orón, L. (2019). A twitter campaign against pseudoscience: The sceptical discourse on complementary therapies in Spain. *Public Understanding of Science*, *28*(6), 679–695. https://doi.org/10.1177/0963662519853228

Chen, H., Cohen, P., & Chen, S. (2010). How big is a big odds ratio? Interpreting the magnitudes of odds ratios in epidemiological studies. *Communications in Statistics—simulation and Computation®*, *39*(4), 860–864. https://doi.org/10.1080/03610911003650383

Claypool, H. M., Mackie, D. M., Garcia-Marques, T., McIntosh, A., & Udall, A. (2004). The effects of personal relevance and repetition on persuasive processing. *Social Cognition*, *22*(3), 310–335. https://doi.org/10.1521/soco.22.3.310.35970

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. Psychology Press.

Dekker, S., Lee, N. C., Howard-Jones, P., & Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology*, *3*(OCT), 1–8. https://doi.org/10.3389/fpsyg.2012.00429

Díaz-Vilela, L., & Álvarez-Gonzál-Ez, C. J. (2004). Differences in paranormal beliefs across fields of study from a Spanish adaptation of Tobacyk's RPBS. *Journal of Parapsychology*, *68*(2), 405–421.

Fasce, A. (2017). What do we mean when we speak of pseudoscience? The development of a demarcation criterion based on the analysis of twenty-one previous attempts. *Disputatio. Philosphical Research Bulletin*, *6*(7), 459–488.

Fasce, A., Avendaño, D., & Adrián-Ventura, J. (2021). Revised and short versions of the pseudoscientific belief scale. *Applied Cognitive Psychology*, *1-15*, 828–832. https://doi.org/10.1002/acp.3811

Fasce, A., & Picó, A. (2019a). Conceptual foundations and validation of the pseudoscientific belief scale. *Applied Cognitive Psychology*, *33*(4), 617–628. https://doi.org/10.1002/acp.3501

Fasce, A., & Picó, A. (2019b). Science as a vaccine. *Science & Education*, *28*(1–2), 109–125. https://doi.org/10.1007/s11191-018-00022-0

Fazio, L. K., Rand, D. G., & Pennycook, G. (2019). Repetition increases perceived truth equally for plausible and implausible statements. *Psychonomic Bulletin and Review*, *26*(5), 1705–1710. https://doi.org/10.3758/s13423-019-01651-4

Ferrero, M., Garaizar, P., & Vadillo, M. A. (2016). Neuromyths in education: Prevalence among Spanish teachers and an exploration of cross-cultural variation. *Frontiers in Human Neuroscience*, *10*, 1–11. https://doi.org/10.3389/fnhum.2016.00496

Furnham, A. (2007). Are modern health worries, personality and attitudes to science associated with the use of complementary and alternative medicine? *British Journal of Health Psychology*, *12*(2), 229–243. https://doi.org/10.1348/135910706X100593

Furnham, A., & Hughes, D. J. (2014). Myths and misconceptions in popular psychology: Comparing psychology students and the general public. *Teaching of Psychology*, *41*(3), 256–261. https://doi.org/10.1177/0098628314537984

García-Arch, J., Ventura-Gabarró, C., Adamuz, P. L., Calvo, P. G., & Fuentemilla, L. (2021). Reducing implicit cognitive biases through the performing arts. *Frontiers in Psychology*, *12*, 1–8. https://doi.org/10.3389/fpsyg.2021.614816

Garcia-Marques, T., & Mackie, D. M. (2000). The positive feeling of familiarity: Mood as an information processing regulation mechanism. In H. Bless & J. P. Forgas (Eds.), *The message within: The role of subjective experience in social cognition and behavior* (pp. 240–261). Philadelphia: Psychology Press/Taylor & Francis.

Garcia-Marques, T., & Mackie, D. M. (2001). The feeling of familiarity as a regulator of persuasive processing. *Social Cognition*, *19*(1), 9–34. https://doi.org/10.1521/soco.19.1.9.18959

Garcia-Marques, T., Mackie, D. M., Maitner, A. T., & Claypool, H. M. (2016). Moderation of the familiarity-stereotyping effect: The role of stereotype fit. *Social Cognition*, *34*(2), 81–96. https://doi.org/10.1521/soco.2016.34.2.81

Gardner, R. M., & Brown, D. L. (2013). A test of contemporary misconceptions in psychology. *Learning and Individual Differences*, *24*, 211–215.

Gardner, R. M., & Dalsing, S. (1986). Misconceptions about psychology among college students. *Teaching of Psychology*, *13*(1), 32–34. https://doi.org/10.1207/s15328023top1301_9

Goreis, A., & Voracek, M. (2019). A systematic review and meta-analysis of psychological research on conspiracy beliefs: Field characteristics, measurement instruments, and associations with personality traits. *Frontiers in Psychology*, *10*, 1–13. https://doi.org/10.3389/fpsyg.2019.00205

Harnack, L. J., DeRosier, K. L., & Rydell, S. A. (2003). Results of a population-based survey of adults' attitudes and beliefs about herbal products. *Journal of the American Pharmacists Association*, *43*(5), 596–601. https://doi.org/10.1331/154434503322452238

Hayton, J. C., Allen, D. G., & Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis.

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Organizational Research Methods, *7*(2), 191–205. https://doi.org/10.1177/1094428104263675

Hughes, S., Lyddy, F., & Lambe, S. (2013). Misconceptions about psychological science: A review. *Psychology Learning and Teaching*, *12*(1), 20–31. https://doi.org/10.2304/plat.2013.12.1.20

Hussain, A., Ali, S., Ahmed, M., & Hussain, S. (2018). The anti-vaccination movement: A regression in modern medicine. *Cureus*, *10*(7), e2919. https://doi.org/10.7759/cureus.2919

Kallery-Vlahos, M. (2001). Early-years educators' attitudes to science and pseudo-science: The case of astronomy and astrology. *European Journal of Teacher Education*, *24*(3), 329–342. https://doi.org/10.1080/02619760220128888

Kaufman, S. B. (2013). Opening up openness to experience: A four-factor model and relations to creative achievement in the arts and sciences. *Journal of Creative Behavior*, *47*(4), 233–255. https://doi.org/10.1002/jocb.33

Kim, R. S. (2011). *Electronic theses, treatises and dissertations the graduate school*.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

Lassonde, K. A., Kendeou, P., & O'Brien, E. J. (2016). Refutation texts: Overcoming psychology misconceptions that are resistant to change. *Scholarship of Teaching and Learning in Psychology*, *2*(1), 62–74. https://doi.org/10.1037/stl0000054

Lee, K., & Ashton, M. C. (2008). The HEXACO personality factors in the indigenous personality lexicons of English and 11 other languages. *Journal of Personality*, *76*(5), 1001–1054. https://doi.org/10.1111/j.1467-6494.2008.00512.x

Lewandowsky, S., Ecker, U. K. H., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and its correction: Continued influence and successful Debiasing. *Psychological Science in the Public Interest*, *Supplement*, *13*(3), 106–131. https://doi.org/10.1177/1529100612451018

Lilienfeld, S. O. (2015). Introduction to special section on pseudoscience in psychiatry. *Canadian Journal of Psychiatry*, *60*(12), 531–533. https://doi.org/10.1177/070674371506001202

Lilienfeld, S. O., Ammirati, R., & David, M. (2012). Distinguishing science from pseudoscience in school psychology: Science and scientific thinking as safeguards against human error. *Journal of School Psychology*, *50*(1), 7–36. https://doi.org/10.1016/j.jsp.2011.09.006

Lilienfeld, S. O., & Beyerstein, B. L. (2011). Gildan media companion PDF 50 great myths of popular psychology by recommended.

Lilienfeld, S. O., Ritschel, L. A., Lynn, S. J., Cautin, R. L., & Latzman, R. D. (2014). Why ineffective psychotherapies appear to work: A taxonomy of causes of spurious therapeutic effectiveness. *Perspectives on Psychological Science*, *9*(4), 355–387. https://doi.org/10.1177/1745691614535216

Lindeman, M., & Svedholm, A. M. (2012). What's in a term? Paranormal, superstitious, magical and supernatural beliefs by any other name would mean the same. *Review of General Psychology*, *16*(3), 241–255. https://doi.org/10.1037/a0027158

Lobato, E., Mendoza, J., Sims, V., & Chin, M. (2014). Examining the relationship between conspiracy theories, paranormal beliefs, and pseudoscience acceptance among a university population. *Applied Cognitive Psychology*, *28*(5), 617–625. https://doi.org/10.1002/acp.3042

Macdonald, K., Germine, L., Anderson, A., Christodoulou, J., & McGrath, L. M. (2017). Dispelling the myth: Training in education or neuroscience decreases but does not eliminate beliefs in neuromyths. *Frontiers in Psychology*, *8*, 1–16. https://doi.org/10.3389/fpsyg.2017.01314

Majima, Y. (2015). Belief in pseudoscience, cognitive style and science literacy. *Applied Cognitive Psychology*, *29*(4), 552–559. https://doi.org/10.1002/acp.3136

Matute, H., Blanco, F., Yarritu, I., Díaz-Lago, M., Vadillo, M. A., & Barberia, I. (2015). Illusions of causality: How they bias our everyday thinking and how they could be reduced. *Frontiers in Psychology*, *6*, 1–14. https://doi.org/10.3389/fpsyg.2015.00888

Mccrae, R. R., & Jr, P. T. C. (1977). Joint ratings: Factors in self-reports and and openness to experience. *Anxiety*, *4*, 245–255.

McCright, A. M., & Dunlap, R. E. (2011). Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environmental Change*, *21*(4), 1163–1172. https://doi.org/10.1016/j.gloenvcha.2011.06.003

McKeachie, W. J. (1960). Changes in scores on the northwestern misconceptions test in six elementary psychology courses. *Journal of Educational Psychology*, *51*(4), 240–244.

McLean, C. P., & Miller, N. A. (2010). Changes in critical thinking skills following a course on science and pseudoscience: A quasi-experimental study. *Teaching of Psychology*, *37*(2), 85–90. https://doi.org/10.1080/00986281003626714

Mercier, H., Majima, Y., & Miton, H. (2018). Willingness to transmit and the spread of pseudoscientific beliefs. *Applied Cognitive Psychology*, *32*(4), 499–505. https://doi.org/10.1002/acp.3413

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*(2), 175–220.

Ozer, D. J., & Benet-Martínez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology*, *57*, 401–421. https://doi.org/10.1146/annurev.psych.57.102904.190127

Pennycook, G., Cannon, T. D., & Rand, D. G. (2018). Prior exposure increases perceived accuracy of fake news. *Journal of Experimental Psychology: General*, *147*(12), 1865–1880. https://doi.org/10.1037/xge0000465

Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, *123*(3), 335–346. https://doi.org/10.1016/j.cognition.2012.03.003

Piejka, A., & Okruszek, Ł. (2020). Do you believe what you have been told? Morality and scientific literacy as predictors of pseudoscience susceptibility. *Applied Cognitive Psychology*, *34*(5), 1072–1082. https://doi.org/10.1002/acp.3687

Posadzki, P., Alotaibi, A., & Ernst, E. (2012). Prevalence of use of complementary and alternative medicine (cam) by physicians in the UK: A systematic review of surveys. *Clinical Medicine, Journal of the Royal College of Physicians of London*, *12*(6), 505–512. https://doi.org/10.7861/clinmedicine.12-6-505

Reyna, C., & Ortiz, M. V. (2016). Psychometric study of the rational experiential inventory among undergraduate Argentinean students. *Revista de Psicologia*, *34*(2), 337–355. https://doi.org/10.18800/psico.201602.005

Roncero, M. (2013). Hexaco. *Revista Argentina de Clínica Psicológica*, *XXII*, 205–217.

Rutjens, B. T., Sutton, R. M., & van der Lee, R. (2018). Not all skepticism is equal: Exploring the ideological antecedents of science acceptance and rejection. *Personality and Social Psychology Bulletin*, *44*(3), 384–405. https://doi.org/10.1177/0146167217741314

Sanford, N. N., Sher, D. J., Ahn, C., Aizer, A. A., & Mahal, B. A. (2019). Prevalence and nondisclosure of complementary and alternative medicine use in patients with cancer and cancer survivors in the United States. *JAMA Oncology*, *5*(5), 735–737. https://doi.org/10.1001/jamaoncol.2019.0349

Schmaltz, R., & Lilienfeld, S. O. (2017). Corrigendum: Hauntings, homeopathy, and the Hopkinsville goblins: Using pseudoscience to teach scientific thinking [Front. Psychol., 5, (336)] doi: 10.3389/fpsyg.2014.00336. *Frontiers in Psychology*, *8*, 3389. https://doi.org/10.3389/fpsyg.2017.01982

Smith, E. R., Miller, D. A., Maitner, A. T., Crump, S. A., Garcia-Marques, T., & Mackie, D. M. (2006). Familiarity can increase stereotyping. *Journal of Experimental Social Psychology*, *42*(4), 471–478. https://doi.org/10.1016/j.jesp.2005.07.002

Standing, L. G., & Huber, H. (2003). Do psychology courses reduce belief in psychological myths? *Social Behavior and Personality*, *31*(6), 585–592. https://doi.org/10.2224/sbp.2003.31.6.585

Subramanian, A., & Qaim, M. (2010). The impact of Bt cotton on poor households in rural India. *Journal of Development Studies*, *46*(2), 295–311. https://doi.org/10.1080/00220380903002954

Swami, V., Stieger, S., Pietschnig, J., Nader, I. W., & Voracek, M. (2012). Using more than 10% of our brains: Examining belief in science-related myths

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

from an individual differences perspective. *Learning and Individual Differences*, *22*(3), 404–408. https://doi.org/10.1016/j.lindif.2011.12.005

Taylor, A. K., & Kowalski, P. (2004). Naïve psychological science: The prevalence, strength, and sources of misconceptions. *The Psychological Record*, *54*(1), 15–25. https://doi.org/10.1007/BF03395459

Torres, M. N., Barberia, I., & Rodríguez-Ferreiro, J. (2020). Causal illusion as a cognitive basis of pseudoscientific beliefs. *British Journal of Psychology*, *111*(4), 840–852. https://doi.org/10.1111/bjop.12441

Vaughan, E. D. (1977). Misconceptions about psychology among introductory psychology students. *Teaching of Psychology*, *4*(3), 138–141. https://doi.org/10.1207/s15328023top0403_9

Waters, K. E. (2020). A sociological critique of cognitive deviance: Unconventional beliefs reconsidered. *Conspectus Borealis*, *5*(1), 9.

Wesseler, J., & Zilberman, D. (2014). The economic power of the Golden Rice opposition. *Environment and Development Economics*, *19*(6), 724–742. https://doi.org/10.1017/S1355770X1300065X

Wilson, J. A. (2018). Reducing pseudoscientific and paranormal beliefs in university students through a course in science and critical thinking. *Science Education*, *27*(1-2), 183–210. https://doi.org/10.1007/s11191-018-9956-0

York, A. (2017). American flat earth theory: Anti-intellectualism, fundamentalism and conspiracy theory citation: Pilot scholars version (modified MLA style). http://www.cnn.com/2017/11/08/opinions/trump-reality-opinion-dantonio/index.html.

Zhang, A. L., Story, D. F., Lin, V., Vitetta, L., & Xue, C. C. (2008). A population survey on the use of 24 common medicinal herbs in Australia. *Pharmacoepidemiology and Drug Safety*, *17*(10), 1006–1013.

Zaboski, B. A., & Therriault, D. J. (2020). Faking science: Scientificness, credibility, and belief in pseudoscience. *Educational Psychology*, *40*(7), 820–837. https://doi.org/10.1080/01443410.2019.1694646

How to cite this article: García-Arch, J., Ballestero-Arnau, M., Pérez Hoyas, L., & Giaiotti, F. (2022). Disproven but still believed: The role of information and individual differences in the prediction of topic-related pseudoscience acceptance. *Applied Cognitive Psychology*, *36*(2), 268–282. https://doi.org/10.1002/acp.3914

APPENDIX A: PSEUDOSCIENCE BELIEFS INCLUDED AFTER FACTOR ANALYSIS

1 (CAM). ***Homeopathy***: Homeopathic remedies are effective as complements in the treatment of some diseases.

2 (CAM). ***Bach flowers***: Natural remedies, such as Bach flowers, help overcome emotional imbalances.

3 (CAM). ***Detox therapy/diet***: Diets or detox therapies are effective at eliminating toxic substances from the organism.

4 (CAM). ***C Vitamin and common cold***: Vitamin C can help cure the common cold.

5 (CAM). ***Herbal medicine***: Conventional medicine and herbal remedies are equally effective in treating the same symptoms.

6 (PRP). **Hypnosis and trauma**: By means of hypnosis, it is possible to discover hidden childhood traumas.

7 (PRP). **Graphology**: One's personality can be evaluated by studying the form of their handwriting.

8 (PRP). **Dream interpretation**: Our dreams can reflect unconscious desires.

9 (PRP). **Learning languages**: We can learn languages listening to audios while we are asleep.

10 (CHRP). **Mobile phone radiation**: Radiation derived from the use of a mobile phone increases the risk of a brain tumor.

11 (CHRP). **GMOs**: Genetically Modified Food contributes to the development of cancer.

12 (CHRP). ***Wi-Fi***: Exposure to Wi-Fi signals can cause symptoms such as frequent headaches, problems sleeping, or tiredness.

13 (CHRP). ***Chemophobia (pesticides and additives)***: Many of the pesticides and additives used by the food industry are unsafe.

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

APPENDIX B: FINAL FACTOR SOLUTION FOR PSEUDOSCIENCE BELIEFS STUDY 2

Type	Item	F1	F2	F3
CAM	*Homeopathy*	**0.59**	0.02	0.15
CAM	*Bach flowers*	**0.81**	0.04	−0.06
CAM	*Detox therapy/diet*	**0.41**	0.25	0.04
CAM	*Herbal medicine*	**0.42**	0.00	0.09
CAM	*C Vitamin and common cold*	**0.40**	−0.03	0.31
Psychology	*Hypnosis and trauma*	0.14	**0.43**	0.17
Psychology	*Graphology*	0.17	**0.63**	−0.04
Psychology	*Dream interpretation*	−0.02	**0.71**	0.02
Psychology	*Learning languages*	−0.05	**0.80**	0.04
Harm	*Mobile phone radiation*	0.12	−0.10	**0.74**
Harm	*GMOs*	0.03	0.12	**0.69**
Harm	*Chemophobia (pesticides and additives)*	0.01	0.08	**0.54**
Harm	*Wi-Fi*	−0.08	0.04	**0.81**
	% of variance	0.14	0.16	0.18
	Cronbach's α	0.77	0.79	0.81

Note: Factor analysis shows three differentiated factors. One of them conformed by five items (CAM), and the other two by four items (psychology-related and harm-related).

APPENDIX C: ITEMS INCLUDED IN THE UNCONVENTIONAL THINKING DIMENSION AFTER FACTOR ANALYSIS

1. I often encourage people to take a novel point of view.
2. I enjoy being someone who thinks differently.
3. I see myself as an alternative-thinking person.
4. I enjoy thinking of alternative explanations.
5. I tend to have theories that others do not share.

10990720, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/acp.3914 by Readcube (Labtiva Inc.), Wiley Online Library on [08/11/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License