

Title: Do as the Romans do: On the authoritarian roots of pseudoscience

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Running title:

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Do as the Romans do: On the authoritarian roots of pseudoscience

Abstract: Recent research highlights the implications of group dynamics in the acceptance and promotion of misconceptions, particularly in relation to the identity-protective attitudes that boost polarisation over scientific information. In this study we successfully test a mediational model between right-wing authoritarianism and pseudoscientific beliefs. Firstly, we carry out a comprehensive literature review on the socio-political background of pseudoscientific beliefs. Secondly, we conduct two studies ($n = 1189$ and $n = 1097$) to confirm our working hypotheses: H-1 — intercorrelation between pseudoscientific beliefs, authoritarianism, and three axioms (reward for application, religiosity, and fate control); H-2 — authoritarianism and social axioms fully explain rightists' proneness to pseudoscience; and H-3 — the association between pseudoscience and authoritarianism is partially mediated by social axioms. Lastly, we discuss our results in relation to their external validity regarding paranormal and conspiracy beliefs, as well as to their implications for group polarisation and science communication.

Keywords: Pseudoscience, authoritarianism, conventionalism, submission, social axioms.

Human cognition has proven to be strongly influenced by group dynamics that often involve uncritical practices, such as conventionalism, disinformation, and fact resistance, which characterise social epistemology as a fragile process. Current social polarisation, and the consequent strengthen of these collective uncritical inclinations (Kreiss, 2018), has given rise to a cultural landscape in which unfounded beliefs thrive. Accordingly, the personalised access to the world (Pariser, 2011) that determines the prevailing post-truth situation (Lewandowsky, Ecker, & Cook, 2017) has reinforced the prominence of evidence-resistant groups within the public sphere — particularly, by means of echo-chambers of information and the affective feedback loop of social media (Boler & Davis, 2018). So, current belief polarisation is not merely a misinformation issue; instead, it is better described as a clash of irreconcilable “alternative epistemologies” that express ingroup systems of beliefs (Lewandowsky, Ecker, and Cook, 2017).

Pseudoscientific beliefs such as intelligent design, climate change denial, homeopathy, German new medicine, morphic fields, quantum quackery, repressed memories, magnet therapy, HIV/AIDS denialism, antipsychiatry, parapsychology, body memory, and the anti-vaccination movement (for more instances see Fasce & Picó, 2019a) are fundamentally characterized as lacking in *epistemic warrant* — defined as "the totality of evidence and knowledge that is available to human knowledge seekers at the time in question" (Hansson, 2009, p. 239) — and classified in two groups: pseudo-theory promotion and science denialism (Fasce & Picó, 2019a). In addition to its basic lack of epistemic warrant, shared with other validated types of unfounded beliefs (such as paranormal and conspiracy theories), pseudoscience shows the distinctive peculiarity

of being presented to the public with the trappings of science (Blancke, Boudry, & Pigliucci, 2017).

This study investigates the kind of cultural inputs — worldviews, ideologies, and social attitudes — that suppress the perception of expert consensus over pseudoscientific claims, promoting the acceptance of these deviant doctrines as a badge of ingroup membership and, consequently, motivated reasoning. Accordingly, we aid understanding about the social acceptance and promotion of alternative epistemologies — more specifically, about the kind of interpretations of the social world that are related to the adoption of pseudoscientific beliefs.

Socio-political sources of motivation for pseudoscience

Pseudoscientific claims have been profusely investigated from a cognitive perspective — for example, regarding their close relationship with intuitive cognitive style (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012), causal illusions (Matute, Yarritu, & Vadillo, 2011), and pseudo-profound bullshit receptivity (Pennycook, Cheyne, Barr, Koegler & Fugelsang, 2015). Additionally, there is a growing *corpus* of research outcomes on their ideological and political dimensions that has flourished within the “politically motivated reasoning paradigm” (Kahan, 2016). The effect of minority but influential forms of motivated reasoning elicited by socio-political worldviews (e.g. Palm, Lewis, & Fend, 2017) is enlightening regarding the recalcitrant nature of certain pseudoscientific beliefs: it makes individuals exposed to information

more polarised than non-exposed ones (e.g. Nyhan, Reifler, Richey, & Freed, 2014; Nyhan & Reifler, 2015; Lewandowsky & Oberauer, 2016; Palm, Lewis, & Fend, 2017), gives rise to backfire effect (e.g. Nyhan, Reifler, Richey, & Freed, 2014; Nyhan & Reifler, 2015), and turns analytical thinking into a polarising factor (e.g. Kahan, 2013). Nevertheless, despite this robust and growing set of research outcomes, group dynamics that underlie this form of politically motivated reasoning are scarcely known.

Recent research on the epidemiology of pseudoscience (e.g. Lewandowsky, Cook, Fay, & Gignac, 2019) suggests that identity-protective cognition related to ingroup systems of beliefs, norms, and values breaks out when pseudoscientific believers get organized as deviant “communities of knowledge” (Sloman & Fernbach, 2016). These intergroup struggles would foster perceived threat and uncertainty, which would motivate group identification to boost self-affirmation and uncertainty reduction (Hogg & Wagoner, 2017). Consequently, prior studies have shown that conspiracy theories have a distinctive quadratic relationship with the political spectrum, thus showing associations with general political extremism and dogmatic intolerance elicited by strong beliefs (van Prooijen, Krouwel, & Pollet, 2015) — there is evidence of homogeneity regarding certain cognitive processes between left-wing and right-wing extremists, for example authoritarianism (Conway, Houck, Gornick, & Repke, 2017; Luttig, 2017) and motivated reasoning (Kahan, 2013; Lewandowsky & Oberauer, 2016).

In contrast, the relation between pseudoscience and the political spectrum remains controversial: although there is a confirmed relationship between conservatism and some instances of science denial, such as climate change denial (e.g. Hornsey, Harris, Brain, & Fielding, 2016), other instances, such as GMO opposition, do not show

distinctive political associations (Lewandowsky, Gignac, & Oberauer, 2013). Despite no prior study has measured the political orientation of pseudoscientific beliefs as a comprehensive construct, it is expected to show a rightward cast by means of greater proneness to conformity, desire to share reality with like-minded others, and ideological echo-chambers among political conservatives (Jost, van der Linden, Panagopoulos, & Hardin, 2018). Further theoretical justification for this expected rightward cast of pseudoscience will be detailed in the following sections.

An authoritarian interpretation of society: the role of conventionalism and intellectual submission

Authoritarianism is a long-established psychological construct, closely related to partisan extremism driven by group-centric affective polarisation (Luttig, 2017). It emerges from fears and uncertainties that give rise to motivated social cognition in which authoritarian attitudes reinforce conformity over social issues (Feldman, 2003), and satisfies epistemic, existential, and ideological needs (Jost, Glaser, Kruglanski, & Sulloway, 2003). Hence, it should be interpreted as a behavioural expression of values that motivates subjects in attaining collective security to the detriment of individual autonomy and critical thinking (Duckitt, Bizumic, Krauss, & Heled, 2010).

The work of Altemeyer (1981) was momentous due to his robust multidimensional model of authoritarianism, in which the construct is composed of three factors. Firstly, *Aggression* refers to the disposition to intentionally harm (in

psychological, physical or social terms) other individuals or outgroups that are perceived as a threat, accompanied by "the belief that proper authority approves it or that it will help preserve such authority" (Altemeyer, 1996, p. 10). Secondly, *Submission* refers to the belief that "proper authorities should be trusted to a great extent and deserve obedience and respect" (Altemeyer, 1996, p. 9). Accordingly, it boosts the willingness to accept authority's statements and actions without critical assessment. Thirdly, *Conventionalism* refers to a "strong acceptance of and commitment to the traditional social norms in one's society" (Altemeyer, 1996, p. 10). These factors lead individuals to fervently endorse ingroup conventions as social imperatives that must be respected — an inflexible conception of social norms that leads them to reject outgroups' conventions, including their beliefs and values.

Prior research has shown perceived social consensus as a source of motivation for facts assessment. So, individuals tend to accept or reject information depending on whether or not it fits with ingroup values and beliefs (Kahan, Jenkins-Smith, & Braman, 2010; Lewandowsky, Cook, Fay, & Gignac, 2019), as a way to achieve short-term social benefits (Khanna & Sood, 2017). Accordingly, some cases of denialism show a striking "consensus-gap" between experts and the public opinion (Lewandowsky, Gignac, & Vaughan, 2013) and perceived group consensus mediates science acceptance on pseudoscientific issues (van der Linden, Leiserowitz, Feinberg, & Maibach, 2015; Lewandowsky, Cook, Fay, & Gignac, 2019). Therefore, authoritarian predispositions may increase consensus-gap through an increment of radicalism over ingroup identity-related conventions and authorities.

We consider this potential effect of authoritarianism over consensus-gap to be explicable by means of the lay epistemic theory (Kruglanski, Orehek, Dechesne, &

Pierro, 2010). Specifically, by means of heightened levels of two of its dimensions: epistemic motivation for non-specific closure (elicited by authoritarian conventionalism) and hyperactive search for epistemic authorities within one's reference group (elicited by authoritarian submission). There is a strong relationship between authoritarianism and need for closure (De Keersmaecker, Roets, Dhont, Van Assche, Onraet, & Van Hiel, 2017) that motivates subjects to close their minds by “seizing” on accommodating information and “freezing” beliefs, thus becoming impervious to adverse data (Kruglanski & Webster, 1996). Group centrism — i.e. the degree to which individuals strive to enhance the “shared-reality” of their collectivity (Kruglanski, Pierro, Mannetti, & De Grada, 2006) — involves uniformity pressures, such as denigrating the dissenters or extolling the conformists, in order to achieve group consensus (Kruglanski & Webster, 1991).

This motivated group centrism manifests a preference for opinions that are unlikely to be challenged by significant others, as it would facilitate their esteem and appreciation, as well as the conservation of ingroup ties and social identity. Moreover, group centrism leads individuals to prefer autocratic group structures wherein a centralized authority shields commonly shared opinions (e.g. Pierro, Mannetti, De Grada, Livi, & Kruglanski, 2003). In sum, there are robust reasons to hypothesise that authoritarianism functions as a cognitive framework that hinders the evidential aspect of knowledge formation — known as “judgmental unimodel” within lay epistemic theory.

Social axioms as socio-psychological backgrounds that foster the authoritarian dimension of pseudoscience

Social axioms constitute a promising cross-cultural variable to aid understanding of the socio-psychological profile of pseudoscientific believers beyond their distribution in the right-wing/left-wing political spectrum. The construct is defined by Leung and Bond (2008) as “generalized beliefs about people, social groups, social institutions, the physical environment, or the spiritual world as well as about categories of events and phenomena in the social world” (p. 10). Social axioms express how society is believed to work through perceived correlational or causal patterns that constitute the basic premises which people endorse and rely upon to make sense of life in society and to guide their actions. In this respect, they differ in several ways from other related constructs such as personality factors (Chen, Bond, & Cheung, 2006; Leung, Lam, Bond, Conway, Gornick, & Amponsah, et al. 2012) and values — such as Hofstede's cultural dimensions, Schwartz's values, and cultural worldviews (Leung, Au, Kurman, Niit, & Niit, 2007).

Social axioms are encoded in the form of an assertion about the relationship between two entities or concepts, whereas values describe axiological reasoning and subjective desires; for example, a statement like "wars are bad" reflects a pacifist value, while statements such as "powerful people tend to exploit others" are regarded as social axioms due to the specified relationship between the entities, independent of its positive or negative social evaluation (Leung & Bond, 2008). The conceptual differences between social axioms and personality factors are even more explicit, as personality

also encompasses attitudes, temperament, values, and feelings. In effect, social axioms have shown greater predictive power than personality traits and values in relation to social behaviour (Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004), as they represent a practical guide to interpret societal functioning in a broad range of contexts.

Five social axioms with cross-cultural validity and psychometric soundness have been reported (Leung, Lam, Bond, Conway, Gornick, & Amponsah, et al. 2012):

Social Cynicism — negative beliefs about human nature, a biased view against some groups of people, mistrust of social institutions, and a belief that people disregard ethical means in achieving their ends. For example, “kind-hearted people are easily bullied” and “the only way to get ahead is to take advantage of others”.

Reward for Application — effort, careful planning, and a belief that the investment of these and other resources will lead to positive social outcomes. Two sample items of this axiom are “hard-working people are well rewarded” and “difficult problems can be overcome by hard work and persistence”.

Fate Control — a belief that life events are determined by external forces, but there are some ways for people to influence the impact of these forces. “Fate determines one’s successes and failures” and “the people whom a person will love in his or her life are determined by fate” are beliefs framed within this axiom.

Social Complexity — a belief that behaviour is inconsistent from situation to situation and that there may be multiple ways of achieving a given outcome. For instance, “there is usually more than one good way to handle a situation” and “people may have opposite behaviors on different occasions”.

Religiosity — a belief in the beneficial social functions of religious institutions and practices. Statements such as “religion helps people make good choices for their lives” and “religion makes people happier” characterise this social axiom.

Current literature on social axioms has found that three of them (Reward for Application, Religiosity and Fate Control) are positively related to authoritarianism, whereas Social Complexity and Social Cynicism are unrelated (Fasce & Avendaño, 2020). In this study, we expect an analogous pattern regarding pseudoscience.

Religiosity

Religiosity has been already linked to unwarranted beliefs (Singelis, Hubbard, Her, & An, 2003) and to social conservatism (Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004). Moreover, the relationship between authoritarian predisposition and normative religious doctrines has been widely documented (e.g. Van Pachterbeke, Freyer & Saroglou, 2011). Moreover, believing in the positive impact of religion among society — for example, over health issues, political decision-making, and ethics — involves a lenient attitude towards unwarranted beliefs, as some alternative epistemologies are perceived by these subjects as socially desirable.

Fate control

Fate Control has also been associated with social conservatism, to the endorsement of traditionalism (Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004; Leung, Au, Huang, Kurman, Niit, & Niit, 2007), and to unfounded beliefs (Singelis, Hubbard, Her, & An, 2003). Hence, this social axiom may be closely linked to the conventionalism dimension of authoritarianism. Fate control could also be related to

pseudoscience by means of its existing association with an external locus of control (Chen, Bond, & Cheung, 2006), and with a conception of facts as shaped by social and political processes (Garrett & Weeks, 2017).

Reward for Application

Reward for Application has been positively linked to strengthened obedience towards social norms and authorities (Leung, Au, Huang, Kurman, Niit, & Niit, 2007), as it is considered an underlying factor of socially conservative worldviews (Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004). Reward for Application may be promoting pseudoscientific beliefs along a different pathway than Religiosity and Fate Control. People who endorse this social axiom tend to prioritize good social relationships over the defence of potentially conflicting ideas, showing heightened levels of social conformity and uncritical attitude. Thus, they are prone to accommodation as conflict resolution, social desirability, and lack of self-acceptance (Singelis, Hubbard, Her, & An, 2003; Bond, Leung, Au, Tong, & Chemonges-Nielson, 2004; Chen, Bond, & Cheung, 2006). Nevertheless, if Reward for Application works as a background during pseudoscientific belief acquisition, then the mechanism should be strongly susceptible to being suppressed, or reverted to, if short-term incentives change (e.g. Khanna & Sood, 2017).

Social Complexity and Social Cynicism

These two social axioms are expected to be unrelated to pseudoscientific beliefs and authoritarian attitudes. On one hand, as Social Complexity is positively related to cognitive flexibility (Singelis, Hubbard, Her, & An, 2003), problem solving, collaboration, self-direction, and openness to change (Bond, Leung, Au, Tong, &

Chemonges-Nielson, 2004), these individuals may react in a more open-minded and self-affirmed way when presented with information that contradicts their belief system, thus promoting flexibility during the assessment of social conventions. On the other hand, there are no theoretical reasons to expect a direct association between Social Cynicism and pseudoscience — although this social axiom may be related to conspiracy theories, as argued in Supplementary Material.

Overview and working hypotheses

We conducted two empirical studies in order to assess the foregoing theoretical framework, structured in three working hypotheses:

H-1 — Pseudoscientific beliefs, religiosity, reward for application, fate control, political orientation, and authoritarianism are all positively intercorrelated.

H-2 — Religiosity, reward for application, fate control, and authoritarianism explain the rightward cast of pseudoscience.

H-3 — The association between authoritarianism and pseudoscientific beliefs is mediated by religiosity, reward for application, and fate control.

Study 1

Study 1 was designed as an exploratory pilot focused on H-1 and H-2, and so was conducted to assess the general likelihood of the mediational model displayed in H-3. This preliminary study includes validated scales on general pseudoscientific beliefs, the three social axioms hypothesised as related to these beliefs (Reward for Application, Religiosity, and Fate Control), and Political Orientation as measured by the right-wing/left-wing axis. Therefore, Study 1 constituted an informative starting point, offering encouraging results that were further replicated and broadened by the thorough confirmatory approach of Study 2.

Sample

We recruited a sample of 1189 Spanish speakers for an online administration of the scales via Google Forms. The respondents were invited to participate using Facebook and Twitter, through forums and groups of pseudoscientific believers. In addition, we counted on the help of science disseminators and sceptic blogs to increase sample's variability. Given the wide audience of those groups in Spanish-speaking social networks, our sample included participants from Spain and Latin America. 228 (19.2%) were women and 961 (80.8%) were men, with an average age of 39.7 (*SD*: 10.2). 248 (20.9%) had pre-university education and 941 (79.1%) a university one. Lastly, 170 (14.3%) self-describe religious identification and 1019 (85.7%) do not.

Measures

To measure Political Orientation, we included a 10-point Likert scale representing the right-wing/left-wing spectrum. To assess pseudoscientific beliefs, we used the 30-

item Pseudoscientific Belief Scale (Fasce & Picó, 2019a), a reliable measure ($\alpha = 0.88$)¹ that includes pseudo-theory promotion and science denialism as forms of pseudoscience. For the three social axioms included in our model, we used three 8-item factors extracted from the Social Axioms Survey II (Leung, Lam, Bond, Conway, Gornick, Amponsah, et al., 2012): Reward for Application ($\alpha = 0.88$), Fate Control ($\alpha = 0.72$), and Religiosity ($\alpha = 0.85$). In addition, we included several measures on need to belong and intergroup variables related to pseudoscientific beliefs, to be reported elsewhere.

Results

Sociodemographic variables

There were significant differences in Sex ($t = -4.21, d = 0.34, p < 0.001$; more Pseudoscientific Beliefs among women), Education ($t = 2.31, d = 0.16, p < 0.05$; more Pseudoscientific Beliefs among subjects with pre-university education), and Religious Identity ($t = -8.64, d = 0.76, p < 0.001$; more Pseudoscientific Beliefs among religious subjects). As we did not find significant association between age and pseudoscience, we discarded this variable for further analyses.

H-1

Regarding the association of the variables tested in Study 1, Pseudoscientific Beliefs were positively correlated to right-wing Political Orientation ($r = 0.11, p < 0.001$) and to the three social axioms included: Reward for Application ($r = 0.20, p <$

¹ All the Cronbach's alphas reported in this article were calculated using our data matrices.

0.001), Religiosity ($r = 0.33, p < 0.001$) and Fate Control ($r = 0.49, p < 0.001$). These results are displayed in Table 1 and support our first working hypothesis.

Table 1
Correlation of pseudoscientific beliefs regarding political orientation and social axioms.

	Pseudoscientific Beliefs
Political Orientation	0.11***
Reward for Application	0.20***
Religiosity	0.33***
Fate Control	0.49***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Values in bold are corrected for multiple comparisons by Bonferroni method ($p < 0.05$). All values survived this correction.

H-2

In order to test H-2, we conducted a hierarchical multiple linear regression with Pseudoscientific Beliefs as the dependent variable. In Model 1, we entered the three sociodemographic variables with significant differences regarding Pseudoscientific Beliefs — namely Sex, Religious Identity, and Education. In Model 2, Reward for Application, Religiosity and Fate Control were entered as independent variables. Lastly, we entered Political Orientation as an independent variable in Model 3, as we wanted to assess its predictive power above social axioms. A multicollinearity test was carried out using VIF and tolerance statistics: all the VIF values were below 1.7 and tolerance statistics were above 0.59. Additionally, our data showed independence of errors

(Durbin-Watson = 1.92). These results are displayed in Table 2 and support our second working hypothesis.

Table 2

Hierarchical multiple linear regression analysis with pseudoscientific beliefs as dependent variable.

Predictor variables	Pseudoscientific Beliefs		
	Model 1 (Adjusted $R^2=0.11$ ***)	Model 2 (Adjusted $R^2=0.31$ ***; $\Delta R^2=0.20$)	Model 3 (Adjusted $R^2=0.31$ ***; $\Delta R^2=0.000$)
Step 1			
Sex	0.16***	0.15***	0.15***
Education	-0.11***	-0.09***	-0.09***
Religious Identity	0.28***	0.12***	0.12***
Step 2			
Reward for Application		0.08***	0.09***
Religiosity		0.12***	0.12***
Fate Control		0.40***	0.40***
Step 3			
Political Orientation			-0.02

Note: Sex was coded as 1 = male, 2 = female; Education as 1 = Pre-universitary, 2 = University; and Religious Identity as 1 = Non-religious, 2 = Religious. All regression coefficients are standardized β . * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Model 1 [$F(3, 1185) = 48.6, p < 0.001$] confirmed the included sociodemographic variables as significant predictors of pseudoscience endorsement, explaining 11% of its variance. Similarly, Model 2 [$F(6, 1182) = 89, p < 0.001$] confirmed the three social axioms as significant predictors of Pseudoscientific Beliefs over sociodemographic characteristics, explaining 31% of its variance. In contrast, where Model 3 [$F(7, 1181) = 76.4, p < 0.001$] explains the same amount of Pseudoscientific Beliefs' variance,

Political Orientation added no predictive power over social axioms and, consequently, was non-significant as a predictor variable. Therefore, social axioms fully explain the positive association between Pseudoscientific Beliefs and right-wing Political Orientation. These results endorse Reward for Application, Religiosity and Fate Control as socio-psychological backgrounds for the dissemination of Pseudoscientific Beliefs.

Study 2

Study 2 was designed as a follow-up to our exploratory results. This second data collection replicated and overcame the limitations of Study 1, by including all the variables and relationships displayed in our working hypotheses — two forms of unwarranted beliefs (pseudoscience and the paranormal), social axioms in full, political orientation, and authoritarianism. Consequently, the comprehensive design of Study 2 allowed us to perform a full assessment of our working hypotheses.

Sample

A convenience sample of 1097 Spanish speakers was recruited using the same data collection strategy described in Study 1 for an online fulfilment of the scales. 395 (36%) were women and 702 (64%) were men, with an average age of 35.5 (*SD*: 12.5). 242 (22.01%) had pre-university education and 855 (77.9%) a university one. Lastly, 194 (17.7%) were religious and 903 (82.3%) were non-religious.

Measures

Besides Political Orientation and Pseudoscientific Beliefs ($\alpha = .90$), in this study we included the 18-item Aggression-Submission-Conventionalism Scale ($\alpha = 0.86$; Dunwoody & Funke, 2016) to the three factors of authoritarianism: Aggression ($\alpha = 0.88$), Submission ($\alpha = 0.75$), and Conventionalism ($\alpha = 0.79$). For social axioms we used the full 40-item Social Axioms Survey II (Leung, Lam, Bond, Conway, Gornick, & Amponsah, et al. 2012). The complete scale includes five subscales: Social Cynicism ($\alpha = 0.89$), Social Complexity ($\alpha = 0.69$), Reward for Application ($\alpha = 0.67$), Fate Control ($\alpha = 0.82$) and Religiosity ($\alpha = 0.87$). Lastly, to assess the extrapolation of other closely related types of unwarranted beliefs, we included the 26-item Revised Paranormal Belief Scale (Tobacyk, 2004), a reliable ($\alpha = 0.94$) and widely used tool to assess paranormal beliefs.

Results

Sociodemographic variables

Following the previous results found in Study 1, Study 2 also revealed significant differences in Sex ($t = -5.67$, $d = 0.36$, $p < 0.001$; more Pseudoscientific Beliefs among women), Education ($t = 4.19$, $d = 0.46$, $p < 0.001$; more Pseudoscientific Beliefs among subjects with pre-university education), and Religious Identity ($t = -10.59$, $d = 0.90$, $p < 0.001$; more Pseudoscientific Beliefs among religious subjects).

H-1

As found in Study 1, and as expected by H-1, Pseudoscientific Beliefs had positive correlations with Political Orientation ($r = 0.21$, $p < 0.001$), Conventionalism ($r = 0.28$, $p < 0.001$), Submission ($r = 0.16$, $p < 0.001$), Aggression ($r = 0.18$, $p < 0.001$),

and three social axioms: Reward for Application ($r = 0.33, p < 0.001$), Religiosity ($r = 0.36, p < 0.001$), and Fate Control ($r = 0.51, p < 0.001$). These results are displayed in Table 3 and fully support our first working hypothesis. In addition, we found that the complete Aggression-Submission-Conventionalism Scale shows a medium-sized positive correlation with Pseudoscientific Beliefs ($r = 0.31, p < 0.001$). As Pseudoscientific Beliefs show no correlation to Social Cynicism and a very weak, almost non-significant correlation to Social Complexity, we discarded these social axioms for further analyses. These latter results were expected based on our literature review and working hypotheses.

Table 3

Correlation of pseudoscientific beliefs regarding political orientation, social axioms, and factors of authoritarianism.

	Pseudoscientific Beliefs
Political Orientation	0.21***
Reward for Application	0.33***
Religiosity	0.36***
Fate Control	0.51***
Social Cynicism	0.06
Social Complexity	0.08**
Conventionalism	0.28***
Submission	0.16***
Aggression	0.18***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Values in bold are corrected for multiple comparisons by Bonferroni method ($p < 0.05$).

H-2

In order to replicate and extend the results of Study 1 in relation to H-2, we conducted a hierarchical multiple linear regression analysis with Pseudoscientific Beliefs as the dependent variable. A multicollinearity diagnosis using VIF and tolerance statistics was carried out: all the VIF values were below 1.79, whereas tolerance statistics were above 0.56. Additionally, our data showed independence of errors (Durbin-Watson = 1.76). The relevant sociodemographic variables — Sex, Education, and Religious Identity — were included in Model 1. We entered the three factors of authoritarianism in Model 2: Conventionalism, Submission, and Aggression. Subsequently, we entered Reward for Application, Religiosity and Fate Control as the independent variables in Model 3, as we wanted to assess their predictive power above authoritarianism. Lastly, Political Orientation was added in Model 4. These results are displayed in Table 4 and fully support our second working hypothesis.

Table 4

Hierarchical multiple linear regression analysis with pseudoscientific beliefs as dependent variable.

Predictor variables	Pseudoscientific Beliefs			
	Model 1 (Adjusted $R^2=0.15^{***}$)	Model 2 (Adjusted $R^2=0.20^{***}$; $\Delta R^2=0.05$)	Model 3 (Adjusted $R^2=0.35^{***}$; $\Delta R^2=0.15$)	Model 4 (Adjusted $R^2=0.35^{***}$; $\Delta R^2=0.004$)
Step 1				
Sex	0.14***	0.15***	0.11***	0.12***
Education	-0.14***	-0.14***	-0.09***	-0.09***
Religious Identity	0.33***	0.25***	0.13***	0.14***
Step 2				
Submission		0.06*	0.02	0.02
Conventionalism		0.14***	0.06*	0.08**
Aggression		0.13***	0.09***	0.11***
Step 3				
Reward for Application			0.14***	0.16***
Religiosity			0.04	0.05
Fate Control			0.35***	0.35***
Step 4				
Political Orientation				-0.08*

Note: Sex was coded as 1 = male, 2 = female; Education as 1 = Pre-university, 2 = University; and Religious Identity as 1 = Non-religious, 2 = Religious. All regression coefficients are standardized β . * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

As with Study 1, Model 1 confirmed sociodemographic variables as good predictors of Pseudoscientific Beliefs [$F(3, 1093) = 67.3, p < 0.001$]. Model 2 [$F(6, 1090) = 46.4, p < 0.001$] confirmed authoritarian factors as significant predictors of pseudoscience — although covariates had a particularly strong effect over Submission. Model 3 [$F(9, 1087) = 65.6, p < 0.001$] confirmed our theoretical model as a significant predictor of Pseudoscientific Beliefs, explaining 35% of its variance. Furthermore, in accordance with Study 1, Model 4 explained the same 35% of Pseudoscientific Beliefs' variance, confirming that Political Orientation has no predictive power above authoritarianism and social axioms.

H-3

In order to test the hypothesised mediational effects of social axioms on the relationship between authoritarianism and pseudoscientific beliefs, we carried out a series of simple mediational analyses by means of the PROCESS macro (v3.4). Mediation analyses are intended to statistically test hypothesised models in which the relationship between an independent and dependent variable is thought to be influenced by a *mediator variable* (MacKinnon, Fairchild, & Fritz, 2007). Thus, mediator variables explain a causal sequence whereby the independent variable predicts indirectly the outcome on the dependent variable — the so-called “indirect effect”. In other words, mediation analyses explain how mediating variables intervene in the relationship between the independent and dependent variable.

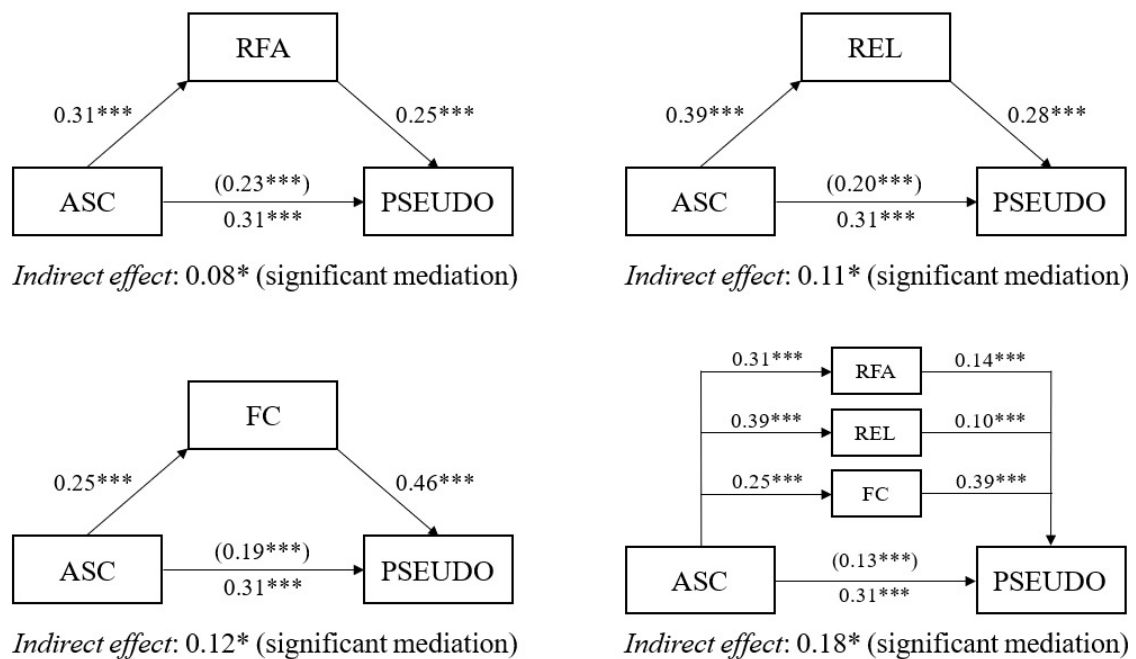


Figure 1. Graphical representation of mediation analyses performed with PROCESS. Pseudoscientific Beliefs was selected as dependent variable, authoritarianism as independent variable, and social axioms as mediator variables. *Note:* Values represent standardized β . Mediational effects were tested by analysing the “indirect effect” via bootstrapping (95% confidence intervals; number of bootstrap samples: 5000). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. ASC = Authoritarianism (as measured by the Aggression-Submission-Conventionalism Scale); PSEUDO = Pseudoscientific Beliefs; RFA = Reward for Application; REL = Religiosity; FC = Fate Control.

To verify the present hypothesis (H-3), we studied the mediational effects by analysing the indirect effect via bootstrapping (95% confidence intervals; number of bootstrap samples: 5000), revealing that Reward for Application, Religiosity, and Fate Control act as partial mediators between authoritarianism (as measured by the whole Aggression-Submission-Conventionalism Scale) and Pseudoscientific Beliefs. All these indirect effects — i.e. the total effect minus the direct effect — fully support our third working hypothesis (see Figure 1 for a detailed graphical representation). These results

do not suggest a univocal causal pathway between authoritarianism, social axioms and pseudoscience. Instead, based on our literature review we propose that authoritarian predispositions constitute a cognitive substrate that *facilitates* the endorsement of certain social axioms; these, in turn, boost the existing association between authoritarianism and unfounded beliefs. Therefore, the observed mediations aid understanding of the primary focus of this article: authoritarianism as a motivational context in which pseudoscience thrives.

Extrapolation to other forms of unwarranted beliefs

We included a validated scale on Paranormal Beliefs to conduct the same analyses as those conducted for Pseudoscientific Beliefs. Interestingly, the pattern of associations, statistical significances, and effect sizes of Paranormal Beliefs were very similar to those found in the previous analyses. These results strongly suggest that Paranormal Beliefs are equally related to authoritarianism and partially mediated by the same social axioms as pseudoscience. Hence, the mediational model tested in this study can be rightfully extrapolated to the paranormal, showing that pseudoscience involves strong paranormal content and both groups of believers largely overlap and resemble. Results on Paranormal Beliefs and additional remarks on the potential and nuanced extrapolation of these results to conspiracy theories can be found in Supplementary Material.

Discussion

The data reported in this article show that three social axioms partially mediate the existing association between right-wing authoritarianism and pseudoscience. Hence, these results fully endorse our hypotheses, being compatible with a theoretical interpretation framed within lay epistemic theory. Nevertheless, other forms of authoritarianism may be related to specific unwarranted beliefs by means of different social conceptions — such as left-wing authoritarianism (Conway, Houck, Gornick, & Repke, 2017), subtle forms of competitive authoritarianism (Levitsky & Way, 2002), and even liberal authoritarianism (Babones, 2018). For instance, historical examples such as Lysenkoism (Kolchinsky, Kutschera, Hossfeld, & Levit, 2017) and current leftist conspiracy theories (e.g. Oliver & Wood, 2014) show that left-wing authoritarianism promotes its own forms of disinformation.

Authoritarianism and social axioms as underlying factors of belief polarisation

Authoritarian predispositions toward social conservatism boosted by social axioms may be explanatory regarding the kind of intergroup struggle that leads to motivated belief polarisation among radical minorities. As recent results strongly suggest that science rejection is mediated by lack of perceived social consensus between experts and the public opinion (Lewandowsky, Gignac, & Vaughan, 2013; van der Linden, Leiserowitz, Feinberg, & Maibach, 2015; Lewandowsky, Cook, Fay, & Gignac, 2019), the socio-political profile of pseudoscience described in this study may be blocking the perception of expert agreement by reinforcing ingroup conventionalism — although more research is needed to confirm this causal pathway.

Accordingly, recalcitrant unwarranted believers would be reluctant to accept information from the outgroup, particularly due to hyperactive affective anchoring of ingroup membership that heightens the perception of intergroup threats and leads to the rejection of the open marketplace of ideas. These authoritarian individuals would tend to disregard the freedom of expression of the outgroup, avoiding uncertainty by endorsing a monopoly of truth (Hackett, Gaffney, & Data, 2018), and preferring instead to engage with prototypical, deviant “truth seekers” (e.g. Franks, Bangerter, Bauer, Hall, & Noort, 2017) — i.e. fake experts that hold proper badges of ingroup membership. These authoritarian motives would lead pseudoscientific believers to exploit their analytical thinking in order to rationalise polarisation and partisan science acceptance, thus performing backfire-effect. This potential causal chain constitutes a relevant novel research line on the underlying social conceptions that give rise to motivated reasoning and, consequently, block the public acceptance of science.

Implications for social interventions and science communication

The reported association between authoritarianism and pseudoscience suggests that ingroup ostracism and conventionalism may be pushing individuals toward a consensus-gap. Therefore, the most direct intervention would be to offer conditions to improve intergroup contact related to pseudoscientific issues, such as common goals and cooperation (Pettigrew & Tropp, 2008). As a confrontational rhetoric style has been proved to backfire under conditions of motivated reasoning, we must place value on unregulated free speech, conversations that engage diverse viewpoints, and self-disclosure, as these attitudes facilitate mutual understanding (e.g. Vescio, Sechrist, & Paolucci, 2003; Turner, Hewstone & Voci, 2007). In fact, this is the typical attitude that

can be found among those who hold Social Complexity as an interpretation of the social world — almost unrelated to pseudoscience and authoritarian attitudes.

Another line of interventions may be focused on echo-chambers and partisan media, as they foster social conceptions associated with pseudoscience, such as group bias and, consequently, authoritarian rejection of hostile information. Echo-chambers are often exploited by evidence-resistance groups that effectively promote denialism and pseudo-theories (Lewandowsky, Pilditch, Madsen, Oreskes, & Risbey, 2019). In general terms, it is important to encourage people to counter false-consensus effect and harmful intellectual submission by making their voices heard. It would be very helpful to expand the boundaries established by social media' algorithms to expose users to a wider spectrum of information, including the authoritative voice of scientists — which can participate in the public sphere without risking their credibility (Kotcher, Myers, Vraga, Stenhouse, & Maibach, 2017). Hence, it is important for science communication to deploy pedagogical strategies and inoculation messages to cope with disinformation within corrupted information architectures, making the public aware of how fake news, trolling, and filter bubbles work (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Cook, Lewandowsky, & Ecker, 2017; Lewandowsky, Ecker, & Cook, 2017).

In addition, even though scientific literacy and critical thinking are negatively correlated to pseudoscience endorsement (Fasce & Picó, 2019b), previous research outcomes consistently concluded that courses that promoted a motivational state of distrust in pseudoscience produced a reduction of those beliefs, whereas general education classes on critical thinking and research methods did not (Dyer & Hall, 2018;

Wilson, 2018)². So, under the light of these results, efficient interventions on pseudoscience endorsement and science communication should include motivational strategies to deal with authoritarianism and counterproductive social conceptions, such as worldview and values affirmation, in order to exploit the existing negative association between trust in science and pseudoscientific beliefs (Ståhla & van Prooijen, 2018; Fasce & Picó, 2019b).

Limitations

We want to remark on some of the limitations of the reported studies. Firstly, these results must be taken cautiously, particularly in regard to their interpretation in causal terms. These theory-driven correlational results suggest a causal relationship between authoritarian attitudes and pseudoscientific beliefs; however, this potential pathway needs further experimental confirmation, particularly to identify confounders. Secondly, both samples are composed by a higher number of men, more university educated and more non-religious subjects — even though the samples' variabilities were acceptable enough to include these sociodemographic variables in further analyses. Consequently, these sample asymmetries should be assessed in future studies to confirm that they did not affected the reported results.

² We are not suggesting that the public acceptance of science is a process analogous to that of pseudoscience. As we have already mentioned, critical thinking disposition, cognitive reflection, and basic knowledge about scientific theories are relevant characteristics of successful scientific literacy (e.g. Fasce & Picó, 2019b), nevertheless, scientific scepticism *also needs* motivational and affective components (Ståhla & van Prooijen, 2018).

Concluding remarks

We have successfully tested a mediational model that characterises pseudoscientific beliefs as related to an authoritarian interpretation of society, in which three social axioms that place great value on unwarranted beliefs play an explanatory role. Hence, the previously reported associations of certain instances of pseudoscience with right-wing ideologies may be explicable by means of this richer socio-political background, related to the lay epistemic theory. Exacerbated levels of authoritarian attitudes may be at the root of motivated reasoning already observed among recalcitrant groups of pseudoscientific believers. As such, some strategic interventions could be beneficial to foster evidence-based behaviours and public acceptance of science.

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