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Science through a tribal lens: A group-based account of polarization over scientific facts

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Abstract

Previous research has confirmed the prominent role of group processes in the promotion and endorsement of disinformation. We report three studies on a psychological framework derived from integrated threat theory—a psychological theory which describes how perceived threat leads to group polarization and prejudice—composed of the following constructs: group belongingness, perceived threat, outgroup derogation, and intergroup anxiety. Our pilot study suggested that need to belong and intergroup anxiety predict antiscientific beliefs (pseudoscientific, paranormal, and conspiracy theories), thus justifying the general applicability of integrated threat theory. Study 1 investigates the transition from weak to strong critical thinking regarding pseudoscientific doctrines. Besides greater outgroup derogation and perceived threats among strong critical thinkers, the model does not perform well in this context. Study 2 focuses on the intergroup conflict around anthropogenic global warming, revealing the strong predictive power of the model. These results are discussed in relation to the distinctive psychological profiles of science acceptance and rejection.

Keywords

climate change denial, group belongingness, integrated threat theory, intergroup anxiety, scientific consensus

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Science denial is not common: citizens frequently tend to converge on the best available evidence through an appropriate chain of reasoning between perceived scientific agreement, belief formation, risk perception, and support for public action—a psychological process that can be explained by the gateway belief model, a dual-process model that explains how people form judgments about scientific issues (e.g., van der Linden et al., 2015, 2019). Nevertheless, in some circumstances, citizens do not converge on a common understanding of evidence, and deep and

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potentially corrosive polarization can result. These sociopsychological processes have aroused great interest in recent years, especially due to rising polarization in public opinion on important scientific issues (Kerr, Panagopoulos, & van der Linden, 2021; Lewandowsky & Oberauer, 2016) such as climate change, vaccinations, and COVID-19 (Lewandowsky et al., 2017; Rutjens et al., 2021).

In this article, we advance the conceptual foundations of—and report empirical evidence for—a psychological framework based on integrated threat theory (ITT; Stephan & Stephan, 2017), which aims to predict the inability of partisans to come to an agreement on acceptable evidence at the group level—as a potential underlying mechanism of the political promotion of disinformation. Based on a literature review, we hypothesized that psychological constructs framed within ITT positively predict polarized perspectives on antiscientific conceptions—that is, strong belief and strong disbelief—so that groups of critical thinkers[1] (first hypothesis) and science deniers (second hypothesis) would exhibit heightened levels of group belongingness, perceived threat, outgroup derogation, and intergroup anxiety. After a pilot study aimed at assessing the applicability of ITT in this new context, we conducted two comprehensive studies using large cross-sectional samples recruited from online communities, finding evidence for our second but not our first hypothesis. Therefore, our data suggest that, although ITT-related constructs poorly predict critical appraisal of pseudoscience in general (Study 1), these variables positively predict climate change denial in particular (Study 2). We discuss the potential of ITT to shed light on group polarization across a wide range of belief-related social affairs.

Interpreting Science Polarization Through Integrated Threat Theory

The belief that other groups pose a threat to one's own group is among the fundamental causes of negative stereotyping and social unrest. Stephan and Stephan's (2000) integrated threat theory offers one useful framework for understanding the behavioral (e.g., discrimination, cheating, and harassment), cognitive (e.g., prejudice, intolerance, and ethnocentrism), and emotional (e.g., hatred, resentment, and humiliation) effects of perceived intergroup threat—also accounting for various antecedent factors such as intergroup conflict, status inequalities, strength of ingroup identification, knowledge of the outgroup, and intergroup contact, which influence the extent to which an outgroup is perceived as threatening. As a well-established theory in social psychology, ITT has been used to explain and predict a wide range of group-based phenomena such as intercultural attitudes, stigmatization, and political campaigns (Croucher, 2017; Stephan & Stephan, 2017).

In this program of research, we report a pilot testing and two comprehensive studies aimed at assessing the predictive power of ITT in the context of polarization over scientific facts. Disputes around scientific information are increasingly polarized—as we find in relation to, for example, climate change and vaccination (Kerr, Schneider, et al., 2021; Uscinski et al., 2017). Both groups, critical thinkers and antiscientific collectives, are well organized and fiercely opposed to each other, establishing a relationship dominated by distrust, competition, and mutual disparaging (e.g., Brulle et al., 2021; Cano-Orón, 2019). Therefore, the most striking instances of polarization over scientific facts may show the necessary characteristics to be framed within ITT: strong group belongingness that motivates the perception of intergroup threats, triggers intergroup anxiety, and boosts outgroup derogation.

In the following studies, we consider four of the most important constructs comprising ITT:

1. Group belongingness. People derive part of their identity from the groups to which they belong, such as their political party, nationality, gender, company, or sport team. Social identity theory defines "group" in terms of people's self-conception, so a group exists psychologically if

three or more people make use of their shared attributes to distinguish themselves collectively from other people (Hogg, 2018). Previous research suggests that the search for epistemic authorities within one's reference group motivates individuals to close their minds by "freezing" core beliefs that are unlikely to be challenged by significant others (Kruglanski et al., 2006; Kruglanski & Webster, 1996).

2. Perceived threat. ITT includes two types of perceived intergroup threat (Stephan & Stephan, 2000, 2017). Realistic threats, defined as potential tangible harms related to the political, economic, or physical well-being of the ingroup—in this context, for example, the use of potentially harmful alternative health care or possible economic losses caused by carbon dioxide regulations. And symbolic threats, defined as potential intangible harm related to the ingroup system of values, beliefs, and norms—which, from the standpoint of critical thinkers, considers that pseudoscientists denigrate the cultural and epistemological dimensions of science, and from the pseudoscientists' standpoint, that critical thinkers try to impose a reductionist, scientistic worldview. Nevertheless, drawing a clear distinction between both types of threats may be problematic in certain contexts, as they often overlap (Riek et al., 2006). Intergroup threats increase cohesion among individuals, fostering identification with groups that provide distinctive identities by means of normative beliefs and behavioral prescriptions (Hogg & Wagoner, 2017).
3. Outgroup derogation. ITT encompasses a wide range of biases favoring one's affinity group, including antipathy, discrimination, prejudice, stereotyping, and social-dominance-based reactions toward disliked outgroups (Riek et al., 2006). For instance, perceived threats can cause negative beliefs about immigrants and ethnic minorities (e.g., Stephan et al., 2005), which fuel negative behavioral intentions toward these groups (e.g., Kauff & Wagner, 2012).
4. Intergroup anxiety. This construct is defined as feelings of apprehension that stem from anticipated negative interactions with the outgroup and is associated with psychophysiological changes that are typical indicators of anxiety. Intergroup anxiety constitutes one of the best predictors of negative intergroup outcomes, even when both groups have direct day-to-day contact (Stephan, 2014), because it promotes repressive attitudes against free speech and intergroup deliberation (Hackett et al., 2018). Intergroup anxiety hinders constructive conversations that are characterized by diverse viewpoints, self-disclosure, and perspective taking that typically create an avenue for mutual understanding and reconsideration of stereotypes (Pettigrew & Tropp, 2008). As a result, anxiety creates cognitions and emotions that reinforce negative attitudes toward outgroup members (van Zomeren et al., 2007).

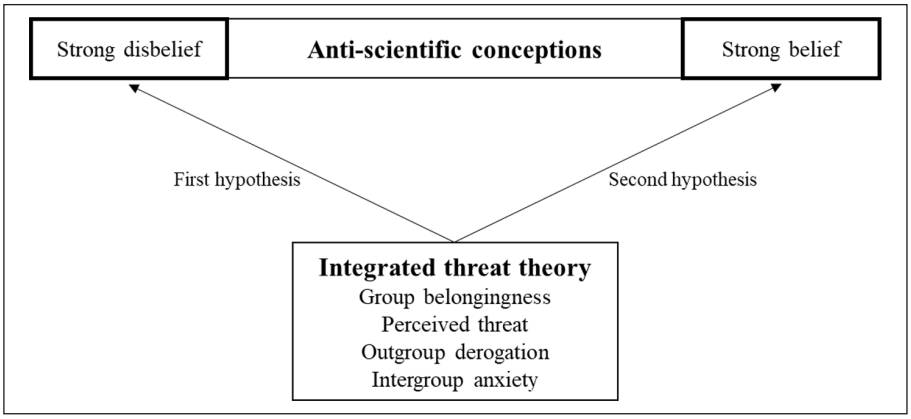
Overview and Hypotheses

Based on our literature review, we predicted that group dynamics typically associated with ITT would positively predict polarized perspectives on antiscientific conceptions. We present two specific hypotheses:

> Hypothesis 1: Variables framed within integrated threat theory (group belongingness, perceived threat, outgroup derogation, and intergroup anxiety) positively predict disbelief in antiscientific conceptions for critical thinkers.

> Hypothesis 2: Variables framed within integrated threat theory (group belongingness, perceived threat, outgroup derogation, and intergroup anxiety) positively predict belief in antiscientific conceptions for science deniers.

Figure 1. Representation of both hypotheses: Variables framed within integrated threat theory would predict polarized positions about antiscientific conceptions—either strong belief or strong disbelief.



The nomological network expressed by these hypotheses is represented in Figure 1—a quadratic, u-shaped distribution of ITT-related variables across the spectrum of antiscientific beliefs, with heightened levels at the poles. Due to the fact that these poles (strong disbelief and strong belief) are targeted toward opposing groups (critical thinkers for believers, and believers for critical thinkers), each hypothesis was tested through an independent study, designed to measure how groups of pseudoscientific believers (Study 1) and of people that accept anthropogenic climate change (Study 2) are perceived.

Pilot Study

An exploratory pilot study was conducted to test the applicability of ITT in relation to three types of antiscientific conceptions—pseudoscientific, paranormal and conspiracy beliefs—through the assessment of intergroup anxiety as a robust predictor of intergroup conflict (Riek et al., 2006; Stephan, 2014). In addition, we measured participants' need to belong as a construct associated with a wide range of affiliative traits (Leare et al., 2013).

Sample

A sample of 1,054 Spanish speakers was recruited through social networks for an online study. To ensure diversity, we sent invitations to participate through a wide range of groups using Facebook and Twitter—for example, forums on conspiracy theories, scientific skepticism, scientific communication, and alternative medicine. All participants gave their informed consent prior to their inclusion in the study; 36.1% of the sample were women and 63.9% were men, with a combined average age of 35.56 years (SD = 11.78). Regarding educational level, 21.1% reported pre-university-level and 78.9% university-level education. Regarding religious identity, 17.5% were religious and 82.5% were nonreligious. Lastly, participants' political orientation was assessed using a 10-point Likert scale representing the left-wing–right-wing axis (1 = *extremely left-wing*, 10 = *extremely right-wing; M* = 3.61, SD = 1.95).

Measures

Paranormal beliefs. We used the 26-item Revised Paranormal Belief Scale (Likert 1–7; item M = 1.71, SD = 0.80; α = .94; e.g., "During altered states, such as sleep or trances, the spirit can leave the body," "Black cats can bring bad luck"; Tobacyk, 2004).

Conspiracy beliefs. We used the 15-item Generic Conspiracy Belief Scale (Likert 1–5; item M = 2.30, SD = 0.91; α = .94; e.g., "The spread of certain viruses and/or diseases is the result of the

Table 1. Multiple linear regression analyses with paranormal beliefs, conspiracy beliefs, and pseudoscientific beliefs as dependent variables.

Predictor variables	Paranormal beliefs	Conspiracy beliefs	Pseudoscientific beliefs
Model			
Age	−0.15*** [−0.01, −0.01]	−0.16*** [−0.02, −0.01]	−0.10*** [−0.01, −0.00]
Sex	0.12*** [0.11, 0.27]	0.09** [0.07, 0.29]	0.14*** [0.10, 0.23]
Education	−0.10*** [−0.28, −0.09]	−0.15*** [−0.47, −0.21]	−0.18*** [−0.33, −0.18]
Religious identity	0.44*** [0.82, 1.04]	0.18*** [0.28, 0.57]	0.29*** [0.34, 0.51]
Political orientation	0.14*** [0.04, 0.08]	−0.02 [−0.04, 0.02]	0.11*** [0.02, 0.05]
Need to belong	0.10*** [0.04, 0.12]	0.07* [0.01, 0.12]	0.07* [0.01, 0.07]
Model			
Age	−0.16*** [−0.01, −0.01]	−0.17*** [−0.02, −0.01]	−0.11*** [−0.01, −0.00]
Sex	0.13*** [0.13, 0.30]	0.11*** [0.09, 0.31]	0.16*** [0.12, 0.25]
Education	−0.10*** [−0.29, −0.09]	−0.15*** [−0.47, −0.22]	−0.19*** [−0.33, −0.18]
Religious identity	0.45*** [0.85, 1.06]	0.18*** [0.28, 0.58]	0.29*** [0.34, 0.51]
Political orientation	0.15*** [0.04, 0.08]	−0.02 [−0.04, 0.02]	0.10*** [0.01, 0.05]
Intergroup anxiety	−0.07** [−0.15, −0.03]	−0.10*** [−0.23, −0.06]	−0.13*** [−0.16, −0.06]

Note. All regression coefficients are standardized β. Values in brackets show 95% confidence intervals (lower and upper limits). Sex was coded as 1 = male, 2 = female; education as 1 = preuniversity, 2 = university; religious identity as 1 = nonreligious, 2 = religious. Intergroup anxiety levels regarding paranormal, conspiracy, and pseudoscientific beliefs were introduced separately for each analysis
*$p < .05$. **$p < .01$. ***$p < .001$.

deliberate, concealed efforts of some organization," "Evidence of alien contact is being concealed from the public"; Brotherton et al., 2013).

Pseudoscientific beliefs. We used a 30-item scale validated by Fasce and Picó (2019; Likert 1–5; item $M = 1.94$, $SD = 0.57$; $\alpha = .90$), which includes instances of both pseudotheory promotion (e.g., "Food should be chosen according to the blood group of each person") and science denialism (e.g., "Vaccines are unsafe, some of them cause diseases such as autism").

Intergroup anxiety. A six-item Intergroup Anxiety Scale (Paolini et al., 2004) was administered three times, once for each type of Antiscientific Beliefs Scale: anxiety-paranormal (Likert 1–4; item $M = 2.41$, $SD = 0.64$; $\alpha = .77$), anxiety-conspiracy (Likert 1–4; item $M = 2.38$, $SD = 0.63$; $\alpha = .78$), and anxiety-pseudoscience (Likert 1–4; item $M = 2.41$, $SD = 0.64$; $\alpha = .78$). Respondents read the following question before indicating if they would feel, for example, awkward or defensive:

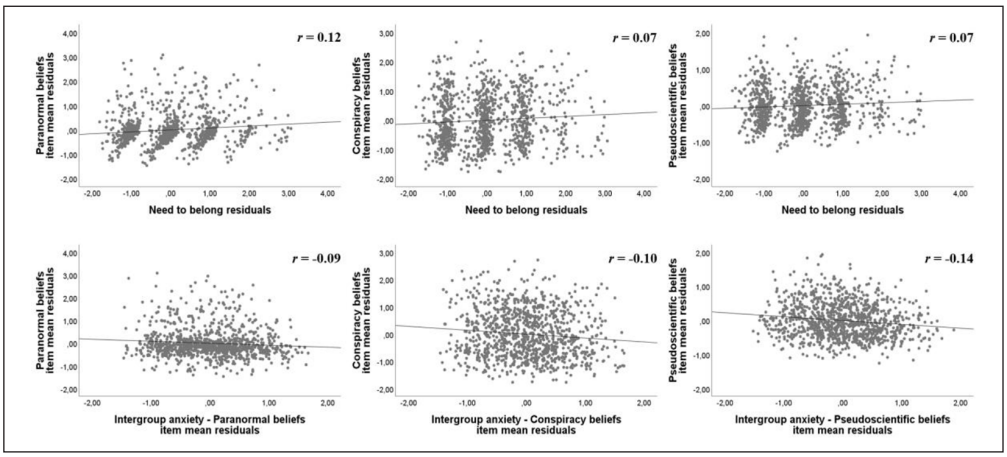
> If you were interacting with people who believe the opposite regarding the statements of the previous questionnaire (e.g., talking with them, working on a project with them), how would you feel compared to occasions when you interact with people who agree with you?

Need to belong. To assess participants' general need to belong, defined as a strong desire to form and maintain enduring interpersonal attachments, we included a 5-point, single-item scale adopted from Nichols and Webster (2013; Likert 1–5; $M = 2.15$, $SD = 1$; "I have a strong need to belong").

Results

Linear regressions on antiscientific beliefs. Multiple regression analyses predicting antiscientific beliefs (i.e., paranormal, conspiracy, and pseudoscientific beliefs) were carried out by taking need to belong and intergroup anxiety as independent variables (see Table 1 and Figure 2). All

Figure 2. Partial regression plots with antiscientific beliefs as dependent variables.



Note. Need to belong (upper row) and intergroup anxiety (lower row) regarding paranormal, conspiracy, and pseudoscientific beliefs were entered in each analysis as the predictive variable. Higher levels in the X-axis denote more intergroup anxiety and need to belong, while higher values on the Y-axis denote greater antiscientific beliefs. All the sociodemographic variables (age, sex, education, religious identity, and political orientation) were also entered in each model to regress out nuisance effects. The regression models and standardized β values were all significant (see Table 1). R values represent partial correlations.

sociodemographic variables (age, sex, education, religious identity, and political orientation) were included in each model. The collinearity tests showed adequacy: All the Variance Inflation Factor (VIF) values were below 1.15, whereas the tolerance statistics were above 0.87 (Hair et al., 2010). We also observed independence of errors (Durbin–Watson values were between 1.72 and 1.95). The six regression models' results were significant: Need to belong predicting paranormal beliefs, $F(6, 1047) = 93.40$, $p < .001$, adjusted $R^2 = 0.35$; intergroup anxiety predicting paranormal beliefs, $F(6, 1047) = 91.47$, $p < .001$, adjusted $R^2 = 0.34$; need to belong predicting conspiracy beliefs, $F(6, 1047) = 19.19$, $p < .001$, adjusted $R^2 = 0.09$; intergroup anxiety predicting conspiracy beliefs, $F(6, 1047) = 20.27$, $p < .001$, adjusted $R^2 = 0.10$; need to belong predicting pseudoscientific beliefs, $F(6, 1047) = 42.14$, $p < .001$, adjusted $R^2 = 0.19$; intergroup anxiety predicting pseudoscientific beliefs, $F(6, 1047) = 45.30$, $p < .001$, adjusted $R^2 = 0.20$. Moreover, β coefficients revealed a significant predictive value of need to belong and intergroup anxiety on all the antiscientific beliefs (see Table 1). Given our sample size ($N = 1{,}054$), the regression models would be sensitive to effects of $R^2 = 0.013$, with 80% power ($\alpha = .05$).

Discussion

The results of the pilot study show that both need to belong (positively) and intergroup anxiety (negatively) predict antiscientific beliefs. Even though the sizes of these effects are small, they suggest that ITT could constitute a fruitful interpretive framework for polarization over scientific facts, which motivated us to conduct subsequent studies administering a more comprehensive set of scales.

Interestingly, participants with higher levels of antiscientific beliefs also showed higher levels of need to belong, which indicates a stronger desire to be accepted by specific people, fear of criticism and rejection, and desire for social affiliation (Leary et al., 2013), whereas participants with lower levels of antiscientific beliefs ("critical thinkers") exhibited higher levels of intergroup anxiety, which indicates stronger perception of intergroup threat (Stephan & Stephan, 2017). Researchers tend to attribute the latter effect to the power relationships between groups. For

example, even though during political elections intergroup anxiety is similarly heightened across all parties, in a postelection context, supporters of the winning party tend to feel a buffer against intergroup anxiety because their conceptions have been legitimized and they have greater control over potential threats (Hackett et al., 2018). In this context, higher levels of anxiety among critical thinkers may be caused by a perception of greater capacity of antiscientific groups to influence public opinion, which is in line with previous research showing that the prevalence of antiscientific beliefs is vastly overestimated by the public (e.g., Levinston et al., 2013).

Study 1

Study 1 was focused on our first hypothesis: the positive predictive power of ITT for strong critical thinking—as a collective opposed to the dissemination of antiscientific conceptions. Therefore, Study 1 sampled critical thinkers and probed how they perceive groups of believers in pseudoscience. The questionnaire measured the ITT's components specified before: group belongingness, perceived threat, outgroup derogation, and intergroup anxiety.

Method

Sample. We recruited, through social networks (Facebook and Twitter), a sample of $N = 947$ Spanish speakers. The recruitment process was focused on groups related to Círculo Escéptico and Sociedad para el Avance del Pensamiento Crítico—the largest associations in the Spanish-speaking context promoting critical thinking, both located in Spain. Additionally, we relied on the help of science disseminators and blogs, such as *Microsiervos*. All participants gave their informed consent prior to their inclusion in the study; 15.6% of participants were women and 84.4% were men, with a combined average age of 39.38 years ($SD = 9.59$); 10.6% were religious and 89.4% were nonreligious; 19.7% had preuniversity education and 80.3% had university education. We measured participants' political orientation using a 10-point Likert scale (1 = *extremely left-wing,* 10 = *extremely right-wing; M* = 3.68, $SD = 1.90$).

Measures

Pseudoscientific beliefs. We administered the same 30-item Pseudoscientific Beliefs Scale used in the pilot study (Likert 1–5; item $M = 1.69$, $SD = 0.31$; $\alpha = .71$; Fasce & Picó, 2019).

Group belongingness. To assess group belongingness, we used a nine-item version of the three-dimensional Strength of Group Identification Scale, modified to measure how relevant opposition toward pseudoscience was for participants' social identity (Likert 1–6; item $M = 4.10$, $SD = 0.80$; $\alpha = .77$; e.g., "I feel strong ties to those who think like me about it," "In general, having this point of view is an important part of my self-image"; Cameron, 2004).

Outgroup derogation. To measure outgroup derogation toward pseudoscientific believers, we used an eight-item semantic differential questionnaire adapted from Lalonde (2002); participants indicated if they considered outgroup members to be, for example, dogmatic/receptive, authoritarian/flexible, and arrogant/humble (Likert 1–7; item $M = 5.70$, $SD = 0.83$; $\alpha = .83$).

Perceived threats. We also included an ad hoc scale to measure perceived threats elicited by pseudoscience (Likert 1–5; item $M = 3.92$, $SD = 0.75$; $\alpha = .89$). This scale includes both types of intergroup threat, five realistic (e.g., "Pseudoscientific believers. . ." ". . . introduce counterproductive and unfair legislation," ". . . can directly or indirectly harm other people") and five symbolic items (e.g., "Pseudoscientific believers . . ." ". . . try to dominate and impoverish our culture," ". . . spread negative stereotypes that humiliate us").

Intergroup anxiety. Lastly, to assess intergroup anxiety in relation to pseudoscientific believers, we administered the same six-item scale used in the pilot study (Likert 1–4; item $M = 2.59$, $SD = 0.63$; $\alpha = .75$; Paolini et al., 2004).

Table 2. Correlation analysis of sociodemographic variables, ITT-related variables, and pseudoscientific beliefs.

	1	2	3	4	5	6	7	8	9	10
1. Pseudoscientific beliefs		−.02	−.02	−.03	**.18*** **	.09**	**−.16*** **	**−.29*** **	.01	**−.11** **
2. Age			−.03	−.06	.01	.07*	.07*	.05	−.05	−.00
3. Sex				.10**	−.04	**−.13*** **	.01	.05	**.19*** **	.08*
4. Education					**.12*** **	.01	−.02	−.02	−.01	.06
5. Religious identity						**.32*** **	−.07*	−.04	−.02	−.06
6. Political orientation							−.08*	−.04	−.10**	**−.15*** **
7. Perceived threats								**.42*** **	.10**	**.20*** **
8. Outgroup derogation									.07*	**.19*** **
9. Intergroup anxiety										**.13*** **
10. Group belongingness										

Note. Sex is coded as 1 = male, 2 = female; education as 1 = preuniversity, 2 = university; religious identity as 1 = nonreligious, 2 = religious; political orientation as 1 = left-wing, 2 = right-wing. Results in bold are corrected via Bonferroni method at $p < .05$. ITT = integrated threat theory.
*$p < .05$. **$p < .01$. ***$p < .001$.

Results

Correlations between variables. Table 2 displays the intercorrelations between ITT-related variables. Only perceived threats and outgroup derogation were moderately correlated in this sample ($r = .42$, $p < .001$), with the remaining pairwise correlations being small in magnitude despite being significant. The weak effect sizes of the existing associations do not provide good prospects for the predictive power of ITT in this specific context. Given our sample size ($N = 947$), our data would be sufficient to reliably detect effects of $r = .09$, with 80% power ($\alpha = .05$, two-tailed).

Hierarchical multiple linear regression analysis on pseudoscientific beliefs. Regression analysis with pseudoscientific beliefs as the dependent variable confirmed that ITT-related variables were poor predictors of stronger critical thinking (see Table 3). In terms of assumption checks, the collinearity tests showed adequacy: All the VIF values were below 1.25, whereas the tolerance statistics were above 0.80 (Hair et al., 2010). We also observed independence of errors (Durbin–Watson = 1.91). Sociodemographic variables (age, sex, education, religious identity, and political orientation) were introduced in Model 1, $F(5, 941) = 7.13$, $p < .001$, adjusted $R^2 = 0.03$, confirming religious identity as a positive predictor of pseudoscientific beliefs ($\beta = .17$; $p < .001$). We next introduced ITT's components in Model 2, $F(9, 937) = 13.94$, $p < .001$, adjusted $R^2 = 0.11$; F-change$(4, 937) = 21.67$, $p < .001$, only confirming outgroup derogation as a significant predictor of stronger opposition toward pseudoscientific beliefs ($\beta = -.26$; $p < .001$). Given our sample size ($N = 947$), Model 1 would be sensitive to effects of $R^2 = 0.014$, with 80% power ($\alpha = .05$), whereas Model 2 would be sensitive to effects of $R^2 = 0.013$.

Discussion

The response of critical thinkers when facing antiscientific groups does not appear to be primarily based on reinforcing group attitudes. Despite the pilot study indicating that critical thinkers tend to manifest substantial levels of intergroup anxiety,

Table 3. Hierarchical multiple linear regression analysis with pseudoscientific beliefs as dependent variable.

Predictor variables	Pseudoscientific beliefs	
	Model 1 (adjusted $R^2 = 0.03$***)	Model 2 (adjusted $R^2 = 0.11$***; $\Delta R^2 = 0.08$)
Step 1		
Age	−0.03 [−0.00, 0.00]	−0.01 [−0.00, 0.00]
Sex	−0.01 [−0.06, 0.05]	0.00 [−0.05, 0.05]
Education	−0.05 [−0.09, 0.01]	−0.05 [−0.09, 0.01]
Religious identity	0.17*** [0.10, 0.24]	0.16*** [0.10, 0.22]
Political orientation	0.04 [−0.00, 0.02]	0.03 [−0.01, 0.02]
Step 2		
Perceived threats		−0.04 [−0.04, 0.01]
Intergroup anxiety		0.04 [−0.01, 0.05]
Group belongingness		−0.04 [−0.04, 0.01]
Outgroup derogation		−0.26*** [−0.12, −0.07]

Note. All regression coefficients are standardized β. Values in brackets show 95% confidence intervals (lower and upper limits). Sex was coded as 1 = male, 2 = female; education as 1 = preuniversity, 2 = university; religious identity as 1 = nonreligious, 2 = religious.
*$p < .05$. **$p < .01$. ***$p < .001$.

their response to perceived threat does not seem to be based on the psychological variables accounted for by ITT—perhaps because, as observed in Study 1, they do not seem to consider their criticism of pseudoscience as a central element of their social identity. These results suggest that the relationship between ITT and critical thinking is particularly complex, so future studies on how communities of critical thinkers cope with intergroup threat and anxiety, to identify potential variables suppressing ITT-related group processes, would be very welcome.

Despite the limited predictive power of the overall model, outgroup derogation positively predicted strengthened critical appraisal, showing that negative assessment of pseudoscientific doctrines may involve a motivational dimension based on negative stereotypes of pseudoscientific believers. Prior research consistently suggests that motivation mediates the transition from antiscientific to science-based conceptions (Dyer & Hall, 2017; Wilson, 2018). Our results could extend these previous findings, suggesting that outgroup derogation may also reinforce proscience dispositions (for related results on paranormal and conspiracy theories, see Ståhla & van Prooijen, 2018), although more research is needed to assess this potential causal pathway (e.g., higher outgroup derogation among strong critical thinkers could also be explained by greater understanding of the dangers and low epistemological status of pseudoscience).

Study 2

Study 2 was focused on our second hypothesis: The positive predictive power of ITT for antiscientific beliefs, in particular climate change denial. In this case, we recruited participants from a wide range of online communities—denying climate change, neutral regarding climate change, and accepting climate change—and probed how they perceive groups that accept anthropogenic climate change.

Sample

We recruited a sample of $N = 494$ Spanish speakers using social networks (Facebook and Twitter). Participants rejecting anthropogenic global warming were recruited through groups that disseminate antiscientific information on the

matter and groups of supporters of a right-wing Spanish party (VOX) that promotes climate change denial. To increase diversity, we also recruited participants through neutral groups (e.g., on psychology, philosophy, and journalism) and groups of people who disseminate scientific information about anthropogenic climate change—and, consequently, oppose climate change denial. All participants gave their informed consent prior to their inclusion in the study; 18.6% of participants were women and 81.4% were men, with a combined average age of 39.22 years ($SD = 13.31$); 26.5% had preuniversity education and 73.5% had university education; 27.5% were religious and 72.5% were nonreligious. We used a 10-point Likert scale (1 = *extremely left-wing*, 10 = *extremely right-wing*) to assess participants' political orientation ($M = 4.56$, $SD = 2.41$).

Measures

Climate change support. To measure climate change support, we used a one-dimensional, 15-item scale extracted from Cook et al. (2017), composed of three thematic dimensions assessed using a 5-point Likert scale: anthropogenic global warming acceptance (e.g., "Human CO2 emissions cause climate change"), trust in climate scientists (e.g., "I trust the things that scientists say about climate change"), and trust in dissenting scientists or independent researchers (e.g., "Scientists that challenge the mainstream view of climate change present an honest treatment of the scientific evidence"). To achieve this unification, these three dimensions were factorized by means of a principal component analysis (PCA). Since we were interested in a unique, higher order dimension, we fixed one factor to extract. The PCA revealed that this one-factor solution was suitable: The resulting scale showed sampling adequacy (KMO = 0.96; Bartlett's test: $\chi^2(105) = 6{,}177.99$, $p < .001$), whereas all the 15 items presented factor loadings > 0.65. Furthermore, the scale showed excellent internal consistency ($\alpha = .95$). The item mean of this scale was 3.34 ($SD = 1.03$). The resulting Climate Change Support Scale can be found in Table 4.

Perceived scientific consensus. We included a single-item measure of perceived scientific consensus ($M = 7.71$, $SD = 2.11$; "On a scale from 0 to 100%, how many climate scientists agree that human activity is causing global warming?"), using a 10-point Likert scale to assess participants' perception of agreement on anthropogenic global warming among climate scientists.

ITT-related variables. We also included modified versions of the scales used in Study 1 to measure ITT-related variables (adapted to the climate change context and aimed at assessing participants' perceptions of groups that accept anthropogenic climate change): perceived threats (Likert 1–5; item $M = 2.65$, $SD = 1.39$; $\alpha = .97$), outgroup derogation (Likert 1–7; item $M = 4.09$, $SD = 1.80$; $\alpha = .96$), group belongingness (Likert 1–6; item $M = 3.04$, $SD = 1.08$; $\alpha = .80$), and intergroup anxiety (Likert 1–4; item $M = 2.06$, $SD = 0.78$; $\alpha = .85$). Regarding intergroup anxiety, participants responded to the following question:

> If you were interacting with people (e.g., talking with them, working on a project with them) who argue that human activity is causing a climate change with dire consequences, how would you feel compared to occasions when you interact with people who argue that climate change, if there is any, is not related to human activity?

Results

Correlations between variables. Correlations between variables are displayed in Table 5. We found strong positive intercorrelations between ITT-related variables, with all these effect sizes above $r = .40$, and the associations between perceived threats and outgroup derogation ($r = .84$, $p < .001$) and perceived threats and group belongingness ($r = .72$, $p < .001$) being particularly strong. In addition, ITT-related variables were negatively correlated to climate change support and perceived scientific consensus (correlation coefficients ranging from $r = -.24$ to $r = -.83$),

Table 4. Factor loadings, means, and standard deviations of the 15 items included in the Climate Change Support Scale.

Item	Loading	*M* (*SD*)
1. The climate is always changing and what we are currently observing is just natural fluctuation. (R)	−0.86	3.38 (1.50)
2. Most of the warming over the last 50 years is due to the increase in greenhouse gas concentrations.	0.88	3.63 (1.42)
3. The burning of fossil fuels over the last 50 years has caused serious damage to the planet's climate.	0.88	3.74 (1.48)
4. Human CO2 emissions cause climate change.	0.86	3.40 (1.51)
5. Humans are too insignificant to have an appreciable impact on global temperature. (R)	−0.82	3.88 (1.42)
6. Climate scientists can be depended upon to help increase our understanding of what's happening to our climate.	0.76	3.99 (1.14)
7. Research that challenges the mainstream point of view is given honest treatment by the scientific community.	0.68	2.92 (1.33)
8. The process by which scientific papers are peer-reviewed and published is reliable.	0.72	3.37 (1.22)
9. Climate scientists are sincere in their research into climate.	0.82	3.47 (1.26)
10. I trust the things that scientists say about climate change.	0.83	3.72 (1.29)
11. Scientists that challenge the mainstream view of climate change present an honest treatment of the scientific evidence. (R)	−0.73	2.96 (1.20)
12. Information provided by scientists that dissent from mainstream climate science is not reliable.	0.68	2.86 (1.23)
13. Scientists that reject the scientific consensus on global warming can be depended upon to increase our understanding of what's happening to our climate. (R)	−0.71	2.92 (1.26)
14. Scientists who reject human-caused global warming are sincere in their scientific position. (R)	−0.73	3.05 (1.26)
15. I do not trust the things that scientists challenging the consensus view of climate change say about climate science.	0.66	2.86 (1.36)

Note. Items 1–5 correspond to anthropogenic global warming (climate belief); Items 6–10 correspond to trust in climate scientists; Items 11–15 correspond to trust in contrarian scientists. Reversed items are noted as (R).

suggesting good predictive power in this context. Given our sample size ($N = 494$), correlations would be sensitive to detect effects of $r = .13$, with 80% power ($\alpha = .05$, two-tailed).

Regression and mediation analyses on climate change support and perceived scientific consensus. We conducted two regression analyses with climate change support and perceived scientific consensus as dependent variables (see Table 6). The collinearity tests in both regressions showed adequacy: All the VIF values were below 4.33, whereas the tolerance statistics were above 0.23 (Hair et al., 2010). We also observed independence of errors (Durbin–Watson values were 2.07 and 2.05, respectively). In the first regression, with climate change support as the dependent variable, Model 1, $F(5, 488) = 35.19$, $p < .001$, adjusted $R^2 = 0.26$, confirmed sociodemographic variables as relevant predictors (particularly the well-documented negative association climate change support with right-wing political orientation), while Model 2, $F(9, 484) = 186.98$, $p < .001$, adjusted $R^2 = 0.77$; F-change$(4, 484) = 277.15$, $p < .001$, revealed that the variables related to ITT add substantial predictive power ($\Delta R^2 = 0.51$). Given our sample size ($N = 494$), Model 1 would be sensitive to detect effects of $R^2 = 0.025$, with 80%

Table 5. Correlation analysis of sociodemographic variables, ITT-related variables, climate change support, and perceived scientific consensus.

	1	2	3	4	5	6	7	8	9	10	11
1. Climate change support		−.12*	**.20***	.09*	**−.28***	**−.46***	**.63***	**−.81***	**−.83***	**−.47***	**−.74***
2. Age			.01	.10*	.07	−.06	−.11*	.07	.05	.07	.12**
3. Sex				**.19***	−.00	**−.20***	.07	**−.22***	**−.24***	**−.16***	**−.21***
4. Education					.03	−.07	.04	**−.15***	−.12**	−.04	−.13**
5. Religious identity						**.33***	**−.16***	**.21***	**.22***	.13**	**.25***
6. Political orientation							**−.26***	**.54***	**.56***	**.24***	**.40***
7. Perceived scientific consensus								**−.54***	**−.55***	**−.24***	**−.46***
8. Perceived threats									**.84***	**.46***	**.72***
9. Outgroup derogation										**.43***	**.66***
10. Intergroup anxiety											**.45***
11. Group belongingness											

Note. Sex is coded as 1 = male, 2 = female; education as 1 = preuniversity, 2 = university; religious identity as 1 = nonreligious, 2 = religious; political orientation as 1 = left-wing, 2 = right-wing. Results in bold are corrected via Bonferroni method at $p < .05$. ITT = integrated threat theory.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 6. Hierarchical multiple linear regression analyses with climate change support and perceived scientific consensus as dependent variables.

Predictor variables	Climate change support		Perceived scientific consensus	
	Model 1 (adjusted $R^2 = 0.26$***)	Model 2 (adjusted $R^2 = 0.77$***; $\Delta R^2 = 0.51$)	Model 1 (adjusted $R^2 = 0.08$***)	Model 2 (adjusted $R^2 = 0.33$***; $\Delta R^2 = 0.25$)
Step 1				
Age	−0.14*** [−0.02, −0.00]	−0.03 [−0.01, 0.00]	−0.12** [−0.03, −0.01]	−0.05 [−0.02, 0.00]
Sex	0.11** [0.09, 0.51]	−0.01 [−0.13, 0.10]	0.02 [−0.38, 0.57]	−0.06 [−0.73, 0.09]
Education	0.06 [−0.04, 0.33]	−0.02 [−0.15, 0.06]	0.03 [−0.25, 0.58]	−0.03 [−0.48, 0.24]
Religious identity	−0.14*** [−0.52, −0.14]	−0.08** [−0.28, −0.07]	−0.07 [−0.76, 0.09]	−0.03 [−0.51, 0.22]
Political orientation	−0.39*** [−0.20, −0.13]	0.06* [0.00, 0.05]	−0.24*** [−0.29, −0.13]	0.09 [−0.01, 0.16]
Step 2				
Perceived threats		−0.23*** [−0.24, −0.11]		−0.23** [−0.58, −0.13]
Intergroup anxiety		−0.05* [−0.13, −0.00]		0.05 [−0.10, 0.36]
Group belongingness		−0.25*** [−0.30, −0.18]		−0.13* [−0.46, −0.03]
Outgroup derogation		−0.46*** [−0.31, −0.22]		−0.34*** [−0.57, −0.24]

Note. All regression coefficients are standardized β. Values in brackets show 95% confidence intervals (lower and upper limits). Sex was coded as 1 = male, 2 = female; education as 1 = preuniversity, 2 = university; religious identity as 1 = nonreligious, 2 = religious.
*$p < .05$. **$p < .01$. ***$p < .001$.

power ($\alpha = .05$), and Model 2 would be sensitive to detect effects of $R^2 = 0.023$.

The second regression analysis, with perceived scientific consensus as the dependent variable, showed similar results, albeit with lower effect sizes than those obtained in relation to climate change support: Model 1, $F(5, 488) = 9.72$, $p < .001$, adjusted $R^2 = 0.08$, confirmed right-wing political orientation as a good predictor in the absence of ITT-related variables, introduced in Model 2, $F(9, 484) = 28.10$, $p < .001$, adjusted $R^2 = 0.33$; $\Delta R^2 = 0.25$; F-change$(4, 484) = 46.55$, $p < .001$. Following the same sensitivity power criteria described for the climate change support regression models, we also confirmed the reliability of Model 1 and Model 2 for perceived scientific consensus.

Both regression analyses suggest that, despite being one of the most thoroughly documented predictors of climate change denial, right-wing political orientation lacks predictive power in Model 2. To analyze these interesting results in greater depth, we carried out a series of simple mediation analyses by means of the PROCESS macro (Version 3.4), to assess the indirect effect of each ITT-related variable via bootstrapping (95% confidence intervals; number of bootstrap samples: 5,000). The negative associations of right-wing political orientation with climate change support ($\beta = -.46$) and perceived scientific consensus ($\beta = -.26$) are fully mediated by perceived threats (indirect effects: −0.43, 95% CI [−0.50, −0.36] and −0.30, 95% CI [−0.36, −0.24], respectively) and outgroup derogation (indirect effects: −0.46, 95% CI [−0.52, −0.40] and −0.32, 95% CI [−0.38, −0.27]). These analyses also revealed the partial mediational effects of group belongingness (indirect effects: −0.27, 95% CI [−0.33, −0.21] and −0.17, 95% CI [−0.22, −0.12]) and intergroup anxiety (indirect effects: −0.09, 95% CI [−0.13, −0.05] and −0.05, 95% CI [−0.08, −0.02]) between right-wing political orientation and climate change support.

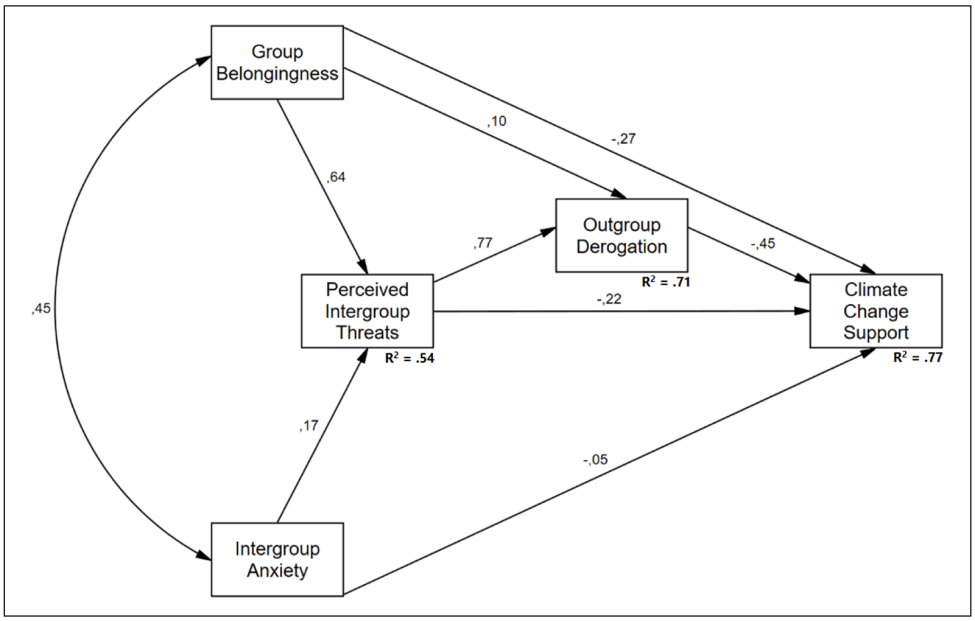
Modelling climate change denial and consensus gap. We conducted exploratory path analyses to assess to what extent ITT fits our data. Despite the relationships among ITT-related variables being highly contextual and reciprocal (Stephan & Stephan, 2017), we followed two principles when designing the model: (a) group belongingness, as an antecedent factor that gives rise to the existence of an ingroup and an outgroup with distinctive identities, affect, and ties, should be at the beginning of the path (Cameron, 2004; Stephan & Stephan, 2000); and (b) prior evidence consistently suggests that perceived threat is a causal antecedent to outgroup derogation (Schlueter et al., 2008). These analyses were carried out with the IBM SPSS Amos 25 software. Figure 3 depicts the model under study with climate change support as the dependent variable. The model showed excellent fit based on conventional standards: $\chi^2(1) = 1.29$, $p = .26$; TLI and CFI > 0.99; RMSEA $= 0.02$; SRMR $= 0.007$.

In addition, as can be seen in Figure 4, the model also fits very well in relation to perceived scientific consensus: $\chi^2(1) = 1.29$, $p = .26$; TLI and CFI > 0.99; RMSEA $= 0.02$; SRMR $= 0.006$. These results suggest that ITT may be an underlying sociopsychological framework for rejection of anthropogenic global warming.

General Discussion

The reported results offer mixed support for our hypotheses. On one hand, despite the pilot study suggesting that critical thinkers tend to show slightly higher levels of intergroup anxiety, Study 1 suggested poor performance of ITT-related constructs among participants, as the model only explained 9% of disbelief in pseudoscientific doctrines—outgroup derogation was the only significant predictor, although its causal relationship with critical thinking remains unclear. We consider that these results highlight a need for studies on the coping strategies of groups of critical thinkers, in order to investigate how they deal with intergroup threat. On the other hand, Study 2 revealed the strong predictive power of ITT for climate change denial, thus being consistent with the exploratory results of the pilot study on the positive predictive power of need to belong for antiscientific beliefs.

Figure 3. Data modelling taking climate change support as dependent variable.



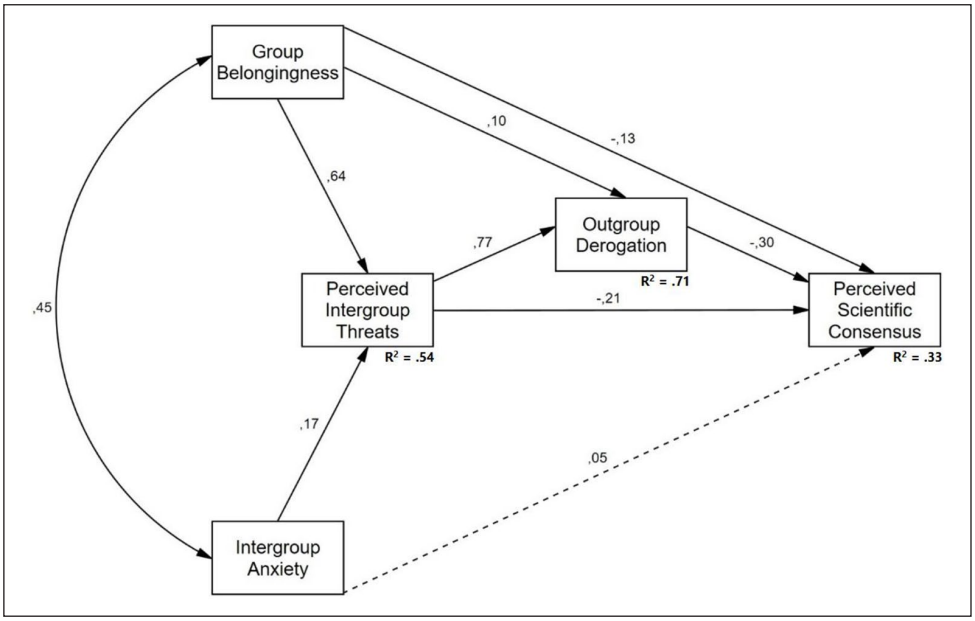
Note. Path analysis revealed excellent fit indices: $\chi^2(1) = 1.29$, $p = .26$; TLI and CFI > 0.99; RMSEA = 0.02; SRMR = 0.007. Values represent standardized β. All links resulted significant at $p < .05$. Error variables are not displayed.

Perceived Threat and the Conspiracy of Scientists

There is a wide corpus of research highlighting the role of group belongingness and perceived threats in conspiracy theories (Federico et al., 2018; Mashuri et al., 2016; van der Linden et al., 2020; van Prooijen, 2015). In effect, van Prooijen (2020) has developed a comprehensive intergroup threat-based model in which distressing social events stimulate conspiracism when antagonistic outgroups are salient. Believing in the existence of secret, powerful, and evil outgroups perpetuates and exacerbates feelings of uncertainty and existential threat (Douglas et al., 2017), so conspiracy theories tend to backfire, being a source of threat in themselves to their own supporters. This situation facilitates a feedback loop that gives rise to a generalized conspiracist worldview (Imhoff & Bruder, 2014; van der Linden et al., 2020; van Prooijen, 2020)—in fact, prior studies have found that the best predictor of belief in one conspiracy theory is belief in another conspiracy theory (Abalakina-Paap et al., 1999; Goertzel, 1994).

Besides its function to justify the legitimacy of ingroup identity and values (Jolley et al., 2018), the prototypical form of intergroup representation that lies at the root of conspiracy theories also provides perceived epistemic justification for antiscientific conceptions of climate change, vaccination, AIDS, and GMOs (Jolley & Douglas, 2014; Nattrass, 2013; Uscinski et al., 2017). Conspiracy theories about scientific information give rise to the kind of epistemic defense mechanisms that characterize self-validating belief systems (Boudry & Braeckman, 2012; Lewandowsky et al., 2015), so contrary evidence is often interpreted as evidence of a conspiracy—for instance, conspiracy theorists typically argue that the match between the official story and the available evidence is indeed predicted by their theory, thus characterizing contradicting evidence as being, consciously or unconsciously, part of the alleged secret plot. Accordingly, conspiracism reduces the existing dissonance between denial and expert

Figure 4. Data modelling taking perceived scientific consensus as dependent variable.



Note. Path analysis revealed adequate fit values: $\chi^2(1) = 1.29$, $p = .26$; TLI and CFI > 0.99; RMSEA $= 0.02$; SRMR $= 0.006$. Values represent standardized β. Solid links resulted significant at $p < .05$, whereas dashed links were nonsignificant. Error variables are not displayed.

consensus, turning contrary information into confirmatory evidence (Lewandowsky et al., 2018).

The aforementioned results on conspiracist ideation fit well with our data on ITT-related group processes, suggesting a nomological network in which perceived intergroup threat would foster forms of science rejection involving strong conspiracism. In this regard, as can be seen from the mediation analyses conducted in Study 2, it would be interesting to design and deploy interventions aimed at making science less threatening when it comes into conflict with ideological assumptions, including inoculation strategies, as well as worldview and values affirmation interventions (Hornsey & Fielding, 2017; Lewandowsky & van der Linden, 2021).

Polarized Identities Underlie Antiscientific Political Campaigns

There is an interesting distinction between psychological and ideological partisan alignment over the authority of science (Rekker, 2021). On one hand, psychological rejection of science takes place implicitly, through the denial and accommodation of scientific data that are inconsistent with social identities, so the psychological rejection of science arises from individuals' tendency to favor information that maintains their status in an affinity group. In this regard, our results in Study 2 suggest strong identity formation around deviant conceptions of climate science. Consequently, this article also offers a potential explanatory framework for the previously reported associations of antiscientific beliefs with authoritarianism, consistent with the underlying group dynamics described by ITT (Fasce et al., 2020; Richey, 2017; Wood & Gray, 2019)—for example, authoritarianism has been described as a group phenomenon that boosts dogmatism by means of amplifying perceived threats (Cohrs & Ibler, 2009; Feldman & Stenner, 1997; Stellmacher & Petzel, 2005).

On the other hand, ideological rejection (religious, political, organizational, etc.) consists of explicit contestation of science through arguments derived from complex doctrines (Nisbet et al., 2015)—for example, climate change countermovement organizations and lobbies produce ideology-driven arguments to oppose carbon dioxide regulations (McKie, 2019). In this regard, Lewandowsky et al. (2020) found that well-known instances of science denial are fueled by distinctive ideological worldviews—for instance, climate change denial and antivaccination are both predicted by conservatism. Prior results have shown that political polarization triggers higher levels of dogmatism, desirability bias, and judgmental shortcuts (Gastil et al., 2011; Tappin et al., 2017).

There is mutual feedback between psychological science rejection (accounted for, at the group level, by our general ITT-based model) and ideological contestation (accounted for by ideology-specific studies focused on antiscientific political campaigns): ideologues generate explicit arguments that reinforce and exploit already existing group identities, whereas group identity constrains ideology's persuasiveness by determining individuals' receptivity (Cohen, 2003). In this regard, there is an extensive literature on how group identities become politicized and ideologies spread because of basic human motives, functioning as prepackaged units of interpretation for shared realities and interpersonal relationships (Huddy, 2015; Jost et al., 2008). This tendency is illustrated in Study 2, as climate change denial shows clear indicators of a politicized, antiscientific group identity—with the ITT-related variables positively linked to right-wing political orientation (correlation coefficients ranging from 0.24 to 0.56).

Limitations

These results must be taken with some caution. Firstly, the choice to focus on affinity groups—because they are most likely to show the phenomena of interest—reduces the generalizability of the findings. Not only were these individuals more likely to have more extreme beliefs than average, but their membership in online groups suggests that these beliefs were likely part of their self-concept. Further studies should test if the average person's science beliefs would be similarly influenced by intergroup threat processes. Secondly, as we were interested in special populations such as critical thinkers and antiscientific groups, unavoidable sample asymmetries (e.g., greater number of men, more university educated, and more nonreligious participants) should be balanced in future studies to confirm that they did not confound our results. Our interest in special populations could be particularly relevant in relation to Study 1, as the sample was below the midpoint of the scale on pseudoscientific beliefs. Thirdly, the hypothesized causal pathways are based on correlational results and should be confirmed experimentally. Lastly, although we have successfully tested a sociopsychological model with predictive power for climate change denial, it would be valuable if future research replicates and extends these results to other antiscientific movements.

Concluding Remarks

Across three studies, we found that group dynamics around belongingness and threat are key to explain denial of scientific facts, but not critical thinking. We interpret this group-based model of belief polarization as a potential source of motivated reasoning, capable of explaining recalcitrant instances of science rejection. As it can be argued that there is no successful ideological science rejection without a proper underlying psychological context, the kind of relational dynamics accounted for by ITT would set the foundations of successful politically driven contestation of science. Accordingly, the current landscape of belief polarization demands more institutional efforts focusing on the intersection between social identity and science communication.

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Note

1. Throughout this article, respondents opposed to antiscientific conceptions will be referred to as "critical thinkers." We are not measuring specific cognitive ability or reasoning skills, instead, we use the term "critical thinking" in a broad sense, denoting disbelief in antiscientific conceptions.

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