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# Ideological predictors of anti-science attitudes: exploring the impact of group-based dominance and populism in North America and Western Europe

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This research examined individual-level ideological variables as predictors of anti-science attitudes, encompassing a lack of acceptance, belief, and trust in science as an institution and source of knowledge. We specifically focused on ideologies associated with group-based dominance and populism while also considering conventional predictors like scientific literacy, symbolic ideology, and partisanship. Study 1 was an original survey (U.S. participants,  $N = 700$ ), which replicated prior research showing that political conservative identity and attitudes favoring group-based dominance most strongly predicted anti-science attitudes. In contrast, populist attitudes had no substantial effect. In Study 2, analyzing data from the Dutch LISS Panel ( $N = 2,186$ ), group-based dominance attitudes, specifically with regard to gender, as well as populist attitudes and conspiracy beliefs, emerged as the most prominent factors predicting anti-science attitudes. These studies speak to the role of group-based dominance attitudes in undermining the perceived validity of science, as observed in both North American and Western European samples. Whether these results reflect more consistent patterns or are specific to particular countries and cultural contexts is not clear, emphasizing the need for future research on how these ideologies shape and perpetuate anti-science attitudes.

## KEYWORDS

anti-science, ideological variables, group-based dominance, populism, science communication

## 1 Introduction

Addressing global crises such as anthropogenic climate change and pandemics, among many other topics, relies on well-established scientific evidence. However, for science to fulfill its role as an evidence-based foundation for decision-making and problem-solving, it requires widespread acceptance, belief, and trust in its principles (Hendriks et al., 2016). In contrast, anti-science attitudes can be defined as viewpoints or beliefs that are mistrustful of or opposed to the principles, methods, or findings of science (e.g., Lewandowsky et al., 2013a; Jylhä et al., 2022). Such attitudes can pose tangible and substantial risks in domains like public health, the environment, and technological progress and innovation (Lewandowsky and Oberauer, 2016, 2021). From a democratic perspective, anti-science can undermine core principles such as evidence-based decision-making, trust in democratic institutions, and the accountability of elected officials. Therefore, identifying the antecedents of these attitudes is imperative to safeguarding the integrity of democratic systems, the wellbeing of individuals and society, and effectively confronting the complex challenges of our time.

While global trust in science and scientists is generally high (Wellcome Global Monitor, 2018, 2020; Nisbet and Nisbet, 2019; Funk et al., 2020), the polarization over science along political lines has grown increasingly concerning in recent years. Most research on this polarization has been conducted in the United States, where there has been a notable increase in mistrust of science among political conservatives over the past few decades, a trend not observed among liberals (Gauchat, 2012). Research in the U.S. has consistently shown a link between anti-science attitudes and political conservatism (e.g., Rutjens et al., 2018a; Azevedo and Jost, 2021; Kerr and Wilson, 2021). A parallel trend has emerged regarding partisanship, with trust in science declining among Republicans but increasing among Democrats since 2018 (Associated Press-NORC Center for Public Affairs Research, 2023; Davern et al., 2023), and from 1974 to 2018, Democrats have exhibited a notable rise in their trust in science compared to both independents and Republicans (Lee, 2021).

As it seems, science attitudes increasingly align with political identities rather than being primarily influenced by factors such as education or scientific literacy (Rutjens et al., 2018b, 2022; Hornsey, 2020). This may prompt individuals to defend and bolster their positions (Garrett et al., 2019). The attitude roots model of science rejection (Hornsey and Fielding, 2017) explains anti-science attitudes through motivated reasoning (Kunda, 1990), where individuals selectively process information to support their existing beliefs. Within this framework, attitude roots, commonly represented by ideologies, play a central role in shaping and sustaining anti-science attitudes.

Here we focus on ideological predictors of non-domain-specific anti-science attitudes. While some individuals reject certain fields or findings, such as opposing vaccination or denying climate change (e.g., Rutjens et al., 2018a, 2022; Rutjens and van der Lee, 2020), others may believe that science, in general, is untrustworthy or fundamentally flawed in some ways. Previous research has shown that various forms of anti-science attitudes correlate with diverse ideologies (e.g., Pechar et al., 2018; Rutjens et al., 2018b, 2022; Washburn and Skitka, 2018; Rutjens and van der Lee, 2020; Schröder, 2022). However, overarching anti-science attitudes tend to mediate the effect of different ideological variables when predicting anti-science attitudes across domains (Rutjens et al., 2018a, 2022; Rutjens and van der Lee, 2020; Večkalov et al., 2023).

Although there is no “grand unified theory” of anti-science attitudes (Hornsey and Fielding, 2017), recent arguments suggest that these attitudes often originate from a broader attitude root emphasizing tradition, stability, and hierarchy (Kerr and Wilson, 2021). We focus on hierarchy and social dominance orientation (SDO) within Kerr and Wilson’s argument. SDO, rooted in social dominance theory (Sidanius and Pratto, 1999), measures individuals’ acceptance of social hierarchies and the dominance of superior groups over inferior groups (Pratto et al., 1994). This motivation to maintain hierarchies primarily targets groups perceived as hierarchy-attenuating and subordinate, including ethnic minorities and immigrants, and those challenging mainstream norms and values, like feminists (e.g., Duckitt and Sibley, 2007; Lee et al., 2011; Pratto et al., 2013). SDO shapes ideological and partisan identities, such as conservative or liberal, Republican or Democrat (Hornsey, 2021), and is associated with

conservative political views (Pratto et al., 1994; Jost et al., 2003; Duckitt and Sibley, 2009).

Recent U.S. and New Zealand studies have shown that SDO predicts rejection of various scientific consensus and lower trust in scientists (Azevedo and Jost, 2021; Kerr and Wilson, 2021). This adds to the more established association between SDO and climate change denial (Häkkinen and Akrami, 2014; Jylhä and Akrami, 2015; Jylhä et al., 2016, 2021; Stanley and Wilson, 2019; Hornsey, 2021). Further evidence linking the endorsement of social hierarchies to anti-science attitudes can be found in the science communication theory of cultural cognition, which distinguishes between individuals’ cultural worldviews as hierarchy-egalitarianism (e.g., Kahan, 2010). Those favoring a hierarchical societal structure are less likely to trust scientists (Hartman et al., 2017) and more skeptical of scientific consensus in various domains (e.g., Kahan et al., 2011, 2012).

The reasons why individuals with stronger group-based dominance attitudes hold more anti-science attitudes are not clear. Social dominance theory suggests that institutions can either amplify or attenuate social hierarchies, with universities falling into the latter category (Sinclair et al., 1998). Given that most science originates from universities, Kerr and Wilson (2021) suggested that individuals with higher SDO might be more prone to anti-science attitudes due to the hierarchy-attenuating aspect conflicting with the motivation to restore social hierarchies (Sidanius and Pratto, 1999). For example, these attitudes may be at odds with the principles of meritocracy and equitable opportunities within the university context, as outlined in Article 26 of the *Universal Declaration Human Rights* (1948): “Higher education shall be equally accessible to all on the basis of merit,” ideally promoting social mobility regardless of one’s social background.

Furthermore, science tends to symbolize human progress—that societies can improve, develop, and evolve over time (Farias et al., 2013). This concept may be incompatible with the desire to maintain the prevailing social order. Scientific discoveries have the potential to challenge established hierarchies and entrenched power structures in society. For example, science can highlight societal problems and inefficiencies, providing evidence for the need to reform policies or governance structures. International agencies like UNESCO (the United Nations Educational, Scientific and Cultural Organization) (2023) emphasize this aspect of science by explicitly highlighting science’s role in driving more equitable development in areas such as healthcare, education, and access to information.

However, as Kerr and Wilson (2021) note, perceptions of science and its role in advancing equality can vary due to personal beliefs, experiences with science, and the cultural and social context. Some cultures may see science as a driver of progress and improvement, while others may be skeptical, especially if they perceive it as challenging traditional beliefs and practices. Historical interactions between cultures and science can also influence current perceptions. Science’s historical use to justify discrimination, oppression, and inequality (Jackson et al., 2005) might impact how it is seen in addressing social disparities. Considering these contextual variations, one can imagine that science could also be perceived as aligned with the societal dominant group or elite rather than pushing for equality. Therefore, it is worth exploring how anti-science attitudes relate to another ideological framework: populism.

Populism, defined by the ideational approach, comprises three core components: opposition to elites, people's sovereignty, and a Manichean worldview (Mudde, 2004, 2017; Hawkins and Kaltwasser, 2018). In contrast to group-based dominance ideologies, including SDO, which emphasize preserving social hierarchies, populist ideology leans toward "flattening hierarchies" (Pellegrini, 2023). Unlike SDO, which categorizes society into inferior and superior groups (Pratto et al., 1994), populist ideology views all "ordinary people" as a homogeneous entity, with the elite seen as the adversary (e.g., Hawkins and Kaltwasser, 2018).

Although there is a growing body of scholarly work on populism (Hunger and Paxton, 2022), there remains a paucity of empirical research exploring the association between populist ideology and anti-science attitudes (Giorgi and Eslen-Ziya, 2022). However, some scholars have suggested a link between populist worldviews and anti-science attitudes (e.g., Mede and Schäfer, 2020; Jylhä et al., 2022), rooted in populism's opposition to elites and mistrust of not only social institutions (Rydgren, 2017) but also scientists and experts (Merkley, 2020). Studies have demonstrated that this skepticism can lead to questioning well-established science, such as anthropogenic climate change (Huber, 2020; Huber et al., 2022). Within the context of anti-science, populism's emphasis on the power and will of the "common people" can be understood as being linked to valuing common-sense knowledge and folk wisdom over scientific expertise (Mede and Schäfer, 2020). And the Manichean outlook inherent to populism, pitting "the good people" against "the evil elite," may extend to the realm of science, framing a conflict between allegedly virtuous ordinary people and an allegedly unvirtuous academic elite (Mede and Schäfer, 2020). Collectively, this framework has been referred to as "science-related populism" (Mede and Schäfer, 2020), which empirically partly overlaps with political populism (Eberl et al., 2023).

Populist attitudes share common elements with beliefs in conspiracy theories, such as the perceived secretive coordination among actors and skepticism toward social institutions (Rydgren, 2017; Douglas and Sutton, 2023). In line with this, several studies show that populist attitudes correlate with belief in conspiracy theories (Castanho Silva et al., 2017; Eberl et al., 2021; Erisen et al., 2021; Marcos-Marne et al., 2022). Drawing on the attitude root model (Hornsey and Fielding, 2017), belief in conspiracy theories is identified as another root of anti-science attitudes, corroborated by a significant body of research (e.g., Lewandowsky et al., 2013a,b; Jolley and Douglas, 2014; Hornsey et al., 2018; Rutjens and van der Lee, 2020).

To summarize, this article seeks to predict anti-science attitudes—the overall lack of belief, trust, and acceptance of science—by examining various individual-level ideological variables. While previous research mainly focuses on mainstream political contexts (Jylhä et al., 2022), our focus is on ideologies related to group-based dominance and populism. In Study 1, we report the results of an original online survey using an American sample ( $N = 700$ ). Our aim here is twofold: first, to replicate recent research on the contribution of group-based dominance attitudes (Azevedo and Jost, 2021; Kerr and Wilson, 2021), and second, to investigate the relationship between populist ideology and attitudes toward science, addressing a current gap in the

literature. In Study 2, we analyze data from the Dutch LISS Panel ( $N = 2,186$ ). Our aim here is to extend the outcomes observed in Study 1 in a Western European context, given that most research on anti-science attitudes has been confined to the U.S. and other English-speaking countries (Rutjens and van der Lee, 2020).

## 2 Study 1: U.S. survey

### 2.1 Method

#### 2.1.1 Participants

All data was collected in February 2023 using an online questionnaire developed in Qualtrics. Participants were recruited and participated through the online data collection platform Prolific. Prolific is a website that connects researchers with participants. The sample consisted of 700 participants from the United States ( $M_{\text{age}} = 40.77$ ,  $SD_{\text{age}} = 13.53$ ), who received a payment of \$16.39 per hour for completing the questionnaire, which took  $\sim 7$  min (see [Supplementary material](#) for demographics).

#### 2.1.2 Measures

All items described below were scored on scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), and mean scores were calculated for each scale, unless stated otherwise (see [Table 1](#) for scale properties and [Supplementary material](#) for the item list).

The outcome variable, anti-science attitudes, was measured using five items (Farias et al., 2013; see Rutjens et al., 2022 for use of the five-item scale). These items measure participants' overarching belief, trust, and acceptance of science as a reliable and superior path to knowledge; for example, "Science is the most efficient means of attaining truth" (note that higher values indicate more pro-science attitudes).

The ideological variables included symbolic ideology, partisanship, populist attitudes, and attitudes on group-based dominance. Symbolic ideology, conceptualized as political conservatism, was assessed using a self-placement scale ranging from 1 (*clearly liberal*) to 7 (*clearly conservative*). Participants were also asked which party they liked the most (*the Republican party*, *the Democratic party*, or *none/other*), which was coded as two dummy variables with none/other as the reference category.

Populist attitudes were measured by the six-item scale from Akkerman et al. (2014), for example, "The people, and not politicians, should make our most important policy decisions." These items aim to capture both the political focus on the people and the perceived corruption of the political elite.

To capture attitudes toward group-based dominance, we included a measurement of SDO as well as negative attitudes toward gender equality, homosexuality, and multiculturalism. SDO was measured using the four-item short scale from Pratto et al. (2013) (see Aichholzer and Lechner, 2021 for recent adaptation and validation), for example: "In setting priorities, we must consider all societal groups" (reverse-coded). The items on anti-gender equality, homosexuality, and multiculturalism were all adopted from Jylhä and Hellmer (2020). Anti-gender equality included two items, for example: "Feminist

TABLE 1 Study 1 descriptive statistics for the main variables.

Variable	Valid	Missing	M	SD	Skewness	Kurtosis	$\alpha$	$\omega$
Science attitudes	700	0	4.16	1.56	-0.09	-0.84	0.89	0.90
Group-based dominance attitudes	693	7	3.05	1.40	0.46	-0.43	0.92	0.92
Political conservatism	700	0	3.94	1.94	-0.12	-1.15		
Populist attitudes	700	0	5.32	0.96	-0.33	-0.04	0.75	0.75
Scientific literacy	699	1	6.14	1.62	-0.73	-0.03	0.58	0.58

messages create a worrying development in society”; as did anti-homosexuality, for example: “Marriage as an institution is diluted when the church marries homosexual couples”; and anti-multiculturalism consisted of four items, with one of the items originally from Müller et al. (2014): “In society, too much consideration is given to different minorities than to the people as a whole.”

We conducted an exploratory factor analysis to see whether SDO, anti-gender equality, homosexuality, and multiculturalism shared a common underlying structure as suggested by prior research (Duckitt and Sibley, 2007; Lee et al., 2011; Pratto et al., 2013). The analysis revealed a one-factor solution, explaining 52% of the variance, with all 12 items loading on this factor. Thus, all 12 items were combined into a mean index, which we refer to as group-based dominance (loadings  $\geq 0.62$ ; see Supplementary material).

We also included a measurement of participants’ scientific literacy, as it has been found in previous research to explain some variance in science attitudes (Rutjens et al., 2018b, 2022; Hornsey, 2020). Participants answered true or false claims about eight uncontested scientific facts, originally from Hayes and Tariq (2000) (see Rutjens et al., 2022 for use of the eight-item scale), for example: “The center of the earth is very hot.” The binary answers were summed up to an additive index ranging from 0 to 8, with higher scores indicating higher scientific literacy (i.e., a higher frequency of correct answers).

Lastly, we included a set of demographic variables. Gender was coded as a dummy variable (1 for men, 0 for women, non-binary, and blank), and race was coded as a dummy variable (1 for White or Caucasian, 0 for other). Age and education were treated as continuous variables, with higher scores representing older age and higher levels of completed education, respectively.

## 2.2 Results

A total of 14 cases were missing, and participants with missing data were excluded on an analysis-by-analysis basis. Descriptive statistics and inter correlations are presented in Tables 1, 2. The outcome variable, (anti)science attitudes, was significantly correlated with all other variables except education, race, and populist attitudes. Anti-science attitudes correlated with older age, Republican affiliation, political conservatism, and group-based dominance. Conversely, gender (men), Democrat

affiliation, and scientific literacy were correlated with more pro-science attitudes.

To predict (anti)science attitudes, we conducted a hierarchical linear regression analysis (see Table 3 for coefficients; VIF values ranged from 1.04 to 2.85, and tolerance values ranged from 0.35 to 0.96). In Step 1, including age, gender, education, race, Democrat affiliation, Republican affiliation, political conservatism, and scientific literacy, political conservatism emerged as a significant predictor of anti-science attitudes, followed by a smaller effect of age. Gender and a modest effect of scientific literacy significantly predicted pro-science attitudes. Together, these variables explained 23% of the variance [ $F_{(8,680)} = 26.57, p < 0.001, \text{adj. } R^2 = 0.23$ ].

In Step 2, with the addition of group-based dominance, the effects of political conservatism and age decreased, while the effect of gender increased, and scientific literacy was no longer a significant predictor. Group-based dominance emerged as a significant predictor of anti-science attitudes and contributed an additional 2% to the explained variance [ $\Delta F_{(1,679)} = 21.59, p < 0.001, \text{adj. } R^2 = 0.25, \Delta R^2 = 0.02$ ]. In the third step, introducing populist attitudes, the effects of the previously listed predictors remained unaffected. However, populist attitudes did not demonstrate a significant effect [ $\Delta F_{(1,678)} = 0.80, p = 0.371, \text{adj. } R^2 = 0.25, \Delta R^2 = 0.00$ ].

In sum, the bivariate correlations demonstrated that older participants, Republicans, political conservatives, and individuals with stronger group-based dominance attitudes tended to report more anti-science attitudes. When considering all variables simultaneously, political conservatism and group-based dominance had the most substantial effects. Notably, populist attitudes did not significantly predict attitudes toward science.

## 3 Study 2: LISS panel

Next, we sought to test whether the results obtained in Study 1 could be generalized beyond the U.S. To this aim, we analyzed data from the LISS Panel (Longitudinal Internet Studies for the Social Sciences) administered by Centerdata (Tilburg University, the Netherlands) to conceptually replicate and extend our findings. We identified measures of science attitudes, group-based dominance attitudes, populist attitudes, and demographics. Unlike Study 1, this dataset did not include any items on SDO, scientific literacy, or political conservatism. Instead, we included a measure on left-right political identification. We also broadened our examination by including conspiracy beliefs.

TABLE 2 Study 1 Pearson's correlations.

Variable	1	2	3	4	5	6	7	8	9	10									
1. Science attitudes																			
2. Age	-0.24	***																	
3. Gender (men)	0.16	***	-0.13	***															
4. Education	-0.01		0.15	***	0.06														
5. Race (White or Caucasian)	-0.07		0.30	***	-0.06		-0.04												
6. Democrat	0.33	***	-0.22	***	-0.04		0.05		-0.20	***									
7. Republican	-0.30	***	0.32	***	0.06		0.08	*	0.30	***	-0.67	***							
8. Political conservatism	-0.42	***	0.28	***	0.07		0.06		0.23	***	-0.71	***	0.75	***					
9. Scientific literacy	0.12	**	0.07		0.03		0.14	***	0.05		0.07		-0.04		-0.10	**			
10. Group-based dominance attitudes	-0.41	***	0.24	***	0.15	***	0.05		0.14	***	-0.56	***	0.59	***	0.74	***	-0.12	**	
11. Populist attitudes	0.04		-0.10	*	-0.06		-0.05		-0.09	*	0.02		-0.06		-0.06		-0.00		-0.03

Pairwise deletion was used for missing cases. \* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

TABLE 3 Study 1 hierarchical linear regression predicting science attitudes.

	Step 1		Step 2		Step 3	
	B (SE)	$\beta$	B (SE)	$\beta$	B (SE)	$\beta$
(Constant)	4.90 (0.34)***		5.21 (0.35)***		4.92 (0.47)***	
Age	-0.02 (0.00)***	-0.13	-0.01 (0.00)**	-0.12	-0.01 (0.00)**	-0.12
Gender (men)	0.53 (0.11)***	0.17	0.61 (0.11)***	0.19	0.62 (0.11)***	0.20
Race (White or Caucasian)	0.22 (0.13)	0.06	0.18 (0.13)	0.05	0.19 (0.13)	0.05
Education	0.01 (0.06)	0.01	0.01 (0.05)	0.01	0.01 (0.05)	0.01
Democrat	0.26 (0.16)	0.08	0.22 (0.16)	0.07	0.22 (0.16)	0.08
Republican	0.19 (0.17)	0.06	0.25 (0.17)	0.08	0.25 (0.17)	0.08
Political conservatism	-0.32 (0.05)***	-0.39	-0.20 (0.05)***	-0.25	-0.20 (0.05)***	-0.25
Scientific literacy	0.08 (0.03)*	0.08	0.06 (0.03)	0.07	0.06 (0.03)	0.07
Group-based dominance attitudes			-0.26 (0.06)***	-0.23	-0.26 (0.06)***	-0.23
Populist attitudes					0.05 (0.05)	0.03

Negative coefficients signify anti-science, and positive coefficients indicate pro-science. Pairwise deletion was used for missing cases. \* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

## 3.1 Method

### 3.1.1 Participants

We analyzed data from a single-wave study conducted by the LISS panel in January 2020 on political and social attitudes in the Netherlands (project number 321). This data was merged with another dataset from the LISS Panel on background variables conducted in the same month. The LISS panel comprises Dutch households and individuals who participate in online questionnaires, with all data accessible through the LISS data archive. The sample, representing individuals who fully responded to the relevant items in both sets of questionnaires, consisted of 2186 participants [ $M_{\text{age}} = 55.2$  years,  $SD_{\text{age}} = 17.5$ ,  $\text{range}_{\text{age}} (18-93)$ ; 54.1% women; 63% with a college or university degree].

### 3.1.2 Measures

The items listed below were identified as relevant to the aim of the current research and were scored on scales ranging from 1 (*completely disagree*) to 7 (*completely agree*), unless otherwise indicated, and we then calculated the mean scores (see Table 4 for scale properties and Supplementary material for the item list).

Our outcome variable, anti-science attitudes, was conceptualized as lower trust in science and measured using a single item: “How much do you trust the following institutions or persons?” (science), scored on a scale from 1 (*no trust at all*) to 7 (*complete trust*; i.e., higher values indicate higher trust in science). Parallel to Study 1, the ideological variables on group-based dominance attitudes encompassed the following components: anti-gender equality, measured using one item: “It is unnatural when women hold a position of authority over men in a firm”; anti-homosexuality, measured using one item: “Homosexuals should be left as free as possible to live their own lives” (reverse-coded); and anti-multiculturalism, measured using four items, for example,

“Cultural life in the Netherlands is generally enriched by people coming to live here from other countries” (reverse-coded).

Similar to our approach in Study 1, we performed an exploratory factor analysis on the items pertaining to negative attitudes toward gender equality, homosexuality, and multiculturalism. The analysis suggested a two-factor solution, explaining 32% of the variance. All four items on anti-multiculturalism loaded onto Factor 1 ( $\geq 0.46$ ), and the two items on anti-gender equality and anti-homosexuality loaded onto Factor 2, referred to as “anti-egalitarian” ( $\geq 0.61$ ; see Supplementary material).

In contrast to Study 1, symbolic ideology was measured using a self-placement scale ranging from 1 (*very left*) to 7 (*very right*). Populist attitudes were measured using five of the six items from Akkerman et al. (2014), as included in Study 1. In addition, we identified four supplementary items, for example, “The real power in the Netherlands is in the hands of invisible elites.” Furthermore, we also included four items on beliefs in various conspiracy theories, for example, “the American government is responsible for the 9/11 attacks.” Participants were asked to rate their agreement with these statements on a scale ranging from 1 (*they are absolutely wrong*) to 7 (*they are absolutely right*; i.e., higher values represent higher belief in conspiracy theories).

Once again, we conducted an exploratory factor analysis on these related constructs. The analysis suggested a two-factor solution, explaining 37% of the variance. All five items from Akkerman et al.’s (2014) scale, along with three of the four additional items on populist attitudes, loaded onto Factor 1 ( $\geq 0.47$ ). In this factor, one item with a loading lower than 0.4 was excluded. All items on conspiracy beliefs loaded onto Factor 2 ( $\geq 0.72$ ; see Supplementary material).

Finally, the demographic variables included age (continuous), gender as a dummy variable (1 for men, 0 for women), and education level as a dummy variable (1 for a college or university degree, 0 for no college or university degree).

TABLE 4 Study 2 descriptive statistics for the main variables.

Variable	M	SD	Skewness	Kurtosis	$\alpha$	$\omega$
Anti-egalitarian	1.84	1.01	1.43	1.63	0.61	0.61
Anti-multiculturalism	4.13	1.14	0.26	-0.15	0.75	0.77
Conspiracy beliefs	2.81	1.24	0.23	-0.59	0.87	0.87
Populist attitudes	4.36	0.99	-0.04	-0.06	0.85	0.85
Right-wing	4.04	1.30	-0.07	-0.70		
Trust in science	4.81	0.99	-0.64	1.67		

## 3.2 Results

There were no missing values. Descriptive statistics and intercorrelations are reported in Tables 4, 5. Anti-science attitudes, here measured as lower trust in science, were most strongly correlated with conspiracy beliefs, followed by anti-egalitarian, populist, and anti-multiculturalism attitudes, as well as right-wing ideology and older age. Higher trust in science was correlated with gender (men) and education.

In line with Study 1, we conducted a hierarchical linear regression analysis to predict (lower) trust in science (see Table 6 for coefficients; VIF values ranged from 1.02 to 1.29, and tolerance values ranged from 0.80 to 0.99). We included age, gender, education, and right-wing ideology in Step 1. Among these variables, right-wing ideology and age predicted lower trust, whereas gender and education predicted higher trust [ $F_{(4,2181)} = 24.06, p < 0.001, \text{adj. } R^2 = 0.04$ ]. In Step 2, the ideological variables anti-egalitarian and anti-multiculturalism were introduced. In this step, the effect of right-wing ideology became non-significant, while the other predictors remained. Anti-egalitarian and anti-multiculturalism predicted lower trust, with the former having a larger effect and contributing an additional 7% of the explained variance [ $\Delta F_{(2,2179)} = 81.91, p < 0.001, \text{adj. } R^2 = 0.11, \Delta R^2 = 0.07$ ]. In the third step, when introducing populist attitudes and conspiracy beliefs, all previously mentioned predictors, except for anti-multiculturalism and education (both of which lost significance), retained similar effects. Populist attitudes and conspiracy beliefs predicted lower trust with comparable effect sizes [ $\Delta F_{(2,2177)} = 61.31, p < 0.001, \text{adj. } R^2 = 0.15, \Delta R^2 = 0.05$ ].

In summary, when considering the bivariate analysis, individuals who exhibited stronger anti-egalitarian, anti-multiculturalism, and populist attitudes, as well as a belief in conspiracy theories, a stronger alignment with right-wing ideology, and older age, tended to report lower trust in science. Subsequent regression analysis further clarified the magnitude of these effects, with anti-egalitarian attitudes having the most substantial impact, followed by conspiracy beliefs and populist attitudes.

## 4 Discussion

Mistrust, misbelief, and resistance to acknowledging well-established scientific evidence and methodologies can result in adverse consequences for individuals and societies (e.g., Lewandowsky and Oberauer, 2016, 2021). In line with the attitude

roots model of science rejection (Hornsey and Fielding, 2017), this research reports how individual-level ideological variables can serve as predictors of anti-science attitudes. Our specific aim was to replicate and expand prior research on the association between anti-science and group-based dominance ideologies (Azevedo and Jost, 2021; Kerr and Wilson, 2021) and investigate the less-explored realm of populist ideology while accounting for conventional predictors in this context.

In Study 1, our findings align with previous research from the U.S. This earlier work consistently demonstrates that political conservative identity and Republican affiliation are associated with a higher prevalence of anti-science attitudes, spanning various scientific domains, including a general skepticism toward scientists and scientific methods (Gauchat, 2012; Hornsey et al., 2016; Rutjens et al., 2018a; Azevedo and Jost, 2021; Kerr and Wilson, 2021; Lee, 2021; Davern et al., 2023). Furthermore, our regression model supports recent research on the association between attitudes on group-based dominance and anti-science attitudes (Azevedo and Jost, 2021; Kerr and Wilson, 2021). Notably, there was no significant effect observed for populist attitudes in this study, a point we return to below.

Most research on the political and ideological antecedents of anti-science attitudes has been conducted in the U.S. and other English-speaking countries (Rutjens and van der Lee, 2020). However, these countries may be outliers when viewed from a global perspective, as the association between, for example, political identity and trust in scientists seems to be most pronounced in English-speaking countries (Funk et al., 2020). In our subsequent study, our aim was to test whether the findings from Study 1 could be conceptually replicated beyond the U.S. context by analyzing large-scale survey data from the Netherlands LISS Panel. Within this Dutch sample, the most substantial predictors of anti-science attitudes, here measured as lower trust in science, were anti-egalitarian attitudes, populist attitudes, and conspiracy beliefs.

Collectively, these two studies align with earlier research, indicating that factors often thought of as “intuitive,” such as education and scientific literacy, have limited predictive power regarding attitudes toward science (Rutjens et al., 2018b, 2022; Hornsey, 2020). In line with Hornsey and Fielding’s (2017) framework, it is ideological beliefs and values that exert the most significant influence. Our findings show that anti-science attitudes are closely linked to ideologies associated with group-based dominance, and this connection holds true in both North American and Western European samples. This is consistent with previous research that suggests that hierarchical worldviews pose

TABLE 5 Study 2 Pearson's correlations.

Variable	1	2	3	4	5	6	7	8	9
1. Trust in science									
2. Age	-0.06								
3. Gender (men)	0.13	0.07							
4. Education	0.13	-0.15	0.09						
5. Right-wing	-0.08	-0.05	0.09	-0.04					
6. Anti-egalitarian	-0.25	-0.01	0.09	-0.12	0.16				
7. Anti-multiculturalism	-0.15	0.13	0.07	-0.16	0.42	0.18			
8. Conspiracy beliefs	-0.28	-0.07	-0.192	-0.15	0.03	0.22	0.15		
9. Populist attitudes	-0.22	0.15	-0.00	-0.15	0.10	0.02	0.36	0.37	

\* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

a substantial barrier to the acceptance of science (Kahan et al., 2011, 2012; Hartman et al., 2017; Azevedo and Jost, 2021; Kerr and Wilson, 2021), as most extensively studied in the context of climate change (Häkkinen and Akrami, 2014; Jylhä and Akrami, 2015; Jylhä et al., 2016, 2021; Stanley and Wilson, 2019; Hornsey, 2021).

The question is why individuals with stronger group-based dominance attitudes tend to hold more anti-science attitudes. Social dominance theory suggests that universities, where a significant portion of science is generated, may be perceived as an institution working to attune social hierarchies (Sinclair et al., 1998). In contrast to systems that categorize groups in society based on power, privilege, and status, higher education and academia ideally rest on meritocracy and egalitarian principles, as endorsed by the Universal Declaration Human Rights (1948). This emphasis on meritocracy underscores that rewards and opportunities should be allocated based on individual abilities and efforts, irrespective of one's social background. This, from a theoretical standpoint, directly challenges ideologies that advocate the dominance of specific social groups. One might also speculate that the historical evolution of these principles, as exemplified by the exclusionary nature of American higher education in the 1800s, exclusively limited to white males, has further intensified the perception of universities and science as institutions poised to challenge established societal norms and hierarchies.

Importantly, science, by its nature, seeks to challenge established beliefs, sometimes including those that underpin social hierarchies. Thus, science has the potential to question traditional power structures, norms, and authority figures, and science is often associated with the idea of societal progress and the potential for change and improvement (Farias et al., 2013). Considering this, one could assume that individuals subscribing to group-based dominance ideologies to a greater extent may express increased doubt toward applied science aimed at generating practical knowledge and solutions to address real-world issues and enhance society. However, this remains speculative, and while our research expands beyond studies conducted in English-speaking countries, both of our study samples originate from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) populations. People's perceptions of science and its role in promoting equality most likely vary across contexts, and therefore, these findings may not apply to other times and cultures. And certainly, not all individuals with group-based dominance orientations will adopt anti-science attitudes. Furthermore, this association may also fluctuate depending on the prominence of issues related to social hierarchies within society at any given time (Sidanius and Pratto, 1999).

We encourage future research to explore how specific subconstructs, such as the distinction between dominance and anti-egalitarianism within SDO (Ho et al., 2012), are uniquely associated with anti-science attitudes [it is not possible to distinguish specific facets of SDO in the Pratto et al. (2013) scale used in Study 1]. The dominance subcategory of SDO involves the endorsement of hierarchical intergroup relations, while the anti-egalitarianism subcategory opposes equality among social groups. Previous research has demonstrated that SDO can intensify in response to threatening environments and crises (e.g., Sibley and Duckitt, 2013; Onraet et al., 2014). Consequently, in times when science assumes a critical role in society, such as during pandemics, there may be



TABLE 6 Study 2 hierarchical linear regression predicting science attitudes.

	Step 1		Step 2		Step 3	
	B (SE)	$\beta$	B (SE)	$\beta$	B (SE)	$\beta$
(Constant)	5.00 (0.10)***		5.56 (0.11)***		6.28 (0.13)***	
Age	-0.00 (0.00)*	-0.05	-0.00 (0.00)*	-0.05	-0.00 (0.00)*	-0.05
Gender (men)	0.27 (0.04)***	0.14	0.32 (0.04)***	0.16	0.25 (0.04)***	0.13
Education	0.22 (0.04)***	0.11	0.13 (0.04)**	0.07	0.08 (0.04)	0.04
Right-wing	-0.07 (0.02)***	-0.09	-0.01 (0.02)	-0.03	-0.03 (0.02)	-0.03
Anti-egalitarianism			-0.24 (0.02)***	-0.24	-0.21 (0.02)***	-0.21
Anti-multiculturalism			-0.08 (0.02)***	-0.09	-0.02 (0.02)	-0.02
Populist attitudes					-0.13 (0.02)***	-0.13
Conspiracy beliefs					-0.12 (0.02)***	-0.16

Science attitudes are here represented by trust in science; negative coefficients indicate lower trust, and positive coefficients indicate higher trust. \* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

an augmented resistance to science and scientists. Investigating the specific mechanisms by which these ideologies, particularly on the subconstruct level, correlate with anti-science attitudes could inform more effective strategies for science communication and promote public acceptance of science, particularly when facing crises and challenging circumstances.

It is also worth considering that anti-science attitudes could stem from social identity needs (e.g., Hornsey and Fielding, 2017). This suggests that these attitudes could arise from adhering to a set of attitudinal expectations associated with a particular political party or ideology. Given the increased social sorting of partisan, social, and ideological identities, especially in the U.S. (Mason, 2016; Mason and Wronski, 2018), ideologies associated with anti-science attitudes may have become more integral to one's identity. This could result in a stronger emotional attachment to one's in-group, thereby increasing the motivation to mistrust, misbelief, and reject science. When combined, the roots of anti-science attitudes may exert a more pronounced influence than when acting alone (Hornsey and Fielding, 2017). A notable knowledge gap is how this alignment of social, ideological, and partisan identities shapes attitudes toward science.

Turning to populist attitudes, these attitudes had an impact on anti-science attitudes in the Dutch sample, whereas no such effect was observed in the U.S. sample. It is important to note that an extended measure of populist attitudes was used in the Dutch LISS sample, in contrast to the shorter Akkerman et al. (2014) scale in the U.S. study. Considering that these studies were conducted independently, the results may be attributed to different methodological approaches rather than actual cross-country variations. While we avoid extensive comparisons, we acknowledge that in countries where populist attitudes have a stronger effect on anti-science attitudes, there may be a more prevalent perception of science as aligned with an elite establishment, resulting in a more negative view of science among individuals with stronger populist leanings. To address this speculation, future multi-country research should design studies to facilitate valid comparisons.

Finally, in the Dutch sample, we also examined conspiracy beliefs, and our results align with prior research that has linked such beliefs to anti-science attitudes (Lewandowsky et al., 2013a,b;

Jolley and Douglas, 2014; Hornsey et al., 2018; Rutjens and van der Lee, 2020). However, it is noteworthy that anti-egalitarian attitudes exhibited a stronger association compared to both conspiracy beliefs and populist attitudes.

In summary, our results suggest that enhancing education and scientific literacy may not alone reduce anti-science attitudes among the public (Rutjens et al., 2018a). Instead, accentuating the compatibility of scientific inquiry with diverse ideologies could be helpful. Additionally, some findings indicate that trust in scientists can be positively influenced by familiarity with their work (e.g., Funk, 2020). Effectively reaching ideological groups with anti-science attitudes may require strategies like tailored messaging, relatable messengers, community engagement, and fostering open dialogues about science.

## 4.1 Limitations

Some limitations are worth noting. First, some of the variables relied on single or limited-item measurements, which raises concerns about the construct validity of these measures. Future research should consider using more comprehensive and refined measures. For example, in the case of SDO, researchers could explore both the dominance and anti-egalitarianism dimensions (Ho et al., 2012). Similarly, assessing populism using distinct items for each dimension (e.g., Castanho Silva et al., 2018) may be preferable to the scale used in this study, which combines multiple dimensions within individual items (Akkerman et al., 2014).

Furthermore, the cross-sectional design in both studies prevents us from making causal claims about the relationship between ideological variables and anti-science attitudes. It remains plausible that individuals' attitudes toward science could also influence their ideological attitudes. For example, research by Stanley et al. (2019) found that attitudes toward the environment preceded attitudes on social hierarchies over a 5-year period. To unravel the directionality of the relationship between ideologies and science attitudes, future research could consider longitudinal and experimental methodologies. Another limitation, as mentioned

previously, is that while Study 1 used original data, Study 2 relied on secondary data, introducing substantial methodological differences that greatly weaken the validity of cross-country comparisons.

It is also vital to recognize that our focus on non-domain-specific anti-science attitudes rather than specific instances like climate change denial introduces its own set of limitations. When individuals are asked about their attitudes toward science in a general sense, as done in both study samples, their interpretation of “science” may vary (e.g., some may consider specific fields, while others think about the implications of scientific knowledge), influenced by factors such as the current prominence of certain scientific fields in the public sphere or media coverage. Hence, future work on non-domain-specific anti-science attitudes may simultaneously assess how individuals understand and interpret the concept of “science” in a general sense. Importantly, these interpretations may diverge based on ideology. Finally, it is also important to note that individuals have the right to formulate opinions about science however they like, even if that entails holding anti-science attitudes (Jylhä et al., 2022). And categorizing all opinions that diverge from mainstream scientific consensus as anti-science could cheapen the term (Nature, 2017). Therefore, how to operationalize these attitudes is an important avenue for future research.

## 5 Conclusion

Consistent with recent research, our findings demonstrate that ideological variables, particularly attitudes favoring group-based dominance, are associated with anti-science attitudes in both a U.S. and Dutch sample, while the effect of populist ideology was only observed in the Dutch sample. While causality is not clear, these results may imply that, in North American and Western European contexts, science could be perceived as a challenging force against established social hierarchies, potentially conflicting with certain ideologies. These findings illuminate potential strategies for addressing anti-science attitudes, such as highlighting the compatibility of science with diverse ideologies. This may become particularly pertinent in times of crisis and adversity. A better understanding of how ideological variables shape and sustain anti-science attitudes requires, for example, longitudinal and cross-cultural approaches.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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## Ethics statement

Ethical approval was not required for the studies involving humans because for research that is carried out abroad, no ethics approval is required in Sweden. The act (2003:460) on ethical review of research involving humans in Sweden only applies to research to be carried out in Sweden (Section 5). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

AR: Conceptualization, Formal analysis, Methodology, Writing—original draft; ER: Conceptualization, Formal analysis, Methodology, Writing—review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsps.2023.1303157/full#supplementary-material>

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