

Partisanship and anti-elite worldviews as correlates of science and health beliefs in the multi-party system of Spain

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Abstract

In a national sample of 5087 Spaniards, we examine the prevalence of 10 specific misperceptions over five separate science and health domains (climate change, 5G technology, genetically modified foods, vaccines, and homeopathy). We find that misperceptions about genetically modified foods and general health risks of 5G technology are particularly widespread. While we find that partisan affiliation is not strongly associated with any of the misperceptions aside from climate change, we find that two distinct dimensions of an anti-elite worldview—anti-expert and conspiratorial mindsets—are better overall predictors of having science and health misperceptions in the Spanish context. These findings help extend our understanding of polarization around science beyond the most common contexts (e.g. the United States) and support recent work suggesting anti-elite sentiments are among the most important predictors of factual misperceptions.

Keywords

anti-elite worldview, health, misperceptions, partisanship, science, Spain

Social scientists are paying more and more attention to the problem of misperceptions—factual beliefs that are contrary to the best available evidence or consensus expert opinion (e.g. Flynn et al., 2017). In the case of the United States, misperceptions about the economy (Bartels, 2002), foreign policy (Kull et al., 2003), and science (e.g. climate change) are often strongly linked to partisanship. This US-based finding has had an effect on how researchers explain the psychological mechanism that leads individuals to accept as factual information that is contrary to the best available evidence. Researchers routinely point to individual differences in political ideology (Gaines et al., 2007; Kahan et al., 2017; Nyhan and Reifler, 2010). Our project focuses on two aspects that have received less attention in misperception research so far. First, we examine the association between individual differences and misperceptions in a political context outside of the United States. Second, we examine an alternative and competing individual differences explanation for misperceptions: anti-elite worldviews.

So far, most research on misperceptions (about scientific issues) has been conducted in the United States, where parties are ideologically sorted (Levendusky, 2013) and affectively polarized. The United States' two-party system is so entrenched that the same two parties have been dominant since 1860. These partisan divisions permeate every aspect of domestic political competition in the United States (Mason, 2018) to the extent that we expect to see partisan division and disagreement at all turns.

Two aspects are worth highlighting. First, while there is reason to believe that the political context determines the relationship between partisanship and misperceptions, it is difficult to test the causal effect in a study. After all, we cannot randomize exposure to a two- or multi-party system. However, we can explore the association between individual differences and misperceptions in different political contexts. That is what we do in this study. Second, even though partisanship clearly can matter and often does in the United States (especially once parties take divergent stands on an issue), research shows that other individual differences are also important. In fact, religiosity and anti-elite worldviews—particularly the facet of a conspiratorial worldview—have been repeatedly linked to misperceptions in the United States (e.g. Drummond and Fischhoff, 2017; Garrett and Weeks, 2017; Lewandowsky et al., 2013). With this in mind, the need for research examining and comparing the relationship between different individual differences and misperceptions becomes clear.

In this research, we use data from Spain to explore the association between misperceptions and several potentially competing individual differences: partisanship, religiosity, and two separate

constructs that capture an anti-elite worldview (anti-expert and conspiratorial worldviews). Specifically, we examine the prevalence of 10 misperceptions among the Spanish public across five distinct science and health domains: climate change, genetically modified organisms (GMOs), 5G technology, vaccines, and alternative medicine (homeopathy).

Our results reveal that anti-expert and conspiratorial worldviews exhibit the strongest association with misperceptions. While partisanship is sometimes associated with misperceptions in our data, these effects are neither large nor consistent. Anti-expert and conspiratorial worldviews are more consistently associated with factually inaccurate beliefs about science and health, and the magnitude of these relationships is in most cases larger than other individual differences we examine. Moreover, we observe considerable variation in the prevalence of misperceptions. Misperceptions about GMOs are particularly widespread—more than twice as many Spaniards are misinformed as are accurately informed. Yet, on other issues, such as whether vaccines cause autism or whether 5G helps spread the coronavirus—only a very small percentage of Spaniards are misinformed.

Below, we review the potential mechanisms underlying the relationship between individual differences and misperceptions, we discuss misperceptions in the Spanish multi-party context, and we introduce anti-expert and conspiratorial worldviews as individual differences constructs.

I. Partisanship and misperceptions

Previous research shows that individual differences, such as partisanship or religiosity, are associated with factual beliefs about science (e.g. Drummond and Fischhoff, 2017; Hornsey et al., 2016, 2018a, 2018b; Pasek, 2018; Rutjens et al., 2018; Smith and Mayer, 2019). The extent to which science beliefs are polarized based on individual differences has been tested for climate change, GMOs, vaccines, and evolution, and less often for other topics (e.g. stem cell research, the Big Bang, and nanotechnology). In general, research from the United States—the focus of much of this work (Rutjens and van der Lee, 2020)—has found that partisanship alone tends to be correlated with climate beliefs, while both partisanship and religiosity are linked with beliefs on a number of other science issues (Drummond and Fischhoff, 2017; Rutjens et al., 2018). On some issues such as GMOs,¹ there is little evidence of political and religious polarization (Drummond and Fischhoff, 2017; Hasell and Stroud, 2020; Rutjens et al., 2018, though also see Pasek, 2018), and for other issues such as vaccines and vaccination, findings are mixed (Hornsey et al., 2018a; Rutjens et al., 2018; Veenstra et al., 2014). One reason we may see little consistent political polarization on some topics, such as GMOs, is that these issues have yet to exhibit clear politicization at the elite level, despite the circulation of misinformation among the public (Flynn et al., 2017).

Although similar to findings from the US case, correlates of science misperception outside the United States differ in some important ways. Regarding climate change, for example, partisanship still matters in much of the rest of the world, though it is most influential in Anglophone countries (Hornsey et al., 2016, 2018a; Smith and Mayer, 2019). The European context surrounding GMOs may be different than the United States as well, as the issue receives more attention and there is more vocal opposition in some quarters. Furthermore, in more secular Western European countries, such as the Netherlands, spirituality rather than religiosity may do more to shape science beliefs (Rutjens and van der Lee, 2020). While homeopathy is relatively low-profile in the United States (Pennycook et al., 2023), it is so popular in some European countries that it is covered under national healthcare systems (Lobera and Rogero-García, 2020). This issue has become more prominent in Spanish politics—the Spanish health ministry has been campaigning against EU rules that classify homeopathic products as medicines, despite the popularity of homeopathy in Spain (Paun,

2019). In short, there may be cross-national heterogeneity in the correlates of science beliefs, which underlines the need for misperception research in non-US political contexts.

The political context is likely to affect misperceptions and the relationship between partisanship and misperceptions. One potential explanation for this is the cueing process. Party cues and their effect on (political) behavior are country-specific. They are not only likely to differ between two- and multi-party systems but also between political contexts that are characterized by temporal stability or instability (Guntermann, 2019; Steenbergen et al., 2007; Stoeckel et al., 2021; Westwood et al., 2018). So far, it has not yet been comprehensively examined to what extent partisanship structures political misperceptions differently in a two-party system, such as the United States, and a multi-party system, such as Spain. While it seems genuinely difficult to gain causal and ecologically valid evidence for how political contexts determine the relationship between partisanship and misperceptions, we underline the importance of exploring the association between individual differences, such as partisanship and misperceptions in non-US political contexts, such as Spain.

But in what ways might the political context of Spain shape the ways individual differences (e.g. partisanship) relate to misperceptions? The party system in Spain appears to be an interesting case to explore which potential mechanisms are at play behind the relationship between individual differences and misperceptions. The political landscape showcases a multi-party system contrasted with high levels of partisanship (Torcal et al., 2018) and a very salient issue polarization related to the national-peripheral identities (Linz and Montero, 1999). Note that while we aim to explore the association between individual differences (e.g. partisanship, anti-elite worldviews) and misperceptions in Spain, we do not test how political contexts causally determine the relationship between partisanship and misperceptions. It is also worth noting that the media system in Spain may uniquely influence the degree to which members of the public hold misperceptions. Spain's media environment is typically characterized as a polarized pluralist system; not coincidentally, like the United States and other Southern European countries, the media system in Spain is thought to more readily foster exposure to online disinformation than those in Northern Europe (Humprecht et al., 2020). This may differently contribute to the misperceptions we examine (note that we do not attempt to test relationships between self-reported media use and these outcomes due to methodological concerns (see Jürgens et al., 2020)).

2. Anti-elite worldviews and the polarization of factual beliefs

Typically construed as individual differences (i.e. an individual's stable disposition), anti-elite worldviews have been linked to rejection of scientific consensus, particularly regarding climate change and vaccines (Garrett and Weeks, 2017; Hornsey et al., 2018a; Lewandowsky et al., 2013; Merkley, 2019; Motta, 2018). Anti-elite worldviews can be divided into (a) anti-expert and (b) conspiratorial worldviews.

Anti-expert worldviews refer to people's tendency to mistrust, suspect, and despise experts and intellectuals. In this body of research, scientists and medical professionals are considered the most typical experts. By definition, anti-expert worldviews motivate people to oppose scientific consensus (e.g. on climate change), mistrust a wide array of institutions, such as the government, and reject related expert advice (Han et al., 2022; Merkley, 2019). There are diverse sources and drivers of anti-expert worldviews. Most importantly, misperceiving experts' knowledge advantage—that is, overestimating one's own or underestimating expert's knowledge—leads to mistrust of experts (Fernbach et al., 2019; Lyons et al., 2020; Motta et al., 2018). Furthermore, not valuing science, education, and technological and human progress is likely to lead to a disregard of the relevance of experts. Finally, seeing knowledge and information as an instrument that can be

used (by experts) to exploit people will likely foster skepticism toward expert information (Merkley, 2019; Rigney, 1991).

Conspiratorial worldviews refer to people's tendency to endorse conspiracy theories, that is, unsubstantiated explanations of phenomena presumably caused by a small organization consisting of powerful people exploiting others for their own benefit. Conspiratorial worldviews motivate people to believe in convenient "alternatives," and disbelieve in inconvenient facts. The latter often results in referring to inconvenient scientific evidence as a hoax (Garrett and Weeks, 2017; Lewandowsky et al., 2013). Research has likewise identified diverse sources and drivers of conspiratorial worldviews (Goreis and Voracek, 2019). Distrust of authority, for instance, may be a main driver of endorsement of and engagement with conspiracy theories. Similarly, political cynicism fosters the tendency to endorse conspiracy theories (Lewandowsky et al., 2013; Swami et al., 2010).

Besides diverse individual-level sources and drivers of anti-elite worldviews, there are also potential sources from a social identity perspective. In its original conception, social identity is "the individual's knowledge that he [sic] belongs to certain social groups together with some emotional and value significance to him of this group membership," (Tajfel, 1972: 292). Accordingly, individuals with anti-elite worldviews often feel a sense of community (aided by online discussion) and conceive of themselves as a unique group working in opposition to corrupt power (Byford, 2011; Franks et al., 2017), and place value in this resistance. Furthermore, an anti-elite identity fits classic conceptions in that individuals reflect self-definitions of their positions in a system of social categories, by which members define themselves and others (Abrams and Hogg, 1990; Tajfel, 1982; Turner, 1975). Those with an anti-elite identity perceive the out-group as subgroups of "evil elites," for example (Franks et al., 2017). The in-group, meanwhile, are those awakened to the supposed reality of a world controlled by the elite. Similarly, others have conceived an anti-elite social identity that rejects status quo institutions (and the experts who inhabit them) as elitist enterprises opposed to the will of the masses (Jagers and Walgrave, 2007; Schulz et al., 2018). This view is often entwined with populism. This group identity locates experts, journalists, and other "elites" as the out-group, who can be seen as working on behalf of entrenched elected officials opposing the masses (Krämer, 2018; Mazzoleni et al., 2003). Working from a social identity perspective, Schulz et al. (2018) argue that members of this anti-elite in-group must distance themselves from the mainstream elites that constitute their out-group to maintain their identity. Accordingly, scientific expertise is frequently rejected (Kennedy, 2019; Lockwood, 2018; Mede and Schäfer, 2020). Rejecting the influence of out-group members in this manner is unsurprising, as normative group positions are defined perhaps more through contrast with out-groups than through in-group assimilation (Hogg and Reid, 2006). These identities in question are inherently defined by and acquire meaning in relation to an "Other" (Tajfel, 1972). Anti-expert worldviews and conspiratorial worldviews are centered on an us-vs-them narrative of the world. In both cases, they drive group polarization and rejection of scientific consensus.

While anti-expert and conspiratorial worldviews represent distinct individual differences constructs, they conceptually tap into the same anti-elite worldview construct. In fact, anti-expert and conspiratorial worldviews capture different aspects of people's anti-elite tendencies. We contribute to existing research—that has often either focused on anti-expert *or* conspiratorial worldviews—by explicitly examining how both anti-expert and conspiratorial worldviews jointly explain misperceptions.

Overall, we contribute to the broad body of work on science beliefs by examining polarization across multiple individual differences—partisanship, religiosity, anti-expert, and conspiratorial worldviews—over an omnibus of science and health topics (anthropogenic climate change; GMO

consumption and environmental impact; 5G technology's consequences; vaccine misperceptions; and homeopathy efficacy) in the Spanish national context.

3. Methods

Participants

Using the online survey firm YouGov, we collected survey responses (in Spanish) from a national sample in Spain in May–June 2020. YouGov recruits a large panel of opt-in respondents and then uses a weighting and matching algorithm to create a sample that mirrors the demographics of the Spanish public. (YouGov determines the specific eligibility and exclusion criteria for their panel).

Participation in the study was voluntary and participants received YouGov points for their participation. We obtained a total sample of 5087 participants (2592 men, 2495 women, 26% university educated, $M_{\text{age}} = 45.11$, $SD_{\text{age}} = 14.45$), including an oversample of participants residing in Catalonia. All results and analyses that follow use the weights supplied by YouGov to match the demographics of the Spanish population.

Note that we pre-registered our study on the Open Science Framework (OSF) platform (<https://osf.io/eztck>). We also provide our data and code on OSF (<https://osf.io/b6e43/>).

Procedure

After providing informed consent, participants responded to demographic questions (including religiosity), reported which political party they felt closest to, and completed several scales to capture individual differences, such as anti-expert and conspiratorial worldviews. The questionnaire also included a number of questions we asked as part of a larger project comparing misperceptions across Europe. We investigated misperceptions in seven domains, five about science and health misperceptions (the focus of this study) and two others that were excluded from the analyses because they are about other issues. Respondents were randomly assigned to two of our domain-specific misperception batteries.²

Materials

The measures we used are described below. Note that the questionnaire was administered in Spanish; the questions we cite below are translations. All items included a “don't know” response option unless specified otherwise.

Misperceptions. We asked participants to use a five-point Likert-type scale to indicate their agreement with a series of 10 items that reflect misperceptions in the field of science and health. Full item wording (and response distributions) is available in Table S11 in the Supplemental Material. Note that our items were informed by existing literature on misperceptions in the field of science and health (e.g. Arvanitoyannis and Krystallis, 2005; Enders et al., 2020; Hasell et al., 2020; Leshner, 2009; Lyons et al., 2019).

Anti-expert worldview. Anti-expert worldview was measured using the following three items on a five-point Likert-type scale from *strongly disagree* to *strongly agree*: “I am more confident in my opinion than other people's facts,” “Most of the time I know just as much as experts,” and “Experts really don't know that much” ($M = 2.56$, $SD = 0.82$, $\alpha = .69$) (for more details on this scale, see Han et al. (2022)).

Conspiratorial worldview. A conspiratorial worldview (Uscinski et al., 2016) was measured using the following four items on a five-point Likert-type scale from *strongly disagree* to *strongly agree*: “Much of our lives are being controlled by plots hatched in secret places,” “Even though we live in a democracy, a few people will always run things anyway,” “The people who really ‘run’ the country are not known to the voter,” and “Big events like wars, recessions, and the outcomes of elections are controlled by small groups of people who are working in secret against the rest of us,” ($M=3.65$, $SD=0.82$, $\alpha=.77$) (for more details on this scale, see Han et al. (2022), Uscinski et al. (2016)).

Partisanship. Partisanship was measured using the question, “To which of the following political parties do you feel closest to?,” with the following options: Partido Popular (PP), Partido Socialista Obrero Espanol (PSOE), Podemos, Vox, Ciudadanos—Partido de la Ciudadania (Cs), Other, None, or “I don’t know.” Respondents in Catalonia were also presented with two Catalanian parties, meaning they chose between the PP, the PSOE, Podemos, Vox, En Comu Podem, Esquerra Republicana de Catalunya/Izquierda Republicana de Catalunya, and Junts Per Catalunya/Juntos por Catalunya. In our analyses, we use indicators for PP, Podemos, Vox, Ciudadanos, other party (collecting some of the minor parties listed above), and no party (including none and don’t know), with PSOE, currently the largest party, as the reference group.

Religiosity. Religiosity was measured using the item: “Lots of things come up that keep people from attending religious services even if they want to. Thinking about your life these days, how often do you go to religious services?” on a scale that ranged from *never* (1) to *once a week or more* (7) ($M=2.39$, $SD=1.71$).

Covariates. In addition to standard demographics (age, gender, and university education), we asked a true/false question about the number of members of parliament (350) to measure general political knowledge: “There are 550 members in the Congress of Deputies.” We use indicators for correct and don’t know responses, leaving the incorrect response (“true”) as the reference category.

4. Results

All findings below report the results of the weighted data analyses. The weighted population estimates were computed using the “survey” R-package (Lumley, 2020) with the weights provided by YouGov. We begin our analyses by examining the extent of agreement with our misperception items. Next, we check correlations within and across the five domains before we come to the core of this research, examining whether and how partisanship, religiosity, and anti-elite worldviews are associated with misperceptions.

The prevalence of misperceptions in science and health

Table S11 in the Supplemental Material lists each question along with the full response distribution. Following Kuklinski et al. (2000), there is an important distinction to be made being *misinformed* and being *uninformed*. Emphasizing this distinction, the table includes three additional columns that indicate the proportion of respondents who are “misinformed” (reporting beliefs that are inconsistent with scientific evidence), who are “informed” (reporting beliefs that are consistent with scientific evidence), and who are “uninformed” (reporting that they “do not know” the answer, or reporting that they “neither agree nor disagree”).

Table S11 in the Supplemental Material is sorted from the highest to lowest ratio of misinformed to informed. In one domain, we find a much higher ratio of misinformed to informed respondents than in all other domains: GMOs. There are many more Spaniards who are misinformed than informed about the effects of GMOs on the environment (a ratio of 2.17) and about the safety of GMOs (a ratio of 2.13). In addition, one of the 5G questions (concerning a supposed health risk of the new mobile network) also shows a higher share of misinformed than informed.

To detect possible patterns across supporters of the different parties, we split up our sample by party affiliation and replicated the response distribution table for party (see Tables SI2 to SI5 in the Supplemental Material). We found no indication of different misperceptions across supporters of Spain's political parties. While the ratios of misinformed to informed vary slightly depending on respondents' preferred party, misperceptions about GMOs and 5G are always at the top of the list.

Correlations of misperceptions across domains

Table 1 shows the pairwise correlation between our misperception outcome variables. Items are coded such that higher scores indicate greater misperceptions (i.e. we recoded "I believe genetically modified foods are as safe to eat as conventional foods," and "The Earth is getting warmer mostly because of human activity such as burning fossil fuels.>"). The weighted correlations were calculated using the *svycor* function from the "jtools" R package (Long, 2017). Furthermore, this function³ uses a sample-weighted bootstrapping procedure ($n=2000$) to test whether the correlation coefficients are distinguishable from zero. For the most part, misperceptions are correlated reasonably highly within each domain. Looking at misperceptions about vaccines, for instance, we find a .36 correlation between the belief that vaccines cause autism and the belief that they can give you the flu. At .58, the two homeopathy misperceptions (that they cure the flu, and that they cure cancer) are even more strongly correlated.

What about correlations across domains? Will respondents who hold misperceptions about one domain also hold misperceptions about others? The correlation matrix in Table 2 points to a pattern: Misperceptions are clearly correlated across domains.

That means that participants whose beliefs about vaccinations are contrary to the best available evidence or consensus expert opinion typically also hold beliefs about homeopathy and 5G technology that are contrary to the best available evidence or consensus expert opinion. There is only one domain in which misperceptions do not seem to spill over: Climate change. Respondents who did not believe in the human causes of climate change were no more and no less likely to hold misperceptions about GMOs, 5G, or vaccines.^{4,5}

Correlates of misperceptions

We estimate a series of OLS regression models to examine whether and how partisanship, religiosity, and anti-elite worldviews are associated with misperceptions. Variables are coded so that higher values indicate greater misperceptions (i.e. we reverse coded "I believe genetically modified foods are as safe to eat as conventional foods" (GMO: Eating) and "The Earth is getting warmer mostly because of human activity such as burning fossil fuels" (Climate Change)). Missing data and "don't know" answers were removed via listwise deletion. To facilitate comparison across independent variables, all variables are scaled 0–1. Table 2 shows the results for science-related misperceptions (climate change, GMOs, and 5G). Table 3 shows results for health-related misperceptions (vaccines, homeopathy). Both tables show two models for each misperception. The first model (the column on the left, respectively) focuses on the role of partisanship. The reference category is support for the left-leaning PSOE (which was in power at the time the study was run).⁶

Table 1. Correlations between misperception domains.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
GMO environment (1)	1 (864)									
GMO eating (2)	.33*** (845)	1 (926)								
Climate change (3)	-.18* (191)	.03 (212)	1 (1959)							
Vax HPV (4)			.05 (186)	1 (798)						
Vax autism (5)			.05 (210)	.57*** (749)	1 (868)					
Vax flu (6)			-.12 (232)	.29*** (789)	.36*** (849)	1 (970)				
Homeopathy cancer (7)	.21 (77)	.09 (77)	.20* (218)	.56*** (76)	.55*** (79)	.20 (90)	1 (792)			
Homeopathy flu (8)	.32** (78)	.44*** (78)	.03 (218)	.27 (77)	.37** (79)	-.03 (91)	.58*** (770)	1 (792)		
5G coronavirus (9)	.14* (403)	-.02 (403)	-.04 (674)	.49*** (414)	.45*** (415)	.13* (414)			1 (828)	
5G health risk (10)	.33* (70)	.25 (73)	.02 (203)	.41** (75)	.40** (85)	.32** (92)			.42** (649)	1 (703)

The number of observations used in analyzing each pair of variables is reported in parentheses.

* $p < .05$.

** $p < .01$.

*** $p < .005$ (two-sided).

HPV: Human papillomavirus.

Table 2. Science misperceptions across groups.

	Climate change		GMO environment		GMO eating		5G health		5G corona	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
(Intercept)	0.78*** (0.10)	1.05*** (0.12)	3.34*** (0.17)	2.48*** (0.19)	3.08*** (0.18)	3.22*** (0.21)	2.56*** (0.19)	1.56*** (0.21)	1.59*** (0.10)	0.78*** (0.11)
PP	0.23*** (0.07)	0.17* (0.07)	-0.21 (0.11)	-0.36*** (0.11)	0.20 (0.12)	0.24* (0.12)	0.23 (0.13)	-0.01 (0.13)	0.24*** (0.07)	0.01 (0.07)
Podemos	-0.16* (0.08)	-0.07 (0.08)	-0.13 (0.12)	-0.15 (0.12)	0.07 (0.13)	0.16 (0.13)	0.22 (0.15)	0.18 (0.14)	0.15 (0.08)	0.16* (0.07)
Vox	0.59*** (0.08)	0.59*** (0.08)	-0.12 (0.14)	-0.31* (0.14)	-0.04 (0.15)	0.00 (0.15)	0.17 (0.16)	-0.12 (0.16)	0.27* (0.09)	0.02 (0.08)
Ciudadanos	0.13 (0.09)	0.14 (0.09)	-0.24 (0.14)	-0.27* (0.14)	0.02 (0.15)	0.08 (0.15)	0.02 (0.17)	-0.11 (0.17)	0.11 (0.09)	-0.01 (0.09)
Other party	-0.20* (0.08)	-0.08 (0.08)	-0.05 (0.13)	-0.12 (0.13)	-0.16 (0.14)	-0.09 (0.14)	-0.23 (0.16)	-0.37* (0.15)	0.00 (0.08)	-0.04 (0.08)
No party	0.36*** (0.07)	0.33*** (0.07)	0.12 (0.10)	-0.01 (0.10)	-0.08 (0.11)	-0.03 (0.11)	0.21 (0.14)	0.06 (0.13)	0.15* (0.07)	0.01 (0.06)
Anti-expert		0.48*** (0.11)		0.31 (0.18)		0.70*** (0.20)		0.39 (0.21)		1.50*** (0.11)
Conspiratorial		-0.78*** (0.11)		1.40*** (0.19)		-0.78*** (0.20)		1.57*** (0.21)		0.40*** (0.11)
Religiosity		0.30*** (0.08)		0.24 (0.12)		-0.13 (0.13)		0.14 (0.15)		0.15** (0.08)
Control variables	√	√	√	√	√	√	√	√	√	√
N	1942	1937	857	855	919	917	696	694	2268	2261
R ²	.07	.11	.03	.11	.05	.08	.09	.18	.03	.13

All models include age, gender, university education, and political knowledge as controls, and employ survey weights. Cell entries are ordinary least square (OLS) regression coefficients with standard errors in parentheses.

*p < .05.

**p < .01.

***p < .005 (two-sided).

Table 3. Health misperceptions across groups.

	Vax: autism		Vax: HPV		Vax: flu		Homeopathy: flu		Homeopathy: cancer	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
(Intercept)	2.45*** (0.16)	1.23*** (0.18)	2.47*** (0.16)	1.74*** (0.19)	2.75*** (0.17)	1.70*** (0.20)	2.24*** (0.22)	1.31*** (0.25)	2.18*** (0.17)	1.48*** (0.20)
PP	-0.08 (0.12)	-0.28* (0.11)	0.19 (0.12)	-0.06 (0.12)	0.10 (0.12)	-0.09 (0.12)	0.41*** (0.14)	0.13 (0.14)	0.22* (0.11)	-0.00 (0.11)
Podemos	-0.25 (0.13)	-0.22 (0.12)	-0.28* (0.13)	-0.25* (0.12)	0.09 (0.14)	0.05 (0.13)	0.11 (0.17)	0.10 (0.16)	-0.21 (0.14)	-0.17 (0.13)
Vox	0.08 (0.14)	-0.16 (0.13)	0.01 (0.14)	-0.27 (0.14)	0.15 (0.14)	-0.06 (0.14)	0.22 (0.17)	-0.12 (0.17)	0.20 (0.13)	-0.07 (0.13)
Ciudadanos	-0.18 (0.14)	-0.26* (0.13)	-0.14 (0.14)	-0.31* (0.14)	0.21 (0.15)	0.13 (0.15)	0.46* (0.19)	0.38* (0.18)	0.07 (0.15)	0.00 (0.14)
Other party	-0.05 (0.13)	-0.06 (0.12)	-0.07 (0.14)	-0.04 (0.13)	-0.00 (0.14)	-0.11 (0.14)	0.49** (0.16)	0.41** (0.16)	0.13 (0.13)	0.11 (0.12)
No party	0.25* (0.12)	0.07 (0.11)	0.11 (0.12)	0.01 (0.11)	0.22 (0.12)	0.08 (0.12)	0.33* (0.14)	0.09 (0.14)	0.01 (0.11)	-0.17 (0.11)
Anti-expert		1.52*** (0.18)		0.94*** (0.19)		0.22 (0.20)		1.07*** (0.24)		1.25*** (0.19)
Conspiratorial		0.92*** (0.18)		0.45* (0.19)		1.53*** (0.19)		0.82*** (0.24)		0.30 (0.19)
Religiosity		0.47*** (0.12)		0.80*** (0.13)		0.38** (0.13)		0.68*** (0.15)		0.62*** (0.11)
Control variables	√	√	√	√	√	√	√	√	√	√
N	862	861	792	790	964	963	786	785	786	785
R ²	.05	.20	.06	.15	.05	.13	.05	.14	.07	.18

All models include age, gender, university education, and political knowledge as controls, and employ survey weights. Cell entries are OLS regression coefficients with standard errors in parentheses.

*p < .05.

**p < .01.

***p < .005 (two-sided).

HPV: Human papillomavirus.

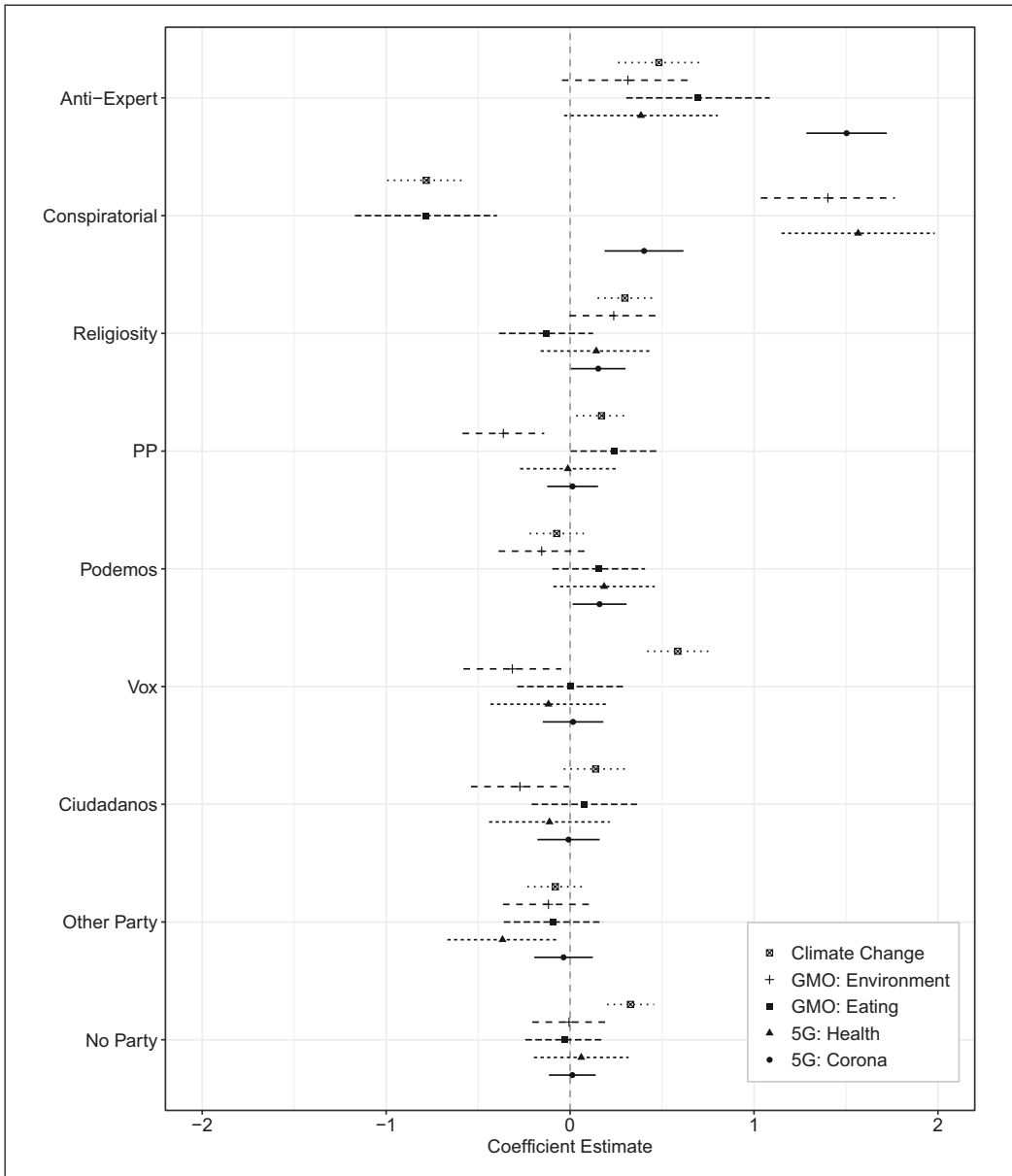


Figure 1. Regression coefficients predicting science misperceptions. Coefficient estimates controlling for demographics and political knowledge. Error bars are 95% confidence intervals. Note that we scaled anti-expert, conspiratorial, and religiosity 0–1 to facilitate comparison across independent variables.

The second model (on the right) adds measures for religiosity, anti-expert, and conspiratorial worldviews (right column). The models include controls for age, gender, education, and level of political knowledge. The corresponding coefficient plots in Figures 1 and 2 visualize the models on the right hand side, including anti-elite worldviews.

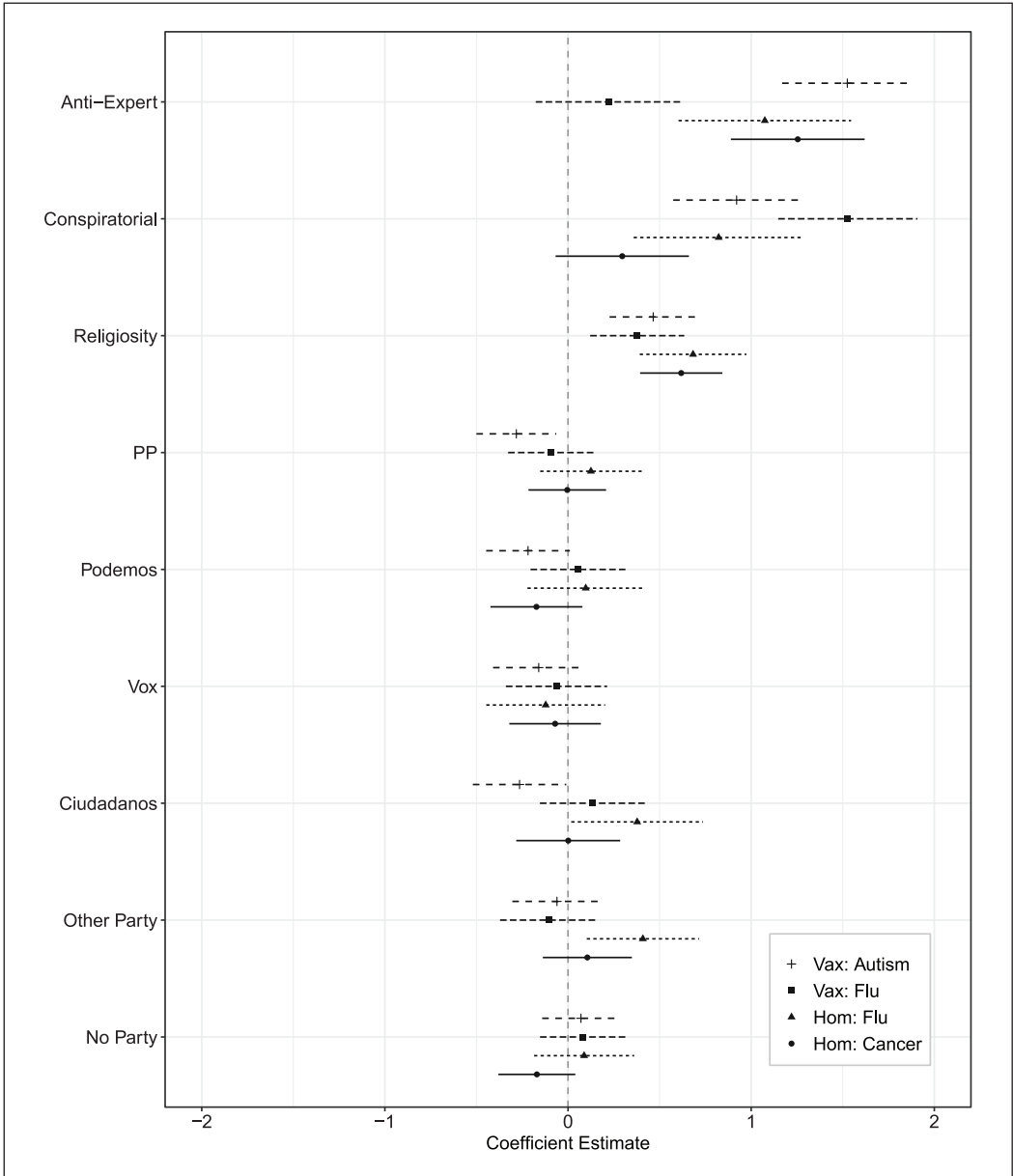


Figure 2. Regression coefficients predicting health misperceptions. Coefficient estimates controlling for demographics and political knowledge. Error bars are 95% confidence intervals. Note that we scaled anti-expert, conspiratorial, and religiosity 0–1 to facilitate comparison across independent variables.

The coefficient plots show that partisanship is not consistently related to misperceptions. While some party affiliations are statistically significant in some models, the effects are small. We find no evidence of any link between support for any particular party and misperceptions in any of the five domains we investigated.

Neither supporters of the populist left-wing party Podemos nor supporters of the populist right-wing party Vox exhibit consistently greater misperceptions than supporters of the mainstream left-leaning PSOE (our reference category). There is only one domain—climate change—in which supporters of one party—Vox—show significantly greater misperceptions than supporters of the other parties (see the outlier in the coefficient plot in Figure 1). Respondents who support “no party” at all are also more likely to be misinformed about climate change.

If partisanship does not predict the prevalence of misperceptions in Spain then what does? We find that anti-elite worldviews predict misperceptions across all five domains. Anti-expert worldviews have a strong and significant effect on 7 of the 10 misperceptions we tested. Conspiratorial worldviews have a strong and significant effect on 9 of them. Both predicted belief in the myths around 5G networks transmitting the coronavirus, vaccines causing autism, HPV vaccinations at age 12 years promoting sexual activity, and homeopathy being an effective cure for mild diseases, anti-expert worldviews predicted skepticism of human-cause climate change, and belief that vaccines can give you the flu, while conspiratorial worldviews predicted belief that GMOs harm the environment, and that the new 5G network poses health risks.

Surprisingly, two of the coefficients for conspiratorial worldviews were negative: Holding a conspiratorial worldview was associated with *lower* levels of misperceptions about the safety of eating GMO food and with *lower* levels of misperceptions about climate change. These anomalous results may represent measurement error as these two items were presented to participants as accurate statements, while all others were presented as inaccurate statements. The answer options were the same for all misperceptions items, and the GMO eating item (“I believe genetically modified foods are as safe to eat as conventional foods.”) and the Climate Change item (“The Earth is getting warmer mostly because of human activity such as burning fossil fuels.”) were reverse coded for our analyses (see item wording in Table S11 in the Supplemental Material).⁷ Besides measurement error due to how items were formulated, it also seems important to underline that the items used to capture misperceptions were created ad hoc (but drawn from the existing literature on misperceptions in the context of health and science) and do not stem from a validated questionnaire. Furthermore, we found that conspiratorial worldviews were slightly, but significantly correlated with overall response time. Hence, we cannot rule out that respondents scoring high (vs low) on conspiratorial worldviews were relatively careless in filling out the survey. Having said this, one has to be careful when interpreting the results.

In addition, our data show that religiosity predicted misperceptions in three of the five domains: vaccines, homeopathy, and climate change. However, this effect was smaller than the effect of anti-elite and conspiratorial worldviews. Overall, the models including anti-expert and conspiratorial worldviews, and religiosity explained the variation in our outcome variables much better than the models focusing on party support. R^2 values for the latter range between .03 and .09, whereas R^2 values for the larger models range between .08 and .20.

5. Discussion

In this study, we examined the overall level of misperceptions in science and health beliefs in Spain. Most importantly, we find that partisanship is not strongly associated with any of the misperceptions aside from climate change, and that two distinct dimensions of an anti-elite worldview—anti-expert and conspiratorial worldviews—are better predictors of having misperceptions in the Spanish context.

We note some important limitations to this work. Most notably, like many studies of polarization surrounding science, we rely on cross-sectional data. While the substantive meaning of our anti-elite variables suggests a general mechanism, our evidence remains suggestive. Also, as we

note the degree of variance explained in some of our models is modest, party model R^2 ranges from 3% to 9% across misperceptions, while R^2 for models accounting for anti-expert views and conspiratorial worldviews ranges from 8% to 20%. In addition, we rely on a single country. Further studies ought to investigate the link between anti-elite worldviews and misperceptions across domains in other countries with varying political systems.

Perhaps our most important contribution is that our data reveal no evidence of partisanship predicting misperceptions in the context of Spain. Support for a particular party was not associated with higher levels of misperceptions. (Note the one exception of Vox support predicting climate change misperceptions). This finding adds nuance to a body of literature that is, in many ways, informed by the highly polarized, two-party system of the United States. While partisanship is not strongly associated with misperceptions in Spain, other individual differences seem to matter more. As observed in other contexts (Pasek, 2018; Rutjens et al., 2018), religiosity is modestly associated with a few of the health and science misperceptions in Spain. A much better predictor of misperceptions is an anti-elite worldview. While the anti-elite worldview particularly stands out, a conspiratorial worldview is associated with most of the misperceptions we examined. This complements recent work that suggests anti-elite sentiments, rather than ideological commitments or party affiliations, are strongly linked with vaccine hesitancy, for instance (Stoeckel et al., 2022). This line of work argues that a more general lack of trust in institutions is likely causally prior to both (populist) party affiliation and specific misperceptions about health and science.

It should also be acknowledged that in the context of science, anti-expert views as we and others have measured them represent distrust of *mainstream* experts and expert consensus; those that hold such views may instead select their own “experts” that offer views outside the consensus and more in line with their own (Yeo et al., 2015). Likewise, individuals espousing conspiracist worldviews often form communities around figureheads or “heroes,” such as “maverick” scientists to whom group members often defer and for whom public vilification acts as proof of belonging (Franks et al., 2017). In the future, more work may be dedicated to teasing apart antipathy toward *all* experts versus antipathy toward the consensus in particular, and what the implications of such a distinction might be.

In this research, we employ a large nationally representative sample of an understudied nation and assess misperceptions on a wide array of science and health issues, including relatively recent misperceptions in the field of 5G technology. Even though concerns over 5G are recent, misperceptions about alleged health risks are already widespread and associated with conspiratorial thinking. Looking at the ratio of misinformed to informed respondents, we find that misperceptions about GMOs and 5G health risks are more widespread than misperceptions about vaccines, homeopathy, and climate change. This is true for supporters of all parties. There is only one exception: Climate change denial is more widespread among supporters of the right-wing populist party Vox. We might speculate on different conditions encouraging greater levels of misperceptions for GMOs and 5G, respectively. Historically, GMOs have been more distrusted in Europe than in the United States (Ceccoli and Hixon, 2012; Wunderlich and Gatto, 2015), and so cultural differences may play a role in this case. A lack of polarization on the issue also allows for misperceptions to be held across the political spectrum, rather than being concentrated on one pole. For 5G risks, we might speculate that as a newer issue, there has been less messaging in public discourse about its safety, less related knowledge uptake, and therefore greater potential for rumors to spread in its absence.

Asking respondents to assess false statements across various domains also allows us to examine correlations between misperceptions across these domains. Our data show that vaccine misperceptions, in particular, tend to be correlated with misperceptions in several other domains, especially as they relate to health (GMOs, homeopathy, and 5G risks). As such, it is possible that anti-vaccine beliefs may “contaminate” other domains in an “oil-spill” model of belief consolidation (DellaPosta,

2020), or that they represent a larger latent construct around health misperceptions. Likewise, though anti-expert and conspiratorial worldviews are often conceived as individual differences, they also possess properties of social identities (Franks et al., 2017; Schulz et al., 2018). Such views coincide with an us-vs-them mentality and a rejection of supposedly naive outgroups (Franks et al., 2017), for instance. Future work, especially that which focuses outside entrenched two-party systems, may consider these as such alongside the standard political and religious groups in this literature.

Our findings underline the importance of country-specific strategies to correct misperceptions. If, as we find, Spaniards who hold anti-elite worldviews are particularly prone to resisting expert opinions, then any interventions in Spain ought to target and address these anti-elite worldviews.

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Supplemental material

Supplemental material for this article is available online.

Notes

1. Note that there are a number of expert panels or groups that have issued statements of GMO safety (in terms of both consumption and environmental effects). While there may be uncertainty about long-term GMO effects on the environment, there is no clear evidence that they do in fact harm the environment (Landrum et al., 2019).
2. The randomization strategy was not equal probability across all batteries. Those who were assigned to the GMO battery were excluded from being assigned to the vaccine battery and vice versa (this relates to participants who are excluded from analysis here because they received experimental treatments about those batteries). Similarly, those who were assigned to homeopathy were excluded from being assigned to 5G and vice versa.
3. Sycor employs the `wtd.cor` function from the “weights” package (Pasek, 2017) to return standard errors and *p*-values for the correlation coefficients
4. Correlations between climate change and homeopathy were less clear: We find a .2 correlation with the belief that homeopathy is an effective cure for cancer but only a non-significant .03 correlation with the belief that it is an effective cure for the flu.
5. Note that the randomization procedure described above means that we cannot compute correlations across all domains, hence the gaps in the table. We cannot compute the correlation between misperceptions in

- the domain of GMOs and vaccinations, or the correlation between the domains of 5G and homeopathy. The design also results in different case counts for each misperception.
- We also estimated models with supporters of Vox and Podemos, respectively, as reference categories. These additional tables can be found in the Supplemental Material.
 - It is worth noting that despite the opposite-signed associations for conspiracism and the GMO eating and GMO environment beliefs, there is a strong correlation between the items overall ($r = .52$) which decreases across conspiracism (within the lowest conspiracism tercile $r = .60$, within the highest conspiracism tercile $r = .43$) but remains fairly strong. Others have also noted seemingly inconsistent beliefs among those with conspiratorial worldviews (Wood et al., 2012).

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