Health Psychology
2018, Vol. 37, No. 4, 307–315

0278-6133/18/$12.00 http://dx.doi.org/10.1037/hea0000586

The Psychological Roots of Anti-Vaccination Attitudes: A 24-Nation Investigation

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Objective: Strengthening of antivaccination movements in recent decades has coincided with unprecedented increases in the incidence of some communicable diseases. Many intervention programs work from a deficit model of science communication, presuming that vaccination skeptics lack the ability to access or understand evidence. However, interventions focusing on evidence and the debunking of vaccine-related myths have proven to be either nonproductive or counterproductive. Working from a motivated reasoning perspective, we examine the psychological factors that might motivate people to reject scientific consensus around vaccination. To assist with international generalizability, we examine this question in 24 countries. ***Methods:*** We sampled 5,323 participants in 24 countries, and measured their antivaccination attitudes. We also measured their belief in conspiracy theories, reactance (the tendency for people to have a low tolerance for impingements on their freedoms), disgust sensitivity toward blood and needles, and individualistic/hierarchical worldviews (i.e., people's beliefs about how much control society should have over individuals, and whether hierarchies are desirable). ***Results:*** In order of magnitude, antivaccination attitudes were highest among those who (a) were high in conspiratorial thinking, (b) were high in reactance, (c) reported high levels of disgust toward blood and needles, and (d) had strong individualistic/hierarchical worldviews. In contrast, demographic variables (including education) accounted for nonsignificant or trivial levels of variance. ***Conclusions:*** These data help identify the "attitude roots" that may motivate and sustain vaccine skepticism. In so doing, they help shed light on why repetition of evidence can be nonproductive, and suggest communication solutions to that problem.

Keywords: vaccination, conspiracy beliefs, health communication, attitude roots

Supplemental materials: http://dx.doi.org/10.1037/hea0000586.supp

For the first time in a century, incidences of some communicable diseases—such as measles, mumps and pertussis—are on the increase in the United States (World Health Organization, 2017). Many commentators lay the blame for this epidemiological outbreak on an increase in anti-immunization activism, and the associated drop in immunization rates in some communities (Betsch, Renkewitz, Betsch, & Ulshöfer, 2010; van Panhuis et al., 2013). As a result, finding ways to overcome fears and myths about vaccinations has been an urgent priority for both health professionals and for researchers interested in science communication (Fischhoff & Scheufele, 2014).

When science communicators encounter an individual who holds attitudes in violation of scientific evidence, the most tempting and intuitive response is to keep repeating the evidence, and to do so as clearly and deftly as possible (i.e., explication). Epistemologically, this is satisfying: it is the defining mission of many scientists to defend facts and to defeat mis-information, and explication is consistent with that mission. It is also likely that, for people who are new to an issue or who have a genuinely open mind, explication is effective.

However, when it comes to converting skeptics, it is widely understood that there are limitations to this approach (Bain, Hornsey, Bongiorno, & Jeffries, 2012; Hart & Nisbt, 2012). First, the process of explication implies that the key problem with those who hold antivaccination attitudes is lack of exposure to information, or failure to understand information (the so-called deficit model of science communication). But there is no clear evidence for this: people who hold antivaccination attitudes are often no less educated than others (Larson, Jarrett, Eckersberger, Smith, & Paterson, 2014), and tend to spend a relatively large amount of time seeking information on the Internet about vaccinations (Jones et al., 2012).

Second, there is limited evidence that repeating evidence makes a demonstrable difference to the beliefs and behaviors of those who hold antivaccination attitudes. One approach has been to highlight antivaccination myths, and then to refute them with evidence. But a recent experiment conducted on 315 Americans suggested that the provision of corrective information had no significant effect on their vaccination attitudes (Horne, Powell, Hummel, & Holyoak, 2015). Other studies suggest the potential for boomerang effects. For example, two experiments on German

This article was published Online First February 1, 2018.

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The work reported in the current paper was supported by funding from the Australian Research Council (DP120100961).

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community members showed that extreme risk negation messages resulted in *increased* perceptions of vaccination risk (Betsch & Sachse, 2013). In another study, Americans were exposed to an intervention in which they were exposed to either (a) corrective information about the lack of evidence that the measles-mumps-rubella (MMR) vaccine causes autism, (b) text describing the dangers of the diseases prevented by MMR, (c) images of children suffering from diseases that can be prevented by MMR vaccine, or (d) a narrative describing the near-death experience of an infant who contracted measles (Nyhan, Reifler, Richey, & Freed, 2014). Compared to a control group, none of the interventions significantly improved participants' intentions to vaccinate a future child. In fact, participants who entered into the experiment with relatively low favorability toward vaccines showed *lower* intentions to vaccinate in the corrective information condition than the control condition.

The low effectiveness of information campaigns on people who are skeptical of vaccines can be explained through the lens of motivated reasoning (Browne, Thomson, Rockloff, & Pennycook, 2015). The principle of explication assumes that evidence drives attitudes. But increasingly researchers understand that the path also works the other way around: people develop an attitude—often through intuitions, emotions, and "gut" responses that are difficult for them to articulate (Haidt, 2001; Slovic, Finucane, Peters, & MacGregor, 2004) – and are motivated to search for evidence to support their attitude. In this process of motivated reasoning, evidence is sampled and critiqued selectively in order to reinforce what one *wants* to believe (Kunda, 1990). Weak, circumstantial or hearsay evidence is embraced to the extent that it reinforces the conclusion that one is motivated to reach. In contrast, scholarly evidence that is inconvenient or inconsistent with one's preferred conclusion can be discarded as corrupt, incorrect or irrelevant. Repeating evidence is not going to be effective for these people because it fails to address the underlying reason why they are processing the information in a biased way in the first place.

From this perspective, the key question is not "Why would people reject the evidence about vaccinations?" but rather "Why would people *want* to reject the evidence about vaccinations"? The "attitude roots" model of science rejection seeks to elucidate these underlying motivations (Hornsey & Fielding, 2017). The authors use a tree metaphor to explain this process. Above the surface—the leaves and branches in the metaphor - are the beliefs, myths and concerns that people hold (e.g., about vaccination). It is these "surface attitudes" that people see and hear, and that are the targets of the interventions described above. But according to the attitude roots model it is what is underneath the surface that is most important: the underlying fears, identity issues and worldviews that motivate people to embrace the surface attitudes. It is these "attitude roots" that lend the surface attitudes power (in the sense of holding the beliefs strongly), and stability (in that they allow the attitudes to survive in the face of contradictory evidence). Four of the attitude roots discussed in that theory paper form the basis for this paper: Conspiratorial beliefs, disgust sensitivity, reactance, and individualistic/hierarchical worldviews.

Conspiratorial Beliefs

There are a number of conspiracy beliefs that are circulated among antivaccination websites: most prevalent is the notion that Big Pharma and other vested interests exaggerate the benefits of vaccines and fail to report the dangers (Jolley & Douglas, 2014). For some, however, individual conspiracy beliefs are not held in isolation, but rather emerge from a unitary "conspiracist" worldview: that it is common for shadowy networks of people with malevolent intentions to execute mass hoaxes on the public in near-perfect secrecy. People who feel this is the way the world works—and for whom this worldview provides a neat way to order, predict and make sense of the universe—might be motivated to believe conspiracies about science, with negative impacts on vaccination intentions. Indeed, there is evidence from an online American sample that people's willingness to endorse conspiracies generally (e.g., about the assassination of John F. Kennedy or the death of Princess Diana) are positively correlated with a range of "anti-science" attitudes, including antivaccination attitudes (Lewandowsky, Gignac, & Oberauer, 2013; see also Lewandowsky, Oberaruer, & Gignac, 2013).

Disgust

According to the model of attitude roots, (sub)clinical fears and phobias can underpin some antiscience beliefs. For example, some people have heightened disgust reactions to needles, hospitals and blood. People who experience these heightened disgust reactions might be tempted to develop a set of attitudes that gives them permission to avoid the triggers for their disgust; for example a rejection of techno-medical interventions, and a skepticism or hesitancy toward immunizations. Consistent with this notion, there is evidence that disgust sensitivity correlates with people's beliefs about trust-sensitive scientific advances such as attitudes toward vaccination (Clay, 2017) and genetically modified foods (Scott, Inbar, & Rozin, 2016).

Reactance

The "value-expressive" function of an attitude captures the capacity of an attitude to communicate to yourself and others the type of person that you would like to be. According to the model of attitude roots, one function that "anti-science" beliefs might have is to establish one's reputation as a nonconformist; someone who is skeptical of consensus views and intolerant of people telling them how to think (i.e., as someone high in reactance; Brehm & Brehm, 1981). To the extent that people nurture this self-image, they may be motivated to reject consensus views (like "immunization is good") as a short-hand way of communicating a nonconformist identity to the self and others.

Individualism—Hierarchy Worldviews

The theory of cultural cognition makes the case that culturally ingrained ideological orientations shape appraisals of risk, evidence, and scientific consensus (Kahan, 2010). The theory focuses on two types of worldviews: individualism/communitarianism and hierarchialism/egalitarianism. The individualism construct focuses on the extent to which people think it is preferable for individuals to make decisions for themselves, as opposed to society and government making decisions for individuals. The hierarchialism construct focuses on the extent to which people think that hierarchies and power differences are natural and healthy parts of

society, as opposed to thinking that society needs more equality and egalitarianism. Although they are distinct constructs, theory and research shows that they share certain attitudinal correlates. For example, people who subscribe to relatively individualistic and hierarchical values are more inclined to value commerce and free enterprise, and so are motivated to believe that "big government" is a problem. In contrast, people who subscribe to relatively egalitarian and communitarian values are more likely to have a moral suspicion of "big business", and so are motivated to embrace the risk that commerce and free enterprise present to the environment and to people (Kahan, 2010). Although these ideological variables have been shown to have a robust relationship with some "anti-science" beliefs (e.g., climate skepticism; Hornsey, Harris, Bain, & Fielding, 2016) the link with vaccination attitudes is less clear. On one hand it is possible that moral suspicion of big business would generalize to a moral suspicion of "Big Pharma", which in turn would be associated with a skepticism or hesitancy toward vaccinations. On the other hand, it is possible that immunization might be viewed as an excessive "big government" initiative, and so be treated with skepticism by those high in individualist and hierarchical worldviews. Consistent with this, hierarchical beliefs are associated with higher perceptions of HPV vaccine risk (Kahan, Braman, Cohen, Gastil, & Slovic, 2010), and vaccine support is negatively correlated with belief in the free market (Lewandowsky, Gignac, & Oberauer, 2013).

In sum, the notion of attitude roots allows for a fresh perspective on what the barriers to vaccination uptake might be: away from beliefs and concerns, and toward the underlying factors that motivate those beliefs and concerns. However, there is only a small body of work that has examined the empirical case for whether these attitude roots are implicated in antivaccination attitudes. Where the links have been drawn—between anti-immunization beliefs and disgust sensitivity (Clay, 2017) and conspiratorial beliefs (Lewandowsky, Gignac, & Oberauer, 2013) - they have been examined in single-nation (American) data sets. This restricted geographical reach means that it is difficult to extrapolate conclusions to nonindustrialized nations, where the benefits of immunization are acute, but where skepticism of technomedical interventions can be relatively high. The existing studies also examined attitude roots in isolation, without controlling for other relevant attitude roots. The current study draws on community samples from 24 nations, allowing us for the first time to examine the extent to which each of these attitude roots uniquely predict antivaccination attitudes, and to do so with a global empirical reach. Drawing on extant theory and research, we test the prediction that antivaccination attitudes would be associated with more conspiratorial beliefs, higher levels of disgust, greater reactance, and stronger individualistic and hierarchical worldviews.

Method

Participants

Data were collected between March 31 and May 11, 2016, using the data collection company Survey Sampling International (SSI). Before beginning the survey, potential participants were asked "what country do you live in?" Respondents were screened out of the study if they stated that they lived in a nation other than the nation being sampled ($n = 692$). Participants with more than 90% data points missing (participant drop-outs) were also excluded from analyses ($n = 60$). This left 5323 usable participants. Sample size was determined to ensure that each of the samples met or exceeded the recommended sample sizes for reliable correlations (Bonett & Wright, 2000). For demographic information broken down by sample, see Supplemental Table S1 online.

SSI was chosen due to their emphasis on representativeness of panel respondents, whereby their global panel comprises relatively representative distributions of gender and age. As can be seen in Supplemental Table S1, our sample was indeed representative for gender (49.9% female). Given that participants needed to be 18 or over to complete the survey, one would expect that our sample would be somewhat older than the population of the respective countries. Even so, the median ages of our samples were, on average, only 4.32 years older than the median age of the respective national populations. One limitation of online samples is that they tend to be more educated than the general population. Overrepresentation of tertiary educated people among the 16 OECD nations in our sample was relatively modest (on average, there was only a 4.01% difference between the percentage of tertiary educated participants in our sample and the percentage of tertiary educated people in the respective populations of the 16 OECD nations). For non-OECD nations, however, the overrepresentation of educated participants was more pronounced. In order to address the potential issues associated with our sampling, we included demographic factors such as education, age, and gender as control variables in key analyses. As will be elaborated below, however, it should be noted that age and education did not have a significant unique relationship with antivaccination attitudes.

The choice of 24 nations was constrained partly by the ability of SSI to reach a satisfactory sample in the relevant nation; consequently, countries with very little Internet penetrations are not represented in the survey. In addition to the 24 countries we also collected a sample from Hong Kong: Hong Kong is an autonomous territory within China, and in our analyses we distinguished between this sample and the sample from mainland China. In choosing countries, we were also mindful of ensuring a broad cross-section of geographical regions (six continents are represented) and cultural orientations (we aimed to have a broad spread of both individualistic and collectivist cultures, e.g.). Participants who did not self-identify as members of the requested nations were excluded from the study. Participants received monetary compensation for their time, which was determined by SSI and adjusted for each country, such that the purchasing power of each reimbursement was consistent across countries.

Materials

Measures of antivaccination attitudes, conspiratorial beliefs, disgust, reactance, and individualism/hierarchical worldviews are summarized below; the full list of items can be found in the supplemental materials online. As can be seen there, some items were adapted to avoid colloquialisms and other culture-specific words and concepts. Questionnaires were translated into the native language of non-English speaking samples using translation/back-translation procedures: concerns about comprehension and translatability were flagged and addressed during that process. The four predictors were presented in a randomized order. The predictors were followed by a measure of the outcome variable (vaccination

attitudes) and finally by demographics. This research was approved by the Behavioral and Social Sciences Ethical Review Committee of the University of Queensland (ethics clearance #2015000181).

Conspiratorial beliefs. Of the conspiratorial beliefs used by Lewandowsky, Gignac, and Oberauer (2013), we measured four that we considered to have worldwide recognition: conspiracies surrounding the assassination of President John Kennedy, the death of Princess Diana, the existence of a New World Order, and American government knowledge of the 9/11 terrorist attacks. Participants rated their agreement with the conspiracy statement on a 5-point scale (1 = *strongly disagree*; 5 = *strongly agree*) but with a sixth option for people who "don't know." Participants choosing the "don't know" option were treated as missing values on this scale. Mean scores for the individual conspiracy beliefs ranged from slightly above the midpoint (JFK: $M = 3.44$) to slightly below (9/11 and New World Order: *Ms* both = 2.78). Consistent with the notion of conspiracy beliefs forming part of a unitary worldview, endorsement of each conspiracy theory was positively correlated and so the four items were combined into a single scale ($\alpha = .81$).

Disgust. Disgust was measured using the "blood and injection" subscale of the Disgust Emotion Scale (Olatunji, Sawchuk, de Jong, & Lohr, 2007). Participants rated the extent to which they would feel disgust or repugnance if they were exposed to 6 objects or events including "A small vial of your blood" and "receiving an anesthetic injection in the mouth" (1 = *no disgust or repugnance at all*; 5 = *extreme disgust or repugnance*). Scores were combined into a highly reliable scale ($\alpha = .90$).

Reactance. Reactance was measured using a selection of items from the Hong Psychological Reactance Scale (Hong & Page, 1989). On a 5-point scale (1 = *strongly disagree*; 5 = *strongly agree*) participants rated their level of agreement with five statements such as: "I find contradicting others stimulating" and "I consider advice from others an intrusion." Higher scores reflect greater dispositional reactance ($\alpha = .64$).

Individualism—hierarchy worldview. The cultural cognition dimensions were measured using the Cultural Cognition Worldview Scale (Kahan et al., 2010). Individualism-communitarianism was measured with 17 items including "The government interferes far too much in our everyday lives" and "It's society's responsibility to make sure everyone's basic needs are met" (reversed). Hierarchy-egalitarianism was measured with 13 items including "We have gone too far in pushing equal rights in this country" and "Our society would be better off if the distribution of wealth was more equal" (reversed). All items were responded to on a 6-point scale (1 = *strongly disagree*; 6 = *strongly agree*) and each scale displayed adequate internal consistency (αs = .68 and .61, respectively). However, the scales were significantly correlated, $r = .32$, $p < .001$. Thus, to avoid these variables competing with each other for unique variance in the regression model, we combined the two scales into a single measure of individualism/hierarchy (at the top end of the scale) and communitarianism/egalitarianism (at the bottom end of the scale).

Attitudes toward vaccinations. Attitudes toward vaccinations were measured using seven items from the Beliefs About Vaccine Safety and Efficacy subscale of the Parent Attitudes About Vaccines Scale (Opel et al., 2011). Participants rated how much they agreed with four statements about vaccine safety and efficacy, including "Children get more vaccinations than are good for them" and "It is better for children to get fewer vaccinations all at the one time" (1 = *strongly disagree*, 5 = *strongly agree*). They also rated how concerned they were about three issues associated with vaccinations, such as "that any one of the childhood vaccines might not be safe" and "that a vaccine might not prevent the disease." For the last three items participants responded on a 5-point scale from 1 (*not at all concerned*) to 5 (*very concerned*) but with a sixth item to register that the item was "not applicable" (scores of 6 were treated as missing values). Note that, although the items assess intentions to vaccinate children, they do not presuppose that participants have children themselves. The items were combined into a single scale, with high scores indicating high levels of concern about the safety and effectiveness of vaccines ($\alpha = .71$). However, removal of the one negatively worded item ("Many of the illnesses that vaccines prevent are severe") resulted in a substantial increase in reliability ($\alpha = .77$) and so we analyzed the 6-item scale.

Analytic Plan

We calculated bivariate relationships by conducting a series of meta-analyses across the 25 samples using the metafor package (Viechtbauer, 2010). All effect sizes were weighted by sample size and calculated using random-effects estimation, specifically, the restricted maximum-likelihood estimation. We then conducted a regression analysis to examine the unique predictive power of each of our variables. To account for the nesting of individuals within countries, we used the lme4 package (Bates, Mächler, Bolker, & Walker, 2015) to conduct mixed-effects modeling (i.e., modeling both within- and between-country variance and covariance). All predictor variables were measured at the individual level (i.e., Level 1) and were group-mean centered at the country level.

Results

Means and Bivariate Correlations

Means and standard deviations within each of the 25 samples are summarized in Table 1. The mean score for the overall sample suggests slightly above-midpoint concerns about the safety and efficacy of vaccination ($M = 3.26$). The scores on antivaccination attitudes were reasonably normally distributed, with 14.8% reporting strong antivaccination attitudes ($M > 4.01$), 39.2% reporting moderately strong antivaccination attitudes ($M = 3.01–4$), 36.2% reporting moderately strong provaccination attitudes ($M = 2.01–3$); and 9.8% reporting strong provaccination attitudes ($M = 2$ or below). As can be seen in Table 1, the strongest antivaccination attitudes tended to be in Asia, and the weakest antivaccination attitudes tended to be in the West.

Figures 1–4 detail country-level correlations between antivaccination attitudes and conspiratorial beliefs, reactance, disgust, and individualism-hierarchy. Table 2 summarizes correlations among variables after being pooled across the 25 samples (indices of cross-sample variability are in Supplemental Table S2 online). Analysis of the pooled correlations showed that antivaccination attitudes featured in significant bivariate relationships with all four of our predictors. The strongest pattern was that participants who displayed more conspiratorial beliefs held more antivaccination attitudes, $r = .334$, $p < .001$. As can be seen in Figure 1, this relationship emerged signifi-

Table 1
Means and Standard Deviations Across 25 Samples

Country	*n*	Anti-vaccination	Conspiratorial beliefs	Reactance	Disgust	Individualism–hierarchy
Argentina	231	3.21 (.71)	3.22 (.92)	3.24 (.68)	2.02 (1.05)	3.26 (.44)
Australia	208	2.72 (.93)	2.63 (1.05)	3.17 (.61)	2.20 (1.09)	3.41 (.59)
Brazil	221	3.06 (.85)	2.70 (1.04)	3.14 (.71)	2.03 (1.13)	3.33 (.45)
Canada	211	2.88 (.99)	2.80 (1.17)	3.11 (.66)	2.28 (1.11)	3.36 (.62)
Chile	218	3.48 (.69)	3.42 (.98)	3.11 (.63)	1.85 (.85)	3.24 (.47)
China	204	3.78 (.60)	3.37 (.83)	3.29 (.53)	2.67 (1.13)	3.28 (.36)
France	211	3.22 (.84)	2.83 (1.04)	3.26 (.56)	2.13 (1.11)	3.39 (.50)
Germany	210	2.96 (.90)	2.99 (1.07)	3.19 (.73)	2.26 (1.15)	3.24 (.47)
Hong Kong	210	3.51 (.54)	3.10 (.81)	3.28 (.47)	2.59 (1.09)	3.48 (.24)
India	203	3.72 (.81)	3.24 (1.04)	3.47 (.78)	2.96 (1.14)	3.48 (.38)
Indonesia	207	3.53 (.68)	3.45 (.91)	3.19 (.61)	2.67 (1.09)	3.33 (.32)
Ireland	207	3.17 (.86)	2.84 (1.08)	3.24 (.54)	2.24 (1.05)	3.31 (.55)
Japan	210	3.43 (.60)	3.06 (.83)	3.26 (.60)	3.19 (1.06)	3.33 (.31)
Mexico	227	3.44 (.63)	3.53 (.84)	3.11 (.67)	1.95 (.94)	3.36 (.38)
New Zealand	211	3.00 (.87)	2.60 (1.11)	3.15 (.57)	1.97 (1.02)	3.42 (.58)
Philippines	204	3.80 (.62)	3.19 (.99)	3.38 (.68)	2.76 (1.24)	3.46 (.36)
Poland	217	2.89 (.83)	2.95 (.83)	3.64 (.63)	2.16 (1.06)	3.53 (.42)
Portugal	219	3.22 (.73)	3.17 (1.07)	3.14 (.61)	2.08 (1.09)	3.12 (.47)
Singapore	207	3.61 (.59)	3.03 (.86)	3.25 (.62)	2.62 (.95)	3.43 (.35)
South Africa	225	3.24 (.83)	3.07 (1.05)	3.31 (.68)	2.40 (1.13)	3.44 (.49)
South Korea	215	3.27 (.65)	3.22 (.84)	3.12 (.54)	2.86 (1.02)	3.29 (.38)
Spain	214	3.27 (.68)	2.97 (1.05)	3.19 (.73)	2.11 (1.11)	3.22 (.45)
Sweden	212	2.98 (.82)	2.49 (1.01)	3.09 (.59)	2.14 (1.04)	3.33 (.61)
UK	214	3.03 (.93)	2.78 (1.09)	3.31 (.73)	2.24 (1.18)	3.46 (.50)
USA	207	3.05 (.96)	2.71 (1.14)	3.24 (.66)	2.32 (1.14)	3.58 (.74)
Total sample	5,323	3.26 (.83)	3.02 (1.03)	3.23 (.65)	2.35 (1.13)	3.36 (.48)
% missing values		5.3%	7.3%	2.3%	5.3%	1.3%

Note. All scores range from 1–5, except individualism–hierarchy (1–6).

cantly in all 25 samples, and seemed to be particularly strong among Western nations (e.g., Australia, Canada, Germany, U.K., U.S.A.).

The next most consistent relationship was with reactance: the more people reported resisting influence and incursions on their freedom, the more they held antivaccination attitudes, $r = .235$, $p < .001$. This relationship was significant in 22 of 25 samples (see Figure 2). Stronger antivaccination attitudes were also found among those who experience relatively high levels of disgust about blood and injections, a relationship that was significant in 17 of 25 cultures ($r = .201$, $p < .001$; see Figure 3). Finally, antivaccination attitudes were stronger the more participants endorsed an individualistic/hierarchical worldview, $r = .186$, $p < .001$. Although this effect was relatively consistent across samples (20 of 25 samples, Figure 4) it was the weakest relationship in terms of effect size.

It is notable that these psychological predictors accounted for more variance than demographic factors. Strikingly, analysis of the pooled correlations showed that education had no significant relationship with vaccination attitudes, $r = -.009$, $p = .646$; neither did gender, $r = .012$, $p = .472$. Younger, $r = -.046$, $p = .012$ participants were significantly more skeptical, although this relationship accounted for a very small amount of variance. More conservative participants, $r = .102$, $p < .001$ also had stronger antivaccination attitudes.

Mixed-Effects Regression Modeling

Mixed-effects regression modeling was used to examine the unique predictive power of each of our variables. The intraclass correlation ($\rho_{ICC} = 0.12$) shows that within-country variation accounted for 88% of the total variance in antivaccination attitudes. Model 1 estimated the fixed effects of reactance, conspiratorial beliefs, individualism-hierarchy, and disgust on attitudes toward vaccinations, controlling for differences in scores and relationships across countries (random intercepts and slopes, see Table 3). Conspiratorial beliefs were the strongest predictor of antivaccination attitudes, followed by reactance, disgust, and individualism-hierarchy, all ps $< .001$. Hence, participants scoring higher on conspiratorial beliefs, disgust, reactance, and individualism-hierarchy were more likely to hold antivaccination attitudes.

Model 2 added fixed effects of age, gender, education, and political ideology (the sample size for this final model was 4688, with 12% of the sample excluded due to missing values on one or more of the measured variables). The effects of conspiratorial beliefs, reactance, disgust, and individualism-hierarchy were almost identical to those reported for Model 1 (see Table 3). Conspiratorial beliefs were again the strongest predictor of antivaccination attitudes, followed by reactance, disgust, and individualism-hierarchy, all ps $< .001$. Political ideology significantly predicted antivaccination attitudes such that more conservative participants were more likely to hold antivaccination attitudes, $p < .001$. Age, gender, and education were nonsignificant predictors of antivaccination attitudes, ps $> .178$.

Discussion

The current study is the first systematic test of the notion of attitude roots and their association with antivaccination attitudes. The data identify barriers to immunization that are deeper (and presumably more distal) than specific attitudes and beliefs about immunization,

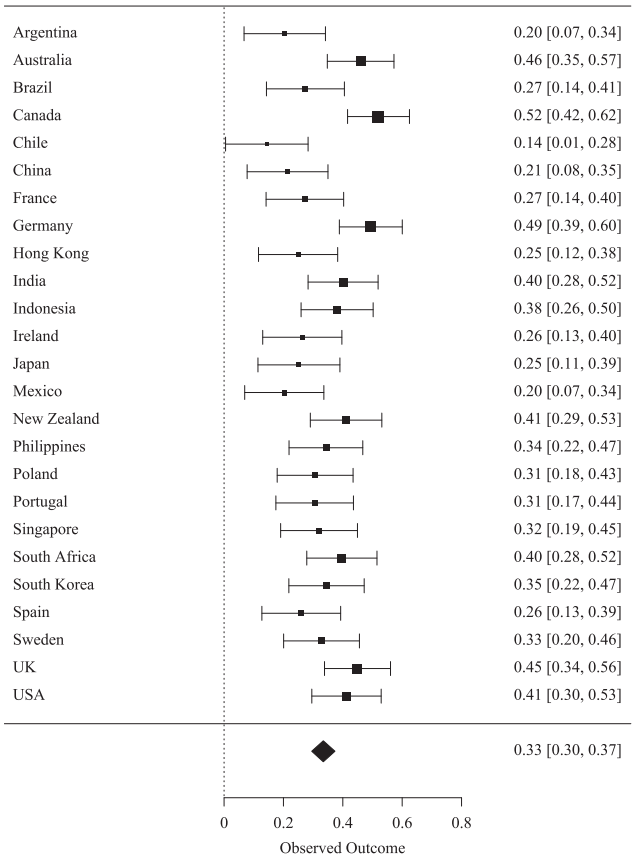

Figure 1. Relationship between conspiratorial beliefs and antivaccination attitudes across 25 samples. Effect sizes to the right indicate larger correlations.

such as risk and myth endorsement. An advantage of doing this is that it opens up novel opportunities to promote vaccination intentions, ones that do not rely on repeating evidence.

According to the attitude roots model, one way to create change is to identify underlying motives for rejecting the science on immunization, and then to tailor interventions that are congenial to those underlying motivations (the so-called *jiu jitsu* approach; Hornsey & Fielding, 2017). From this perspective, the goal of science communication is to align with people's underlying fears, ideologies and identities, thus reducing people's motivation to reject the science. If the motivation to reject the science is reduced, then people should become more willing to embrace the evidence on its merits.

The current data identified three underlying attitude roots that are meaningfully implicated in antivaccination attitudes: conspiratorial beliefs, reactance, and disgust/fear toward blood and needles (the fourth predictor—individualistic/hierarchical worldviews—explained only a small amount of variance and so will not be discussed further). The particularly strong role of conspiratorial beliefs helps contextualize why corrective information and myth-busting about vaccinations has tended to be either ineffective or counterproductive. For most people, official health messages asserting a scientific consensus about vaccination are reassuring and imply an underlying reality (the "consensus implies correctness" heuristic). But for those who have a conspiratorial worldview, these same ingredients—official pronouncements that imply a lack of dissent or that the "science is in"—can be inverted to be proof of a conspiracy. From a *jiu jitsu* approach it is counterproductive to try to reduce people's conspiratorial thinking (and there is no evidence that this is feasible). Rather, one should work with people's underlying worldviews: to acknowledge the possibility of conspiracies, but to show how vested interests can conspire to obscure the benefits of vaccination and to exaggerate the dangers.

Similar methods might be possible for the other two predictors identified in this paper. It might not be feasible to reduce people's levels of reactance. But it might be possible to align vaccination messages with that individual difference factor, by implying that antivaccination movements are high-pressure, highly conformist organizations in which individual freedoms are discouraged. For those who have high disgust toward needles and blood, avoidance of vaccination is a short-term anxiety reduction strategy. But interventions may be able to disable that strategy by reminding people of the consequences of disease in terms of hospitalization, illness symptoms, and exposure to surgery, blood and needles. This may help explain why, of the interventions tested by Nyhan and colleagues (2014), among the most effective (or least noneffective) in terms of vaccination intentions was exposure to dramatic narratives and images about children suffering from measles.

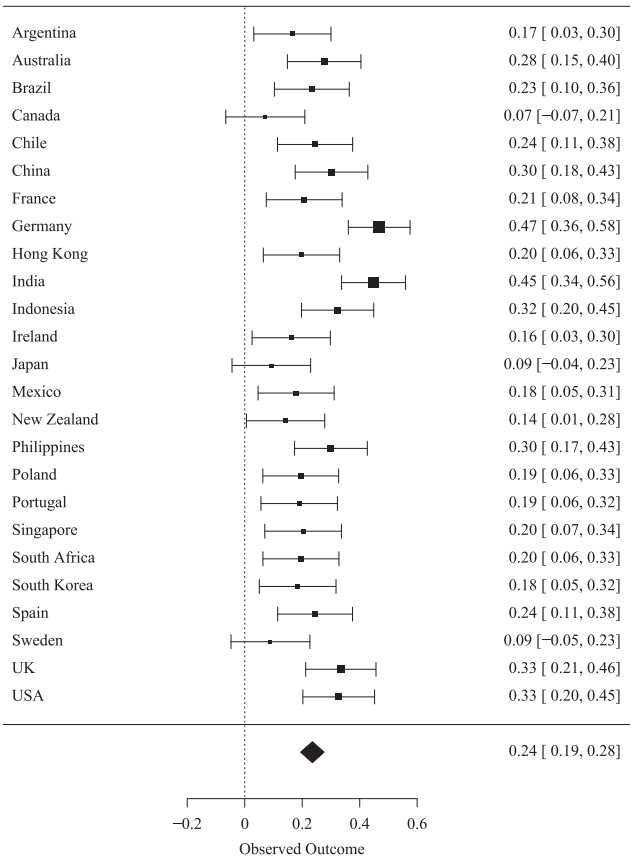

Figure 2. Relationship between reactance and antivaccination attitudes across 25 samples. Effect sizes to the right indicate larger correlations.

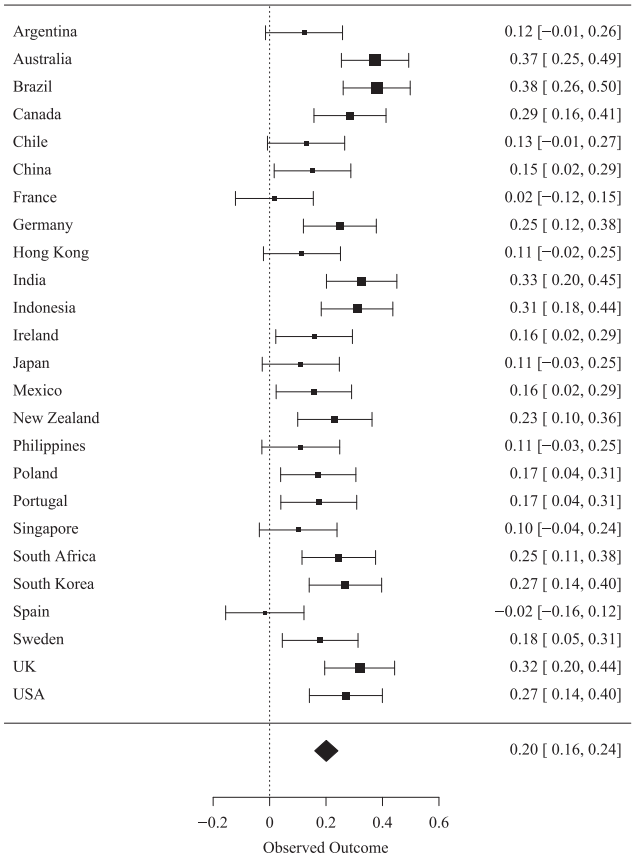

Figure 3. Relationship between disgust and antivaccination attitudes across 25 samples. Effect sizes to the right indicate larger correlations.

Limitations and Future Directions

Like most samples collected over the Internet, our sample is likely restricted to people with relatively high levels of literacy. As noted earlier, the current samples tended to overrepresent highly educated individuals, and as such the generalizability of the effects to less-educated people is not clear.

Given the cross-sectional nature of our design, causal interpretations of the data are speculative. To reduce the possibility that the significant relationships are artifacts of latent third variables, we have controlled for demographic factors such as age, gender, education, and political ideology. However, we are also mindful of the possibility that the relationships reflect examples of reverse causation. For example, it is plausible that someone who had an experience that triggered vaccine hesitance would then develop more general conspiratorial beliefs as they are exposed to conspiratorial material about vaccinations. In the future, issues of causality might best be addressed through large-scale longitudinal surveys.

Our outcome measure is an attitudinal measure; we have no measures of intentions or behaviors around vaccination uptake. Theoretically, we believe that the psychology underpinning antivaccination attitudes is an interesting question in its own right. However, we acknowledge that attitudes are an imperfect proxy for behaviors, and care should be taken not to presume that one necessarily leads to the other. Future studies would benefit from having more explicit measures of behaviors. In so doing, it would also be of value to nuance between parents and nonparents in terms of their vaccination decisions, an issue that lay outside the scope of the current analysis.

We also acknowledge that there are pragmatic challenges associated with the jiu jitsu style of persuasion described earlier. Given that no single message can canvass all of the possible underlying motivations for rejecting science, jiu jitsu persuasion relies on diverse messages delivered through multiple channels to appeal to different segments of the population. The attraction of tailored messaging is clear, but we emphasize that the success of jiu jitsu persuasion rests on marketing and technological sophistication as much as it relies on psychological understanding.

On the question of communication strategy, we acknowledge that some of the effects reported here—while statistically significant—are small. Disgust, for example, accounts for less than 10% of variance in antivaccination attitudes in all but two countries (see Figure 3). Furthermore, although conspiratorial beliefs share a reliable and significant relationship with antivaccination attitudes across all 25 samples, inspection of Figure 1 shows that the effects in some cultures (particularly in Asia and South America) are modest in size. This suggests that conspiracy-related interventions may be less of a priority in these cultures than in the industrialized West. However, it

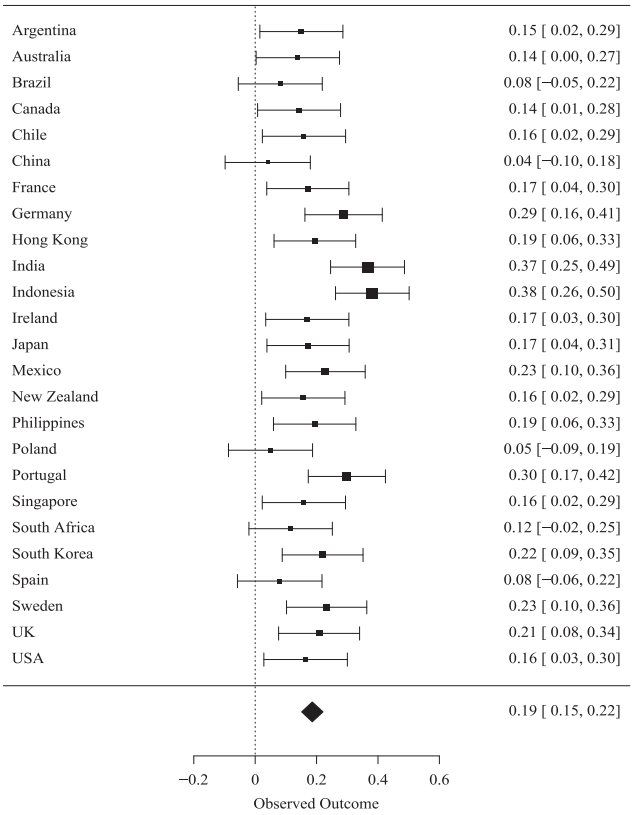

Figure 4. Relationship between individualism-hierarchy and antivaccination attitudes across 25 samples. Effect sizes to the right indicate larger correlations.

Table 2
Inter-Correlations Among Variables

	2	3	4	5	6	7	8	9
1. Anti-vaccination	.33***	.24***	.20***	.19***	.10***	−.05*	.01	−.01
2. Conspiratorial beliefs		.25***	.17***	.22***	.06**	−.10***	−.02	−.04*
3. Reactance			.13***	.24***	.03	−.07***	−.01	−.04*
4. Disgust				.13***	.11***	−.17***	.07***	−.01
5. Individualism–hierarchy					.31***	.02	−.13***	−.06**
6. Political ideology						.04*	.01	−.01
7. Age							−.10***	.01
8. Gender								−.03*
9. Education								

Note. Correlations (*r*s) are pooled effects across 25 independent samples.
* $p < .05$. ** $p < .01$. *** $p < .001$.

should also be noted that some of the relationships in the rich, industrialized Western nations are relatively large: in Australia, Canada, Germany, New Zealand, U.K. and the U.S.A., knowing people's beliefs about conspiracies in general helps account for 17–27% of variance in antivaccination attitudes. This is a nontrivial amount of explanatory power, particularly since this measure does not make any reference to vaccinations or health-related beliefs.

In sum, the current results suggest new understandings of the psychological factors that motivate people to want to reject the science on vaccinations. Understanding these underlying motivations opens up new possibilities in terms of promoting more vaccination uptake, interventions that work in alignment with (rather than against) the effects of motivated reasoning on people's ability to embrace counterattitudinal information.

Table 3
Mixed-Effects Models of Anti-Vaccination Attitudes Across 25 Samples

	Model 1	Model 2
	β (*SE*)	β (*SE*)
Fixed effects		
Intercept	.0009 (.07)	−.048 (.08)
Age		.013 (.01)
Gender		.034 (.03)
Education		>.001 (.01)
Political Ideology		.047 (.01)***
Conspiratorial beliefs	.245 (.02)***	.247 (.02)***
Reactance	.125 (.02)***	.126 (.02)***
Disgust	.119 (.02)***	.119 (.02)***
Individualism–hierarchy	.074 (.02)***	.059 (.02)***
	Variance (*SD*)	Variance (*SD*)
Random Effects		
Intercept	.120 (.35)	.120 (.35)
Residual	.732 (.86)	.728 (.85)
N Samples	25	25

Note. β = standardized fixed effects; SE = Standard Errors; *SD* = Standard Deviation. Gender is coded 1 = male and 2 = female. Both models include random slopes for conspiratorial beliefs, reactance, disgust, and individualism-hierarchy. Because the disgust measure had significant positive skew, we conducted a square root transformation of disgust and included it in the final mixed effects model. Interpretation of results were unchanged; hence we report the model with the untransformed disgust variable.
*** $p < .001$.

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Received June 20, 2017
Revision received October 4, 2017
Accepted October 27, 2017 ■