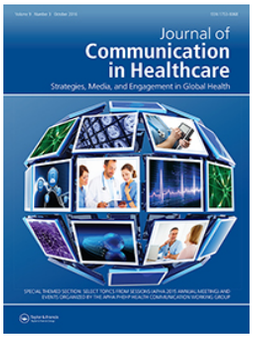

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What makes anti-vaccine websites persuasive? A content analysis of techniques used by anti-vaccine websites to engender anti-vaccine sentiment

Meghan Bridgid Moran[1], Melissa Lucas[2], Kristen Everhart[3], Ashley Morgan[4], Erin Prickett[5]

[1]Department of Health, Behavior & Society, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD, USA
[2]Department of Communication, University of Maryland, College Park, MD, USA
[3]Department of Communication Studies, University of Nebraska-Lincoln, Lincoln, NE, USA
[4]School of Communication, San Diego State University, San Diego, CA, USA
[5]College of Arts & Sciences, University of San Diego, San Diego, CA, USA

Correspondence to:

Meghan Bridgid Moran, Department of Health, Behavior & Society, Johns Hopkins University Bloomberg School of Public Health, 624 North Broadway, Hampton House, 706, Baltimore, MD, USA.
mmoran@jhu.edu

Abstract

Anti-vaccine sentiment can be extremely resistant to change, making it difficult to promote childhood vaccines. Thus, there is a need for effective strategies to communicate the benefits of vaccination to vaccine hesitant parents. Understanding how anti-vaccine advocates successfully persuade parents against vaccinating their children can provide insight into communication tactics that could be incorporated into vaccine promotion efforts. The internet is an important source of vaccine information for many parents, and plays a role informing vaccine hesitancy. To understand what might make anti-vaccine websites so convincing, we used persuasion theory as a lens to examine what information was being presented, and the persuasive tactics being used to communicate the information. We conducted a content analysis of 480 anti-vaccine websites. Four trained coders coded sites for the content of the vaccine information being presented, types of persuasive tactics used, and values and lifestyle norms associated with anti-vaccine advocacy. Anti-vaccine websites contain a considerable amount of misinformation, most commonly that vaccines are dangerous, cause autism and brain injury. Websites used both scientific evidence and anecdotes to support these claims. Values such as choice, freedom, and individuality were linked to anti-vaccine beliefs. The most commonly co-promoted behaviors included the use of alternative medicine and homeopathy, and eating a healthy or organic diet. Anti-vaccine websites use a battery of effective persuasive techniques to forward their agenda. The use of similar persuasive techniques and tapping into parents' values and lifestyles are potentially useful strategies for vaccine promotion communication.

Keywords: Vaccine hesitancy, Vaccine communication, Anti-vaccine websites, Vaccination, Immunization, Vaccine refusal, Health communication, Content analysis

Introduction

Childhood vaccines are an important tool to prevent disease. However, an increasing number of parents opt to delay or refuse vaccination, obtaining nonmedical exemptions on the grounds of religious or philosophical objections.[1–3] Nonmedical exemptions tend to be geographically clustered, increasing the likelihood that vaccine-preventable diseases spread through a community and thus presenting a significant threat to public health.[4–7] Efforts to encourage vaccine hesitant parents to vaccinate their children are critical.

Despite the need for effective vaccine promotion, little is known about the best strategies for encouraging vaccine hesitant parents to vaccinate their children.[8] Existing vaccine promotion interventions

continue to encounter significant challenges.[8–11] Most often, these interventions target parents' beliefs about vaccines by utilizing an information-based approach through which parents receive information about the benefits and safety of vaccines, and the risks of non-vaccination. These standard educational approaches may be perceived by parents to 'over sell' vaccines and do not always result in parents' pro-vaccination comprehension.[12,13] For example, Nyhan *et al.*[9] tested four standard vaccine education strategies and found that none increased parental intent to vaccinate. In fact, one message designed to correct parents' misperception of a link between autism and the measles-mumps rubella (MMR) vaccine produced a boomerang effect, decreasing intent to vaccinate among the most vaccine hesitant parents.

The strength of these negative attitudes toward vaccines, even in the face of facts and evidence, is striking. Understanding how vaccine hesitancy is formed can provide insight regarding the persistence of negative sentiment toward vaccines. The Internet is a key source of vaccine information for parents and can play a critical role in the formation of vaccine hesitancy.[10,14,15] A significant number of websites present misleading and inaccurate information about vaccines and display considerable mistrust in medical authorities.[16–21] In addition to more traditional static 'Web 1.0' websites, communication via social media sites can also affect vaccine perceptions.[18,22–24] In particular, the interactive and interpersonal nature of many social media sites could make posted anti-vaccine content particularly potent.[25]

Understanding how anti-vaccine content on the web (including both traditional 'Web 1.0' websites and 'Web 2.0' sites or social media) convinces parents of the merits of such misinformation may help illuminate why negative sentiment toward vaccines is so resistant to change, and provide insight regarding how healthcare providers and practitioners can better communicate about vaccines. To this end, we conducted a content analysis to better understand not only what is being communicated about vaccines, but *how* that information is communicated.

Theoretical framework

Literature on persuasive communication offers guidance for understanding how anti-vaccine websites might engender anti-vaccine beliefs and attitudes that are so resistant to persuasion.[26] To theoretically ground our content analysis of anti-vaccine websites, we use social judgment theory,[27–29] cognitive dissonance theory[30] and (aptly) inoculation theory[31] to guide our inquiry into anti-vaccine websites.

Social judgment theory

Social judgment theory offers insight as to how anti-vaccine sentiment can be so strongly anchored and resistant to vaccine promotion messages. According to social judgment theory,[27–29] in addition to valence (positive/negative), attitudes vary on strength. Individuals may have attitudes that are very strongly held or that they may not feel very strongly about. When an individual is exposed to a persuasive message, the position (that is, valence and strength) of their initial attitude informs how they perceive and respond to a persuasive message. When individuals have an attitude that is not strongly held, they typically will be receptive to a wider range of persuasive messages. This range of positions that an individual deems acceptable is known as a latitude of acceptance.[32] For example, a parent who has a weak attitude towards vaccines and does not feel strongly about the merits or perceived downsides of vaccination, would likely have a large latitude of acceptance and thus could readily be persuaded in favor of, or against, vaccines.

However, a parent who feels passionately against vaccines would likely have a narrow latitude of acceptance. This parent would find only those persuasive messages that are very similar to his or her anti-vaccine attitude acceptable. Social judgment theory posits that such strong attitudes can be a function of ego-involvement with a particular topic.[32] When an individual is highly ego-involved with a topic – that is, when an attitude is 'central to [one's] sense of self'[32] – attitude strength increases. Thus, the attitude of an individual who is highly ego-involved in a topic should have a small latitude of acceptance, and consequently be very difficult to change.

Individuals with strongly held attitudes typically have small latitudes of acceptance around those attitudes, making them difficult to change. Moreover, when a persuasive message falls outside an individual's latitude of acceptance, that individual may engage in perceptual contrast – that is, she or he may perceive the message to be more extreme than it actually is. For example, a parent with a strongly held anti-vaccine attitude may misperceive a message touting the efficacy of vaccines as unilaterally endorsing the use of any vaccine, regardless of safety. Thus, it would be difficult to persuade that parent to shift their attitude too far from their initially held position. It is crucial, then, for a pro-

vaccine message to advocate for a position that falls within parents' latitudes of acceptance to maximize its' effectiveness.

Cognitive dissonance theory

Cognitive dissonance theory[30] provides additional insight into why certain attitudes may be so strongly held and resistant to change and offers a framework for understanding how pro-vaccine messages could be crafted so that they fall into parents' latitudes of acceptance. Cognitive dissonance theory posits that individuals have an innate drive for consistency. When two cognitive elements (attitudes, beliefs, values, etc.) conflict, dissonance is produced. This dissonance is aversive and, as such, individuals should experience a subsequent drive to reduce or avoid it.[33] One way to accomplish this is by changing a cognitive element – for example, changing an attitude. However, as social judgment theory posits, attitudes and beliefs that are linked to overarching values or lifestyles (i.e., attitudes for which there is high ego-involvement) are particularly strong and difficult to change.[34] Research suggests that negative attitudes toward vaccines may be connected to such core values and lifestyles – for instance, some work has found anti-vaccine attitudes to be connected to aspects of motherhood,[35] linked to 'alternative living' lifestyles (e.g., preference for natural healthcare and remedies, vegan or vegetarian diet),[36,37] or tied to membership in a like-minded community.[37]

Thus, if one's perceives an anti-vaccine attitude to be consonant with important values such as these, shifting to a pro-vaccine attitude would introduce a sense of dissonance that, according to cognitive dissonance theory, individuals would strive to avoid. To this end, anti-vaccine websites could create strong anti-vaccine attitudes by linking anti-vaccine sentiment to important lifestyle norms and values. A pro-vaccine stance advocated in vaccine promotion messages, then, would be perceived as dissonant from one's core values and lifestyle, and would fall into a parent's latitude of rejection.

Inoculation theory

Finally, inoculation theory[31] provides additional theoretical grounding for our study. According to inoculation theory, a communicator advocating a particular position can engender resistance to a counter-position by 'inoculating' the audience against the opposing side's argument. There are several key ways that resistance to a counter-argument can be developed. One way this is accomplished is by providing an audience with a weakened form of the opposing side's position. Similar to the way a vaccine might introduce an attenuated form of a virus so that the patient's immune system is activated and becomes able to fight off the actual virus, inoculation theory posits that individuals who are exposed to a weakened form of an opponent's argument are better able to form counter-arguments and resist being persuaded by the opponent. This inoculation effect is strengthened when a communicator additionally provides refutation to an opponent's position. In the context of anti-vaccine websites, it is possible that anti-vaccine advocates could misrepresent arguments in support of vaccines, prompting individuals who read those misrepresented arguments to form counter-arguments in their own minds, or could provide arguments to refute pro-vaccine communication. Thus, attempts to derogate pro-vaccine advocates (by questioning their credibility or the merits of their scientific arguments) can strengthen anti-vaccine sentiment, making it more resistant to change, the same way in which anti-vaccine attitudes are formed and reinforced can cause them to be invulnerable to persuasion.[31,38]

Inoculation theory can also be used by pro-vaccine advocates by creating messages to inoculate individuals against anti-vaccine communication. For examples, doctors could warn expecting parents that they may encounter anti-vaccine information, and explain why this information is not credible. To this end, it is critical to monitor the specific anti-vaccine information being presented on the internet, as well as the persuasive tactics being used to forward this information, so that pro-vaccine communicators can develop tailored messages to inoculate individuals against such information.

Objectives

The three theories described above guide our inquiry into anti-vaccine websites. Social judgment theory highlights why strongly held attitudes (as anti-vaccine attitudes often are) can be so difficult to change. Cognitive dissonance theory contextualizes these strongly held attitudes in a broader network of cognitions, values and lifestyles. Identifying what the core values and lifestyles being linked to anti-vaccine sentiment are would allow vaccine promotion messages to align themselves with these values and lifestyle norms. Positioning vaccination as consonant with these overarching values and lifestyle norms would thus increase the chances of a vaccine promotion message falling within a parent's latitude of

acceptance and subsequently result in attitude change. Thus, our content analysis examined factors that could illuminate the extent to which anti-vaccine websites attempt to connect anti-vaccine sentiment to values and lifestyles by coding for the presence of different *lifestyle norms and values*.

Inoculation theory explains how presenting, and refuting, an opposing argument can bolster support for a position. In the context of vaccine communication, anti-vaccine advocates could misrepresent or derogate pro-vaccine messages. Thus, we also coded for *statements derogating the credibility of vaccine advocates*. On the other hand, pro-vaccine advocates could create messages to inoculate individuals against anti-vaccine positions. To accomplish this, pro-vaccine advocates must fully understand the messages being presented on anti-vaccine websites so that they can be addressed pre-emptively. To address this, we examined the specific *information about vaccines* being presented as well as the *persuasive tactics* being used to support these claims.

Methods

Selection of webpages

Our sample of 480 webpages was produced through a four stage filtering process (see Fig. 1). The sample of webpages was obtained through Google, Yahoo, and Bing searches of a series of vaccine-related terms such as 'baby vaccinations,' 'childhood vaccinations autism,' and 'MMR side effects'. We started with various combinations of the terms [childhood + vaccine(s) OR vaccination(s) OR immunizations(s) + side effects OR dangers]. We then entered these terms into Google Trends (http://www.google.com/trends/) to identify any related search terms. Ultimately, this procedure resulted in 92 search terms that were then entered into Google, Yahoo, Bing, and Ask. The top 100 results from each search were downloaded for a total of 27 594 URLs (six URLs were not successfully downloaded).

After excluding duplicate URLs, 7071 unique URLs remained. These URLs linked to different webpages. For the purposes of this study, we

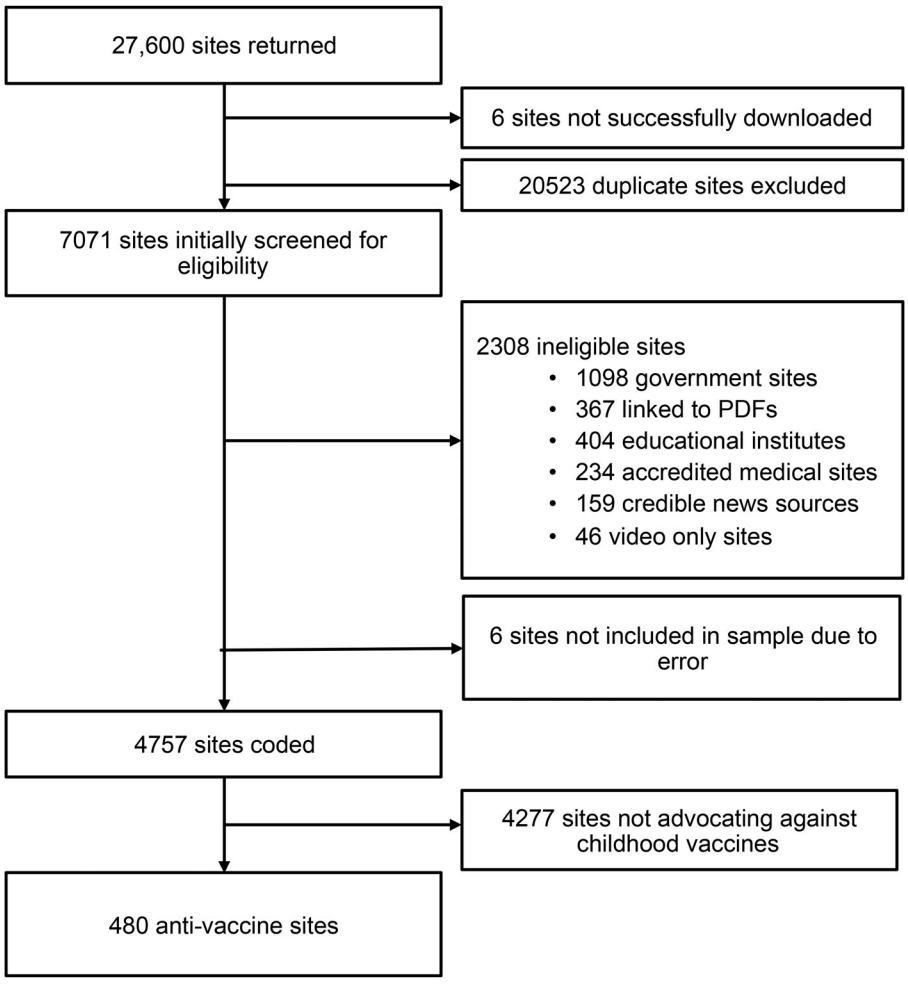

Figure 1 Flow chart documenting sampling procedure.

define a webpage using the APA 6 definition: 'a computer file on the web, displayed on a monitor or mobile device, which could provide text, pictures, or other forms of data'.[39] Thus, the webpages that the URLs linked to could include social media pages (e.g. an individual's profile, or group page), pages featuring video or audio files, pages that were only a PDF, as well as more common traditional web pages that featured primarily text and images. We then examined the webpages to which the URLS linked to determine their eligibility for inclusion in the study. Inclusion criteria were that the webpage be in English, not require downloading anything to view (for example, some URLs linked to PDFs), have primary text content other than video or audio that was produced by the content producer and explicitly advocate against childhood vaccinations. For example, no YouTube pages were coded because, although YouTube pages do contain text, we considered the primary content produced by the content producer (the YouTube user) to be the video. Excluding video and audio pages facilitated the efficiency of coding, as some videos and audio files were fairly long. To help manage the volume of pages, we first filtered out government pages (identified as those ending in '.gov'), webpages from known accredited medical organizations (e.g. AMA, Cleveland Clinic, AAFP), educational institutions (identified as those ending in '.edu') and sites that could be immediately recognized as mainstream, accredited news outlets (e.g. *Washington Post*, *New York Times*), due to the likelihood that these pages would not be advocating against vaccination. We also filtered out links to PDFs, online books, and videos, resulting in a sample of 4757 pages coded by the coders. Pages unrelated to childhood vaccinations or that advocated in favor of vaccines were coded as 'not advocating against childhood vaccinations', and were not further analyzed. This left a sample of 480 webpages that were identified as advocating against childhood vaccinations and further coded. Of the pages coded, non-profits, community groups, or local interest groups operated a majority of pages (45.8%). Fewer of the webpages were operated by individual (22.1%), news or journalistic organizations (18.1%), corporate organizations or businesses (13.3%), or religious organizations (0.2%).

Coding scheme

We used an iterative approach to develop codes, developing some codes a priori based on prior research.[16–21] Other codes were developed through a qualitative review of a selection of webpages and were refined iteratively. We coded for the content of the information presented about vaccines, the types of persuasive tactics used to forward the site's anti-vaccine claims, statements attacking the credibility of those promoting vaccines, and the presence of lifestyle norms and values linked to an anti-vaccine position.

Information about vaccines

This category coded for any specific information about the harms or risks of vaccines, or about their safety, effectiveness, or development. We coded for statements that specific diseases were linked to vaccines (e.g. that vaccines cause autism), as well as more general statements about vaccines' ingredients, safety, or efficacy (e.g. that vaccines contain mercury, that vaccines are inferior to natural immunity, that children are not at risk for vaccine-preventable diseases).

Persuasive tactics

We coded for different persuasive tactics used to support anti-vaccine statements. Specifically, we coded for the presence of anecdotes (e.g., a mom telling a story about how her child suffered after receiving a vaccine), the use of expert opinion (e.g. an article written by an author with the title 'Doctor', quotes from M.D.'s or Ph.D.'s or others with 'expert' credentials), and references to 'hard science', which consisted of references to journal articles or scientific studies. We also coded for the use of 'pseudo-scientific evidence', which we defined as general references to physiological, biological, or physiological processes, without the support of any specific study or report. This included 'popular epidemiology' and misunderstood or faulty science, such as inferring causation from correlation.

Statements derogating the credibility of vaccine advocates

This category encompassed statements presenting suspicion about an individual, organization, corporation, or overarching belief system (for example, doctors, the government, pharmaceutical companies, 'Western medicine'). We also coded more specifically about the nature of the mistrust to understand the rationale for why an entity is mistrusted (for example, that the mistrusted entity is lying, only out for money/profit, or simply misinformed).

Lifestyle norms and values

We coded for lifestyle norms and values that were presented alongside anti-vaccine statements. Lifestyle norms included various practices about health, wellness, and parenting, such as using

homeopathic medicine, eating organic food, and breastfeeding one's children. Values coded were individualism, freedom, independence/individuality, choice, religion, and natural-ness/holism (i.e., valuing a natural, unprocessed, and organic way of life).

Reliability

Four graduate student coders were trained and completed an initial reliability assessment on 30 pages. Acceptable reliability was set a priori as Krippendorf's $\alpha > .80$. Webpages used for training and reliability purposes were not included in the final sample of webpages coded. Two additional rounds of training and reliability coding of 30 pages were required for reliability across all four coders to be at an acceptable level. The webpages were then split evenly across all coders. Coders were directed to code only the landing page. This was done because our search protocol allowed for multiple pages within the same larger website to be returned and coded (for example, several subpages of mercola.com were returned in the search and coded), and thus allowed us to ensure no pages were double coded.

Coders were also directed to exclude any comments (for example, those posted by readers of a blog), embedded video or sound, or pop-up ads. All other content, including advertisements on sidebars, was coded. We opted to code advertisements because they are viewable to webpage visitors and could provide insight into the lifestyles or interests of these visitors (for example, if we found that a particular product was being advertised over and over across sites, that could indicate that such a product was relevant to typical visitors of anti-vaccine websites).

Results

Information about vaccines

Table 1 presents summary statistics for the variables coded; an online supplemental table displays these statistics by website type. About two-thirds of pages presented the non-specific belief that vaccines were dangerous. The beliefs that vaccines contained mercury and that mercury is dangerous were also common, occurring on just under half of the pages. Statements about vaccines containing thimerosal occurred less frequently, though still appeared on about one-third of pages. Pages also presented statements about vaccines being ineffective or weakening one's immune system. Fewer pages presented the beliefs that humans' immune systems were innately strong or that children were not at risk for contracting vaccine-preventable diseases. Some pages stated that vaccines were made from aborted fetuses or animals and animal by-products. Autism was the disease most commonly perceived to be associated with vaccines, while more general concerns about brain damage/injury or vague neurological effects (e.g. 'neurotoxicity') also occurred relatively often.

Statements derogating the credibility of vaccine advocates

Overall, anti-vaccine webpages expressed a great deal of mistrust in multiple entities. The government was the most common source of mistrust, followed by pharmaceutical companies and healthcare providers. This mistrust largely stemmed from the belief that the entity was lying or hiding the truth, that multiple organizations were conspiring together, and that the entity was directly responsible for causing harm. For example, in reference to the National Immunization Surveys, one page stated

> The U.S. Centers for Disease Control, which has been comprehensively exposed as a vaccine propaganda organization promoting the interests of drug companies, is now engaged in a household surveillance program that involves calling U.S. households and intimidating parents into producing child immunization records. (http://www.naturalnews.com/033717_CDC_National_Immunization_Survey.html).

Persuasive tactics

Anti-vaccine sentiment was promoted using several persuasive tactics. Many pages used the trappings of expert opinion (e.g., using the title of 'Dr.') or pseudo-scientific evidence (for example, confusing correlation for causation) to support their claims. For instance, one page claimed

> In 1975 Japan raised the minimum age for infant vaccinations to 2 years. As a result, SIDS (Sudden Infant Death Syndrome, or, crib death) and infant convulsions virtually disappeared. In the 80's, Japan lowered the minimum age back down to 3 months and the rate of SIDS returned to previous levels (http://blog.listentoyourgut.com/should-i-vaccinate-my-child/).

A smaller, yet not insignificant, number of pages used traditional (though potentially misinterpreted) scientific evidence to support their claims.

Table 1 Characteristics of anti-vaccine websites ($n = 480$)

	Number of websites, *n*	% of websites
Site sponsor/owner		
Non-profit/community organization/interest group	220	45.8
Individual	106	22.1
News or journalistic organization(a)	87	18.1
Company/corporate organization	64	13.3
Religious organization	2	0.4
Other	1	0.2
Type of site		
General website	201	41.9
News site or blog	210	43.8
Shopping/commerce	49	10.2
Shopping/commerce	49	10.2
Social media	9	1.9
Message board	8	1.7
Video site	3	0.6
Information about vaccines		
Vaccines are dangerous (general danger)	313	65.2
Vaccines contain mercury	218	45.4
Mercury is dangerous	202	42.1
Vaccines contain thimerosal	171	35.6
Thimerosal is dangerous	154	32.1
Vaccines will weaken one's immune system	136	28.3
Vaccines are ineffective	135	28.1
Too many shots in too short a time period is dangerous	100	20.8
Vaccines are made from animal products	75	15.6
Immunity from vaccines is inferior to natural immunity	69	14.4
Humans' immune systems are strong on their own	63	13.1
Vaccines are made from aborted fetuses	53	11.0
Children are not susceptible to vaccine-preventable diseases	35	7.3
Diseases associated with vaccines		
Autism, autism spectrum disorders	316	65.8
Brain damage, brain injury	204	42.5
Other neurological disorders	194	40.4
SIDS	161	33.5
Learning or developmental disabilities	140	29.2
Cancer	105	21.9
Decreased fertility	27	5.6
Asthma	26	5.4
Depression	21	4.4
Diabetes	18	3.8
Allergies	8	1.7
Mistrust in any vaccine advocate		
Government	377	78.5
Pharmaceutical companies	260	54.2
Doctors/healthcare practitioners	202	42.1
US medical system	116	24.2
Researchers/research	81	16.9
Mass media	74	15.4
Medical industry	50	10.4
Schools	37	7.7
Non-profits	23	4.8
Medical journals	18	3.8
Nonmedical corporations	10	2.1
Liberal/democratic political ideologies or parties	5	1.0
Conservative/republican political ideologies or parties	3	0.6
Nature of mistrust		
Mistrusted organization is lying/hiding the truth	321	66.9
Multiple organizations are conspiring together	212	44.2
Mistrusted organization is responsible for causing harm	205	42.7

Continued

Table 1 Continued

	Number of websites, *n*	% of websites
General suspicion of mistrusted organization	161	33.5
Mistrusted organization is out for profit or power	142	29.2
Mistrusted organization is uninformed/ignorant	106	22.1
Mistrusted organization is careless about one's well-being	89	18.5
Persuasive strategies		
Use of pseudo-science	321	66.9
Use of expert opinion	284	59.2
Anecdotal evidence	147	30.6
Use of hard science	145	30.2
Values		
Choice	155	32.3
Freedom	115	24.0
Natural/holism	89	18.5
Independence/individuality	88	18.3
Religion	43	9.0
Lifestyle norms		
References to alternative/non-western medicine	92	19.2
Messages about eating healthy	92	19.2
Messages about homeopathy	45	9.4
Messages about toxicity/cleansing	34	7.1
References to an organized religion	31	6.5
Messages about organic food	27	5.6
Messages about breastfeeding	22	4.6
References to holism	17	3.5
Messages about natural childbirth	13	2.7
References to spirituality	12	2.5
Messages about natural parenting	11	2.3
Messages about pesticides	9	1.9
Messages about homeschooling	8	1.7
Messages about attachment parenting	6	1.3
References to a healthy planet/environmental concerns	4	0.8
Messages about not circumcising one's child	1	0.2

Anecdotes were also used by about one-third of pages. One page, for instance, reported a mother's story about her child:

> 'He was hospitalized two days after the shot and he was running a fever of 103. And he was so hot that the nurse that was standing there could feel the heat radiating off his body.' Jeremy's mother Lynn said. For the last 29 years, Jeremy has not spoken an intelligible word (http://www.cbn.com/cbnnews/healthscience/2007/october/are-vaccinations-safe-for-your-kids/?mobile=false).

Values

Anti-vaccine sentiment was connected to several values. About one-third of pages presented the value of choice. Freedom and independence/individuality were also commonly expressed values. Natural or holistic values and religion occurred on many pages as well. One page, for example, linked vaccine refusal to freedom, stating 'We need to fight … for OUR COUNTRY, OUR CONSTITUTION, OUR FREEDOM, and OUR CHILDREN !!!' (http://www.jesus-is-savior.com/Health_Concerns/Vaccines/vaccinations_can_kill.htm). Another page discusses both freedom and choice, 'Parents are entitled to a full disclosure of *all* pertinent data and freedom to choose whether or not to vaccinate their children' (http://www.thinktwice.com/).

Lifestyle norms

Anti-vaccine sentiment corresponded with a variety of lifestyle norms. Just under one-fifth of pages advocated for alternative or non-western medicine (19.2%) or healthy eating (19.2%). References to homeopathy occurred on 9.4% of pages, while references to toxicity or cleanses occurred on 7.1%. Several other lifestyle norms, such as eating an organic diet, natural parenting and homeschooling were mentioned less frequently. One page, for instance, touted the benefits of breastfeeding: 'Breastmilk, of course, is a young child's lifeline. It naturally builds immunity during childhood development, and provides perfect and balanced

nutrition necessary for human growth' (http://www.naturalnews.com/034722_breastfeeding_vaccines_CDC.html).

Discussion and implications

Our findings indicate that anti-childhood vaccine webpages communicate much more than just (mis) information about vaccines. Anti-vaccine pages frequently questioned the safety and efficacy of vaccines, and presented statements that vaccines cause a variety of diseases. These statements were communicated using a wide array of persuasive tactics to influence information-seeking parents on the Internet. Many pages used what they represented as scientific evidence to support an anti-vaccination message. Anecdotal evidence in the form of stories or personal testimonials supplemented these 'scientific' arguments. Research from literature on the study of persuasion indicates that both of these strategies can enhance the persuasiveness of a message. Additionally, many pages appealed to readers' underlying values and ideologies – for example, many pages connected anti-vaccine sentiment to one's sense of individuality or freedom of choice. Pages also frequently connected anti-vaccine sentiment to broader lifestyle norms, such as using alternative or non-western medicine, homeopathy, and healthy eating. Table 2 presents a conceptual map linking the study's theoretical framework and coding scheme to specific recommendations based on the study's findings.

Particularly troubling is the extent to which these webpages claim that medical and public health organizations and systems, such as the government and doctors or healthcare practitioners, cannot be trusted. Many pages reported that these groups were lying, conspiring, and/or uniformed about the true dangers of vaccines. This is concerning because these entities are key disseminators of

Table 2 Conceptual map of theoretical framework, codes, and recommendations based on findings

	Social judgment theory	Cognitive dissonance theory	Inoculation theory
Relevant theoretical claim	People will reject messages that do not fall within their 'latitude of acceptance'	People have an innate drive for consistency among their cognitions, behaviors, values, etc.	Individuals can be biased to reject an argument by being presented with a weakened form of that argument
Application for general message design	Communicators should design messages to fall into audience's latitudes of acceptance	Communicators should highlight how the recommended behavior is consistent with the audience's existing values and lifestyle	Communicators should be aware of ways their position is being misrepresented by the opposing side
Translation to code for content analysis and rationale for code	Code for values and lifestyles being communicated on anti-vaccine websites so pro-vaccine communicators can integrate these values and lifestyles into their own messages, increasing the likelihood the message falls into the latitude of acceptance	Code for values and lifestyles being communicated on anti-vaccine websites so pro-vaccine communicators can demonstrate how vaccination is consistent with these values and lifestyles	Code for specific anti-vaccine statements, the persuasive tactics used to further them and attempts to derogate credibility so pro-vaccine communicators can inoculate individuals against anti-vaccine messages and pre-empt attempts of anti-vaccine advocates to derogate pro-vaccine messages
Exemplar recommendation based on study findings	Promote vaccination alongside other healthy, accepted behaviors (such as breastfeeding or healthy diets) to increase the likelihood of falling within a parent's latitude of acceptance	Messages can connect vaccination to values such as freedom and independence – for instance, by illustrating how keeping one's child healthy enables them to live a more free and independent life	Obstetricians can warn expecting parents that they may encounter anti-vaccine messages such as statements that vaccines are ineffective or weaken a child's immune system, and use both scientific evidence and stories/anecdotes to explain why they are inaccurate

information about childhood immunizations and gaining the trust of a target audience is a necessary component of successful health communication strategies.

As with any content analysis, one limitation of the current study is that parents may view these pages differently than the trained coders. Parents may skim over information, interpret information differently, or may not scroll all the way to the bottom of a webpage. Additionally, while our sample used many search terms to collect a large number of webpages from a diversity of websites, it is possible that our sample excluded other anti-vaccine websites. We also do not have information on which pages were most commonly visited by information seeking parents. However, the breadth of our sample increases the likelihood that the full spectrum of anti-vaccine sentiment is represented in our findings. Although we coded for the presence of scientific and pseudo-scientific content, we were interested in how these tactics were used as a persuasive strategy, and thus did not code for the veracity of such claims. Finally, the content on a webpage is often dynamic and can change over time – particularly in the case of advertisements, which may also vary from person to person. This ever-evolving content necessitates the need for continual monitoring so that pro-vaccine advocates are aware of misinformation that may be affecting parental vaccine decisions.

This study's findings point to several areas worth further research. Aspects of the webpages and content that we did not code for, such as the type of language used (e.g., the presence of scientific language) or the amount of text on the page, could affect the way in which audiences view the information on a page. There are also many website characteristics, such as the ability to comment on posts, look at videos or listen to audio, or even play interactive games, that we did not code for, but that could affect the way in which information on a webpage is interpreted. Additionally, it is possible that different combinations of information and presentation styles work together to affect parental vaccine opinions. For instance, the combination of anecdotes and scientific evidence may have a greater impact on parents than either tactic alone. It is also possible that different persuasive tactics may work conditionally depending on the specific piece of vaccine misinformation being presented. For example, statements about vaccine dangers could be more compelling when presented using scientific evidence, while statements about the lack of vaccine efficacy could be more powerful when coupled with statements expressing mistrust in doctors and scientists. While this line of inquiry was beyond the scope of the current study, it is worth studying in the future. Pursuing such research areas could help illuminate pathways through which parents are influenced against vaccinating their children.

Implications

These findings, in the context of our theoretical framework, shed light on why vaccine promotion interventions may have faced such difficulty persuading parents to vaccinate their children and offer potential strategies for vaccine promotion communication. The anti-vaccine webpages analyzed in this study engaged in a variety of techniques known to facilitate the formation of strong attitudes that are resistant to change. Often, attitudes that are connected to values and lifestyles are difficult to change[34] because they are central to one's identity. Moreover, statements of mistrust in doctors, government, and others who advocate for vaccination act as reinforcements to anti-vaccine attitudes and may inoculate parents against pro-vaccine messages.

Findings from this study can be leveraged by pediatricians and others who communicate about vaccination to develop more effective vaccine promotion strategies. First, research related to credibility and trust indicates that health information will be more readily accepted when it comes from a trusted source.[40] Thus, it is important to work to build trust with communities of vaccine hesitant parents. Additionally, pediatricians and others could consider partnering with organizations already trusted by these communities as a way to disseminate vaccine promotion messages. These organizations could include businesses and organizations promoting natural or holistic health. For instance, a pediatrician may find that a natural foods store in her or his community is particularly trusted by vaccine hesitant parents. This pediatrician could work with the store owners to host a vaccine education workshop, or could ask the store to disseminate vaccine education flyers. Vaccine promotion messages could also incorporate a variety of techniques, such as bolstering scientific evidence with the use of vivid and compelling anecdotes or personal testimonials. For example, a vaccine education brochure could feature statistics on the safety and efficacy of vaccines, and then bring the statistics to life by sharing the story of a family whose child got a vaccine-preventable disease.

Similar to how anti-vaccine websites may produce strong anti-vaccine attitudes by derogating the

credibility of those who promote vaccines, vaccine promotion communication could take a similar approach to inoculate individuals against anti-vaccine messages. Wong and Harrison[41] tested this strategy regarding the HPV vaccination. Results of this study indicate that parents who were exposed to an inoculation message that presented arguments denying the safety of vaccines and then refuted those arguments had stronger perceptions of vaccine safety and efficacy than parents not exposed to the inoculation message. Healthcare providers and communicators could leverage the principle of inoculation by alerting patients to the battery of arguments forwarded by anti-vaccine advocates, and then explain why those arguments are inaccurate. For example, when a woman first becomes pregnant, her obstetrician could warn her about anti-vaccine information and explain why common statements – such as vaccines causing autism – are not true. This way, when the woman encountered anti-vaccine information, she would be armed to accurately interpret it, thus reducing its persuasive effect.

Finally, health decisions are often informed by a variety of additional factors such as affect, values, norms, and ideology.[42] As such, individuals may reject an evidence-based educational message in order to remain consistent with deep-seeded values and principles.[43] We found that negative sentiment toward vaccines may be connected to strongly held values or lifestyles among some individuals. As such, vaccine education materials should ensure that their overarching message resonates with vaccine hesitant parents' values and lifestyle, which should increase the likelihood that a vaccine promotion message falls within a parent's latitude of acceptance. Our study found that many anti-vaccine webpages promoted positive health behaviors as well, such as healthy eating and breastfeeding. Vaccine education can take these factors into account and attempt to find common ground with vaccine hesitant parents. For instance, childhood vaccination could be framed as part of a holistic health plan for a child that also includes breastfeeding and healthy eating. This can help overcome the risk that pro-vaccine communications further alienate vaccine hesitant parents.

Vaccine education can also connect to values of choice, freedom and independence, making sure not to engage in messaging that could be interpreted as restricting freedom or choice. Those communicating about vaccines can explain how vaccinating one's child facilitates freedom and independence – for example, noting that one's child will be protected from diseases that could otherwise prevent him or her from living a full and healthy life. Additionally, given the extent to which negative sentiment toward vaccine may be difficult to change once it is already formed, it is important to communicate the benefits of childhood vaccination to individuals before they become parents, and thus may not yet have developed negative attitudes toward vaccines. Finally, pediatricians and healthcare providers can offer guidance on navigating the complex world of online vaccination information, alerting parents that the persuasive nature of anti-vaccine websites may obscure faulty reasoning and unfounded scientific claims.

Conclusion

Anti-vaccine websites provide a useful lens to understand why anti-vaccine sentiment can be so difficult to change. By understanding how these sites go about persuading parents to resist or delay vaccinating their children, pediatricians, public health organizations, and others who communicate about vaccines can better develop effective pro-vaccination messages.

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ORCiD

Meghan Bridgid Moran http://orcid.org/0000-0001-6745-6668

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Author information

Meghan Bridgid Moran is an assistant professor in the Department of Health, Behavior & Society at the Johns Hopkins University Bloomberg School of Public Health. She received her BA from the University of Pennsylvania, and her MA and PhD from the Annenberg School for Communication & Journalism at the University of Southern California. She studies the influence of mass media and pop culture on health, focusing on tobacco use, vaccine communication, and cancer prevention.

Melissa Lucas earned her M.A. degree in Communication from San Diego State University (SDSU) and B.A. degrees in Communication Studies and Political Science from University of San Diego. She is currently a Ph.D. student in the Department of Communication at the University of Maryland, College Park. Her research focuses on rhetoric in communication.

Kristen Everhart is a Ph.D. student in the Department of Communication Studies at University of Nebraska–Lincoln. She received a B.A. and M.A. in Communication from SDSU. She studies how people's communication practices shapes their decision making processes.

Ashley Morgan received a B.A. from Carthage College and an M.A. in Communication from SDSU. She is vice-president of operations at Reality Changers and has served as a lecturer at SDSU. She studies quantitative approaches to intercultural and relational communication.

Erin Prickett received a B.A. in Communication Studies and Spanish from University of San Diego and an M.A. in Communication from SDSU. She is currently faculty in the Communication Studies department at University of San Diego. Her research interests include health communication and interpersonal communication.